DOCTORAL DISSERTATION

Study on Recycling and Planning of Rural Wastewater in Zhejiang, China

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ABSTRACT

With the rapid development of China's social and economic development, the speed of urbanization construction has been accelerating, and various environmental pollution problems have gradually emerged. China has about 604 million people living in the countryside, it is estimated that about 50 million cubic meters of domestic sewage can be produced every day, and, the amount of water and drainage of rural life is increasing. However, due to the rural sewage collection and treatment facilities have been relatively lagging behind the construction of the city, a large number of rural sewage is directly discharged every day because it is not collected and treated. The accumulation of these sewage in the environment over time, far beyond the environmental capacity of its discharge river and lake water bodies, resulting in most of China's watershed water environment has been polluted to varying degrees, and the phenomenon of "water is dirty" and "water body black odor" is common, which has become This has become an important bottleneck that restricts the construction of ecological civilization in China's rural areas and the realization of a well-off society. This shows that the future of rural sewage treatment market demand is huge.

Among them, Zhejiang province is economically developed, with the increasing urbanization of Zhejiang province, the demand for various types of water resources is increasing, resulting in an oversupply of water resources. In particular,Zhejiang province vigorously develops industry, which brings more waste water while increasing water consumption, increasing the risk of water environment pollution. The rapid development of industrialization in Zhejiang province and the change in the lifestyle of rural residents, coupled with the larger total size of the rural population and more dispersed living, have caused serious damage to the local rural ecological environment. The garbage generated by villagers in their daily lives, pollutants brought by agricultural production and industrial waste from township enterprises have caused varying degrees of damage to the water environment in rural areas. Moreover, the treatment of domestic and industrial sewage rural wastewater seems more complicated compared to urban sewage treatment, so the pollution of the water environment is more serious. And in rural areas, constrained by the dual economic structure of urban and rural areas and centralized development policies, the lack of water infrastructure and the great development of rural enterprises, bringing such as water shortages, unsafe drinking water, water pollution and arbitrary disposal of wastewater and a series of problems, the rural water environment is under enormous pressure.

Therefore, the effective prevention and control of rural water environment pollution will become one of the difficulties and challenges facing the sustainable development of rural areas. At present, whether it is the technical model or the business model, there are few mature models

available abroad for China's rural wastewater treatment. Based on this, this paper, based on the theory of "sustainable development", starts from the concept and role of wastewater resource utilization, applies the theory of "sustainable development" to the study of countermeasures of wastewater resource utilization and water resources planning on the basis of the integration of disciplinary results, deepens and improves the existing Based on the integration of disciplinary achievements, we apply the theory of "sustainable development" to the study of countermeasures for wastewater resourceization and water resources planning, and deepen and improve the existing water resources planning theory, and form a water resources planning theory based on the concept of "sustainable development "theory.

Taking the rural areas in Zhejiang province as the main research object, through the analysis of rural water resources and their utilization characteristics, the concept of "sustainable development" is extended downward to pay more attention to water resources system issues and rural special situations; while water resources planning is extended upward, with "sustainable development " "intelligent water" concept, while horizontally combined with the local characteristics of rural areas, the formation of "sustainable development" based on the rural water resources planning methods, to change the current situation of water resources system passive response to social and economic development. At the same time, we draw on some successful experiences of rural water pollution management in foreign countries, and combine them with the actual situation of rural areas in Zhejiang province to propose countermeasures and suggestions suitable for local rural water pollution management and water resources planning, so as to provide methodological guidance and experience for sustainable planning of rural water resources in Zhejiang province , which in turn can provide vivid research materials for rural water pollution management in the south of China, and provide a good basis for China.In turn, it can provide fresh research materials for the management of rural water pollution in southern China, and provide a systematic and complete reference basis for the management and planning practice of rural water environment in China.

In Chapter 1， RESEARCH BACKGROUND AND PURPOSE OF THE STUDY. Firstly, the background and purpose of the study are outlined. The background to the issue of optimising water resources systems is presented from a number of perspectives, and the significance of the research is pointed out. A comprehensive overview of the global water resources crisis and the water resources situation in China is presented, together with an analysis of the current situation and models of rural wastewater management of international. It also provides an overview of the history and progress of domestic and international research. Finally, the content and framework of the study are presented.

In Chapter 2， THEORIES AND METHODOLOGY OF WASTEWATER RECYCLING AND PLANNING . Briefly introduces the theory of sustainable development, the theory of wastewater resourceisation and the theory of water resources planning. Based on an analysis of the characteristics of water resources in Zhejiang, the current water problems and their harmful effects on socio-economic development are identified and corresponding countermeasures are proposed. On the basis of the integration of disciplinary results, the theory of "sustainable development" is applied to the study of the countermeasures of wastewater resourceisation and water resources planning, deepening and improving the existing water resources planning theory, and forming a water resources planning theory based on the concept of "sustainable development "theory.

In Chapter 3，ANALYSIS OF THE STATUS QUO AND COUNTERMEASURES OF WATER POLLUTION IN ZHEJIANG RURAL AREAS. Wastewater treatment is the basis of water resources recycling and a prerequisite for better implementation of wastewater resource utilization, which is related to the survival and development of human beings. Nowadays, the situation of water recycling in Zhejiang is not optimistic, water resources are wasted and polluted, and water conflicts are also very acute. First of all, the current situation of water pollution in Zhejiang and the current situation of rural sewage treatment systems are analysed. The existing policy measures and difficulties in the treatment of rural wastewater are pointed out, and measures are proposed to address the problems in the resourceisation of rural wastewater and the recycling of water resources .

In Chapter 4， INVESTIGATION ON WATER POLLUTION DATA FOR WATER PROTECTION MEASURES—CASE STUDY ON SHANGYU. In this chapter, taking Shangyu in Zhejiang Province as an example, based on the investigation and analysis of water resources and water environment of point and surface pollution sources, carried out water function zoning, pollution capacity calculation, pollutant input estimation, proposed pollutant control and reduction amounts .On this basis, study the countermeasures for water environment protection in Shangyu , and take engineering and non-engineering measures to gradually restore the self-purification capacity of the rivers .

In Chapter 5，TECHNOLOGY RESEARCH OF WASTEWATER RECYCLING. Analyzed the requirements and uses of wastewater recycling and typical technology for wastewater recycling. Studied the use of membrane separation technology in the recycling of water resources and the conversion of salt in wastewater into resource.A combination zero liquid discharge of RO, ED and BMED for salt concentration and acid/base production, with optimal operating parameters, is proposed to process the cold-rolling wastewater.And the electrodialysis bipolar membrane technology was applied to the high-salt leachate recovery process of Shangyu rural landfill.

In Chapter 6，STUDY OF WASTEWATER PLANNING —CASE STUDY ON SHANGYU . A case study of wastewater planning using Shangyu as an example. Firstly, on the basis of an overview of the social-economic and water resources profile of Shangyu, the results of wastewater resourceization are analysed. This is followed by a survey of the current drainage situation and recommendations for the development and use of water resources in Shangyu .Formation of a flow chart for planning the main network of the sewage system in Shangyu .

In Chapter 7，CONCLUSION AND PROSPECT. This chapter summarises the management of pollution in the rural water environment and provides suggestions for the future implementation of water resources planning.

江 功艺 博士論文の構成

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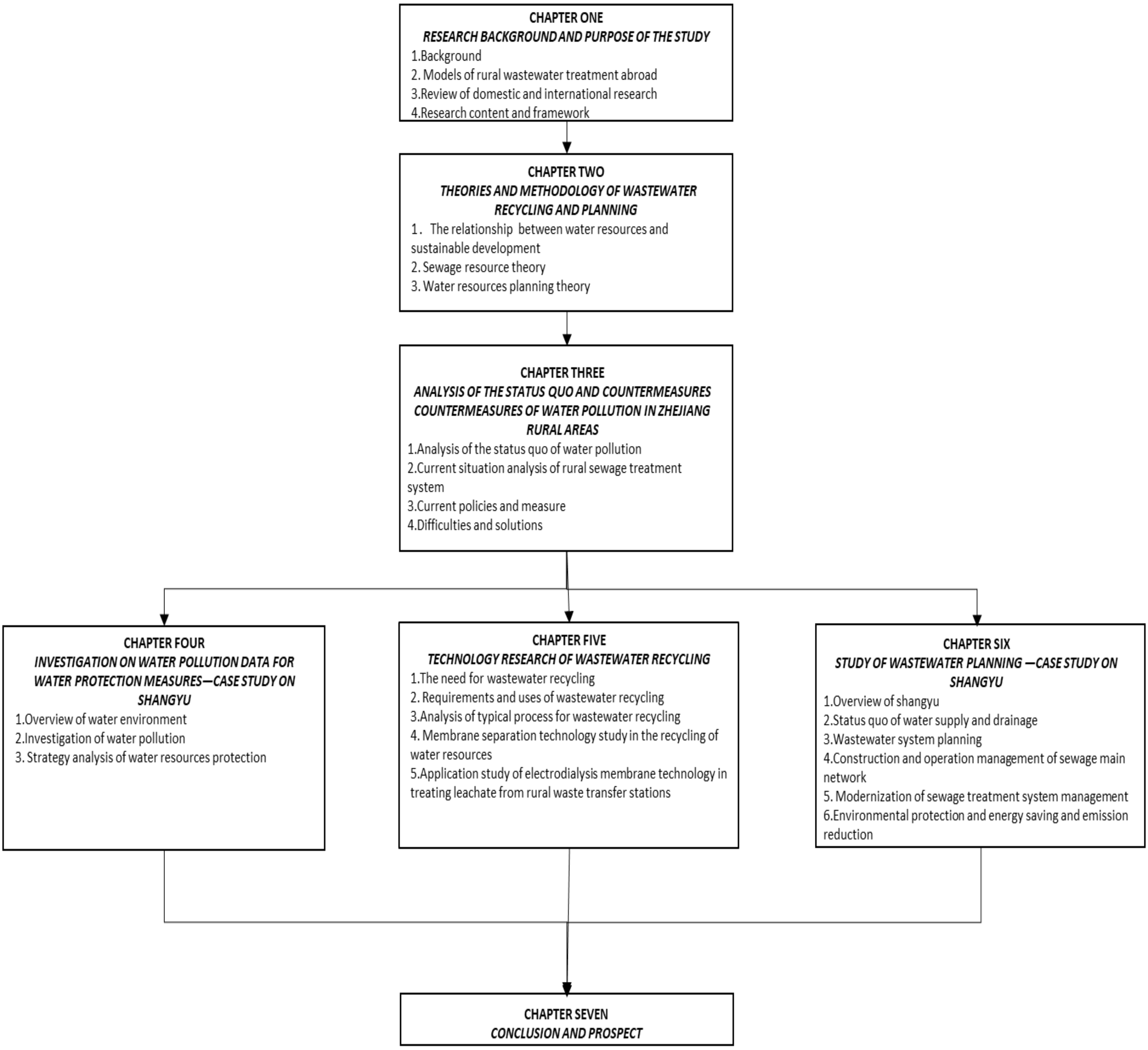

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Chapter1

RESEARCH BACKGROUND AND PURPOSE OF THE STUDY

CHAPTER ONE: RESEARCH BACKGROUND AND PURPOSE OF THE STUDY

1.1 Background

1.1.1 The global water crisis

Water is an irreplaceable basic natural resource for human survival and development, as well as a strategic economic resource . It has important life, production and ecological value, and is a qualitative indicator to measure a country's comprehensive national strength.

The total amount of water resources on the earth is 13.9 billion cubic meters, but the total amount of freshwater resources is very limited, accounting for only 2.5% of the total water [1], of which only about 427 billion cubic meters form surface runoff that constitutes humankind. The amount of "blue" water resources that can be used [2]. However, due to the influence of geographical distribution and seasonal changes, only 120 million cubic meters of these waters form a stable runoff, which can be easily utilized and renewed by humans.

According to the comprehensive assessment of global freshwater resources by the United Nations, taking 1,700 cubic meters of water resources per capita per year as an indicator of water stress, about one-third of the world's population lives in areas with moderate or severe water stress ; about 41% 2.3 billion people live in water-stressed situations; 1.7 billion of them live in high water-scarce conditions (less than 1,000 cubic meters of water per capita). Water scarcity has become a worldwide problem.

On August 28, 2002, the plenary session of the World Summit on Sustainable Development was held in Johannesburg, which listed the water crisis as one of the most serious challenges facing humanity in the next 10 years . Materials published by the Congress stated that 1.1 billion people worldwide currently lack access to safe drinking water and 2.4 billion people lack adequate water sanitation facilities . The United Nations predicts that the world's freshwater demand will increase by 40% by 2025, when nearly half of the world's population will live in water-scarce regions. And now , areas of water scarcity or water stress are expanding, especially in North Africa and West Asia . Another research report from the World Water Council also stated [3]: In 1990, 300 million people in 26 countries were plagued by freshwater shortages ; in 2025, more than 40 countries, accounting for 30% of the global population, will suffer from water shortages. The impact of shortages; in 2050 , 65 countries, representing 60% of the global population, will face freshwater crises . The water crisis has seriously restricted the sustainable development of human beings. As a developing country , China's water resources problems are more prominent , and its severity is worse than the world average. Not only the per capita water resources and water utilization are far below the world level , but also facing the trend of rapid increase in water demand .

It is a relative shortage of water resources in China. The national average total water resources for many years is 2,770.8 billion cubic meters , and the per capita water resources are less than 1/4 of the world average. At the same time, there are still problems such as uneven spatial and temporal distribution of water resources in my country, and incompatibility with population, land resources and mineral resources, which further increases the difficulty of water resources development and utilization. The coexistence of water pollution, water waste and water shortage is an important reason for the contradiction between water supply and demand .

The report of the "19th National Congress of the Communist Party of China" proposed to "speed up the prevention and control of water pollution, implement a comprehensive management system for the basin environment and coastal waters", and "build an environmental governance led by the government, with enterprises as the main body, and social organizations and the public participating together". In recent years, the serious water pollution situation in China has not been fundamentally curbed, and the water environment quality has not been fundamentally improved. 1/10 of the surface water in the country still has a sub-category V water quality, and about 1/5 of the lakes show varying degrees of water quality. Eutrophication, according to the nutrient status monitoring results of 56 lakes (reservoirs), 5.2 % (3) were moderately eutrophic , and 17.2% (10) were mildly eutrophic; About 2,000 urban water bodies are black and odorous, and pollution problems such as nitrogen and phosphorus have become increasingly prominent.

According to the data of "China Water Resources Bulletin 2018 " [4] , the water quality status of 262,000 km of rivers nationwide was evaluated in 2018, and the river lengths of Class I-III, Class IV-V , and Class V inferior to the evaluated rivers respectively accounted for The main pollution items are ammonia nitrogen, total phosphorus and chemical oxygen demand. Compared with the same period in 2017, the proportion of river lengths with waters of class I to III increased by 1.0 percentage points, and the proportion of rivers with waters inferior to class V decreased by 1.3 percentage points. The water quality of 124 lakes with a total surface area of 33,000 km^2 was evaluated , and the lakes of Class I-III, Class IV-V, and inferior to Class V accounted for 25.0%, 58.9% and 16.1% of the total evaluated lakes, respectively. The main polluting items are total phosphorus, chemical oxygen demand and permanganate index. The evaluation results of nutritional status of 121 lakes showed that mesotrophic lakes accounted for 26.5%; eutrophic lakes accounted for 73.5%. Compared with the same period in 2017, the proportion of lakes with water quality of Class I to III decreased by 1.6 percentage points, the proportion of lakes inferior to Class V decreased by 3.3 percentage points, and the proportion of eutrophic lakes decreased by 1.7 percentage points. 1129 reservoirs were evaluated for water quality, and the reservoirs of Class I-III, Class IV-V, and inferior to Class V accounted for 87.3%, 10.1% and 2.6% of the total evaluated reservoirs, respectively. The main pollution items are total phosphorus, permanganate index and 5-day biochemical oxygen demand. The evaluation results of the nutritional status of 1097 reservoirs showed that the mesotrophic reservoirs accounted for 69.6% and the eutrophic reservoirs accounted for 30.4%. Compared with the same period in 2017, the proportion of reservoirs with water quality of Class I to III increased by 1.5 percentage points, the proportion of reservoirs with water quality inferior to Class V remained the same, and the proportion of eutrophication increased by 3.1 percentage points. Water quality in water function zones In 2018, 6,779 water function zones were evaluated nationwide, and 4,503 of which met the water functional targets accounted for 66.4% of the total number of water function zones evaluated. Among them, the first-level water function areas (excluding development and utilization areas) that meet the water function goals accounted for 71.8%; the second-level water function areas accounted for 62.6%. Water Quality at Provincial Boundary Sections In 2018, among the 544 important provincial boundary sections across the country, the proportions of Grade I-III, Grade IV-V, and Grade V inferior sections accounted for 69.9%, 21.1% and 9.0% of the total assessed sections, respectively. The main polluting items are total phosphorus, chemical oxygen demand and ammonia nitrogen. Compared with the same period of 2017, the proportion of sections of Class I to III increased by 2.6 percentage points, and the proportion of sub-category V fell by 3.9 percentage points. Water quality evaluation has been carried out on 2833 groundwater monitoring wells across the country, and the monitoring layers are mainly shallow groundwater. The water quality monitoring wells of Class I-III, Class IV and Class V accounted for 23.9%, 29.2% and 46.9% of the total evaluation monitoring wells, respectively. The main pollution items are manganese, iron, total hardness, total dissolved solids, ammonia nitrogen, fluoride, aluminum, iodide, sulfate and nitrate nitrogen. Among them, heavy metal projects such as manganese, iron, and aluminum, and inorganic anion projects such as fluoride and sulfate may be affected by the background of hydrogeology and chemistry. A total of 1,045 centralized drinking water sources were evaluated in 31 provinces (municipalities and autonomous regions), and the water sources with an annual water quality qualification rate of 80% or above accounted for 83.5% of the total number of evaluations. Compared with 2017, it increased by 1.2 percentage points .

According to the data of "China Ecological Environment Bulletin 2019 " [5] , in 2019 , among the 1,931 water quality sections (points) monitored by the national surface water , 74.9% were Grade I-III water quality sections (points) , which was higher than that in 2018 . Year-on-year increase of 3.9 percentage points; inferior V category accounted for 3.4% , down 3.3 percentage points from 2018 . The main pollution indicators are chemical oxygen demand, total phosphorus and permanganate index. In 2019 , among the 1,610 water quality sections monitored in the seven major river basins of the Yangtze River, the Yellow River, the Pearl River, the Songhua River, the Huai River, the Haihe River, and the Liaohe River, as well as rivers in Zhejiang and Fujian, rivers in the northwest, and rivers in the southwest, 79.1% were Grade I-III water quality sections . , an increase of 4.8 percentage points over 2018 ; inferior V category accounted for 3.0% , a decrease of 3.9 percentage points over 2018 . The main pollution indicators are chemical oxygen demand, permanganate index and ammonia nitrogen. The water quality of the northwestern rivers, the rivers in Zhejiang and Fujian, the southwestern rivers and the Yangtze River Basin is excellent, the water quality of the Pearl River Basin is good, and the Yellow River Basin, Songhua River Basin, Huai River Basin, Liao River Basin and Haihe River Basin are slightly polluted.

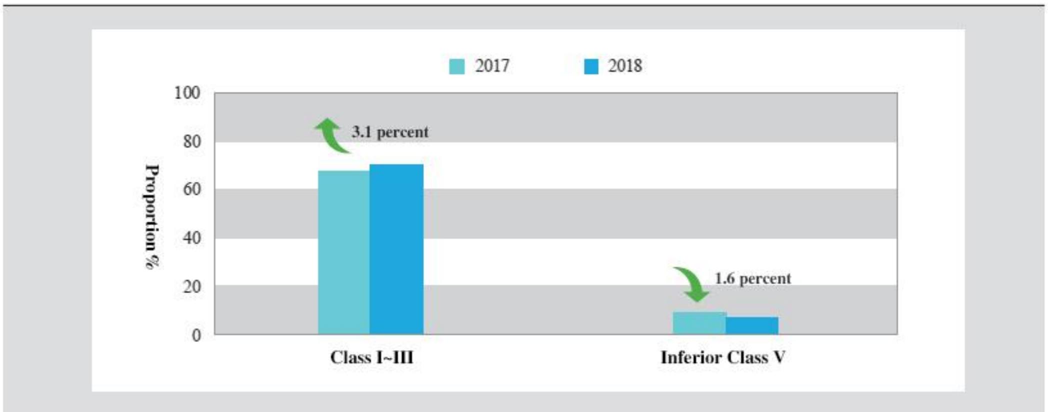

Fig.1-1 Annual comparison of national surface water quality categories in 2018 [4]

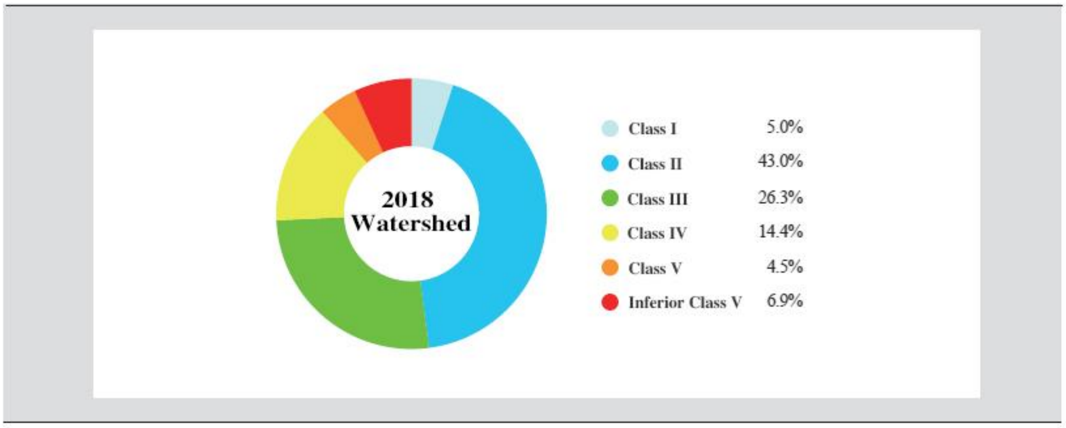

Fig.1-2 The overall water quality of the national river basin in 2018 [4]

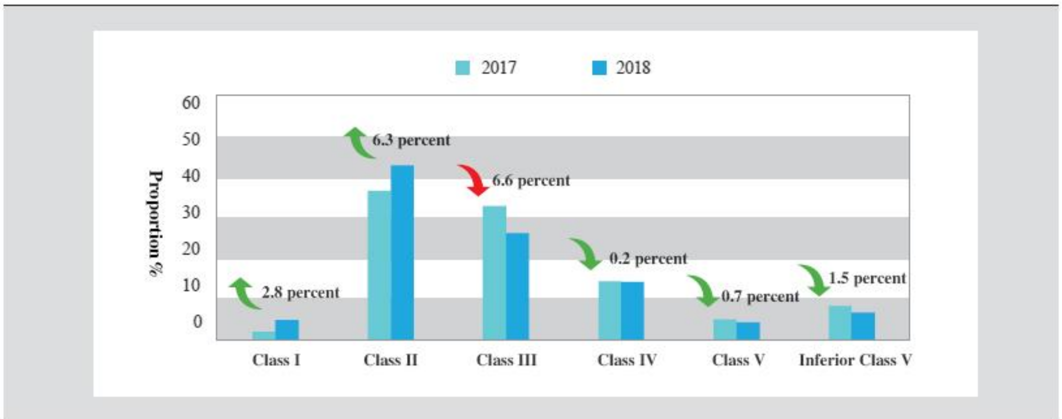

Fig.1-3 Inter-annual comparison of the overall water quality of the national river basin in 2018 [4]

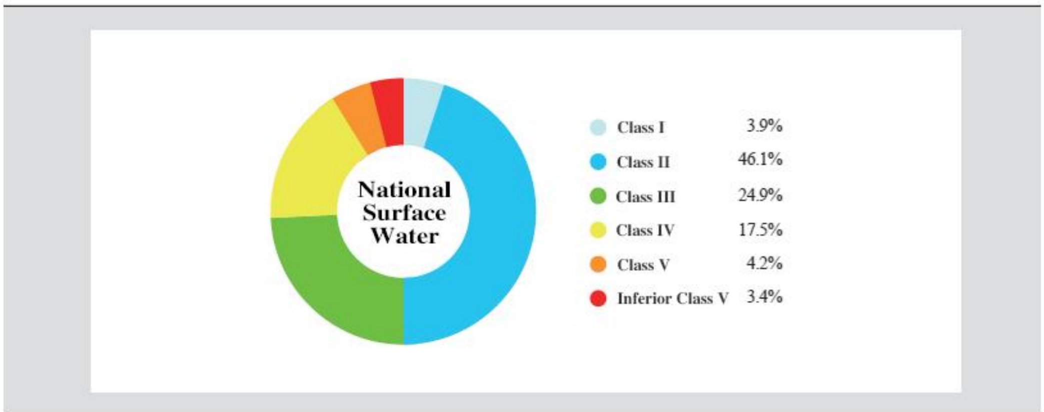

Fig.1-4 The overall water quality of national surface water in 2019 [5]

It is seen that the water pollution is serious and the ecological environment is destroyed . With the development of industry and agriculture and the increase of people's domestic water consumption, the discharge of industrial wastewater and domestic sewage has increased sharply. Arbitrary discharge of untreated sewage deteriorates the quality of the water environment, reduces the effective utilization of water resources, and further aggravates the shortage of water resources. Nearly half of the country's rivers and 90% of urban waters are polluted to varying degrees. The soil erosion area in the country is 3.67 million square kilometers, accounting for 38% of the country's land area.

Shortage of water resources and the prominent contradiction between supply and demand are not only related to the characteristics of water resources and serious water pollution, but also related to the waste of water resources. The utilization rate of water resources in China is low, and there is a big gap with developed countries. Agriculture is a large user of water, and water waste is the most serious. The utilization rate of agricultural water is 30-40 %, while that in developed countries is 70-80 %. In terms of industry, due to the backward production technology and the low reuse rate of water, the water consumption per unit product is significantly different from that of developed countries [3]. For example, synthetic ammonia in China consumes 500-1000 tons of water per ton, while only 12 tons in developed countries; similarly, China consumes 400-500 tons of water per ton of paper , while in developed countries it is 5-20 tons . In addition, the leakage of urban water supply pipes and drainage pipes cannot be ignored.

1.1.2 The situation of water resources

In May 2016, the State Council approved the "Yangtze River Delta Urban Agglomeration Development Plan", which covers a total of 26 cities in Shanghai and most of Jiangsu, Anhui, and Zhejiang provinces , namely Nanjing, Nantong, Wuxi, Zhenjiang, Zhou, Taizhou, Suzhou, Yangzhou, Yancheng, Hefei, Maanshan, Chuzhou, Chizhou, Tongling, Cheng, Wuhu, Anqing in Anhui Province, Hangzhou, Jiaxing, Jinhua, Huzhou, Taizhou, Ningbo, Shaoxing, Zhoushan in Zhejiang Province.

Yangtze River Delta region is the most economically developed region in China. After more than 30 years of urbanization and industrialization , the economy and society have achieved great development, but to a certain extent, the ecological system has been overloaded and the environment has been sacrificed. In particular, the long-term wastewater discharge and non-point source pollution with a wide range of sources have led to widespread pollution of rivers, lakes, and offshore waters in the Yangtze River Delta region, the water environment has continued to deteriorate, and the water ecology has been severely degraded. In 2014, the total amount of wastewater discharged in the Yangtze River Delta was 12.406 billion tons, accounting for about 17.32% of the national total. The increasing water pollution has made the Yangtze River Delta region one of the regions with the most prominent water environment problems in the country: In 2015 , 45.27% of the cross-sections of the Yangtze River Delta state-controlled surface water quality conformed to Class III , far below the national average of 64.5%. ; Only 14.7%, 48.2%, and 72.9% of the city's state-controlled surface water quality conforms to Class III, respectively, and the main pollutants are ammonia nitrogen and total phosphorus; in 2014, the per capita water occupancy was only 993.32 m^3 , lower than the national average. 2001.31m^3 , the contradiction between supply and demand of water resources is very prominent, and water environment problems have increasingly become a restrictive factor for the sustainable development of the

Yangtze River Delta region. Therefore, strengthening water pollution control in the Yangtze River Delta region is of great significance for promoting the green and sustainable development of the Yangtze River Delta and even China .

The "Thirteenth Five-Year Plan" clearly proposes to "build a world-class urban agglomeration in the Beijing-Tianjin-Hebei, Yangtze River Delta, and Pearl River Delta". The long-term and high-intensity economic development of urban agglomerations has also caused them to face severe resource and environmental problems. The unreasonable use of foreign capital and the transfer of carrying industries are acting as "water pollution shelters" for some developed industrial countries. The excess energy and pollution released have caused urban agglomerations or economic belts to gradually evolve into "pollution clusters" and "pollution belts". , this severe situation is common in major river basins and urban agglomerations .

The water quality of most of the main streams in the Yangtze River Delta region declines slightly every year, and the water quality of some branches and main streams such as the Qiantang River is relatively stable, but the water quality in urban areas has deteriorated more seriously, generally maintained at the level of III - V, which is one level worse than that in non-urban areas. The eutrophication phenomenon of lakes and reservoirs is more prominent , ranging between mild and moderate eutrophication. In recent years, the nutrient status of each lake area in Taihu Lake is mild to moderate eutrophication, while other lake areas are more concentrated in moderately eutrophic. Nutrition; the main factors of water pollution in the Yangtze River Delta come from urban industrial and domestic sewage. The continuous accumulation of pollutants has far exceeded the self-purification capacity of lakes and reservoirs. The quantity of pollutants is large but the environmental capacity of lakes is limited, resulting in the inability to improve water quality and long-term There is also a trend of continued deterioration.

According to the data of "China Ecological Environment Bulletin 2019 " [5] , the water quality of the Yangtze River Basin is excellent. Among the 509 water quality sections monitored, 91.7% were Grade I-III water quality sections , up 4.2 percentage points from 2018; 0.6% were inferior to Grade V , down 1.2 percentage points in 2018 . Among them, the water quality of the main stream and main tributaries is excellent.

Water body	Number of sections (pieces)	Proportion (%)						Change from 2018 (%)					
		Class I	Class II	Class III	Class IV	Class V	Inferior Class V	Class I	Class II	Class III	Class IV	Class V	Inferior Class V
watershed	509	3.3	67.0	21.4	6.7	1.0	0.6	-2.4	12.3	-5.7	-2.3	-0.8	-1.2
main stream	59	6.8	91.5	1.7	0.0	0.0	0.0	0.0	13.5	-13.6	0.0	0.0	0.0
main tributaries	450	2.9	63.8	24.0	7.6	1.1	0.7	-2.6	12.1	-4.6	-2.6	-0.9	-1.3
Provincial boundary section	60	3.3	81.7	13.3	1.7	0.0	0.0	-8.4	11.7	0.0	-3.3	0.0	0.0

Fig.1-5 The water quality of the Yangtze River Basin in 2019 [5]

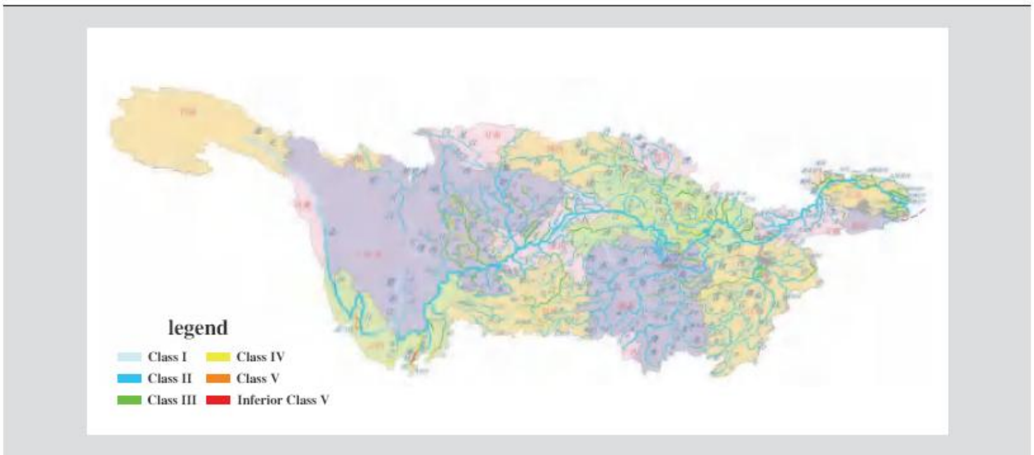

Fig.1-6 Schematic diagram of water quality distribution in the Yangtze River Basin in 2019 [5]

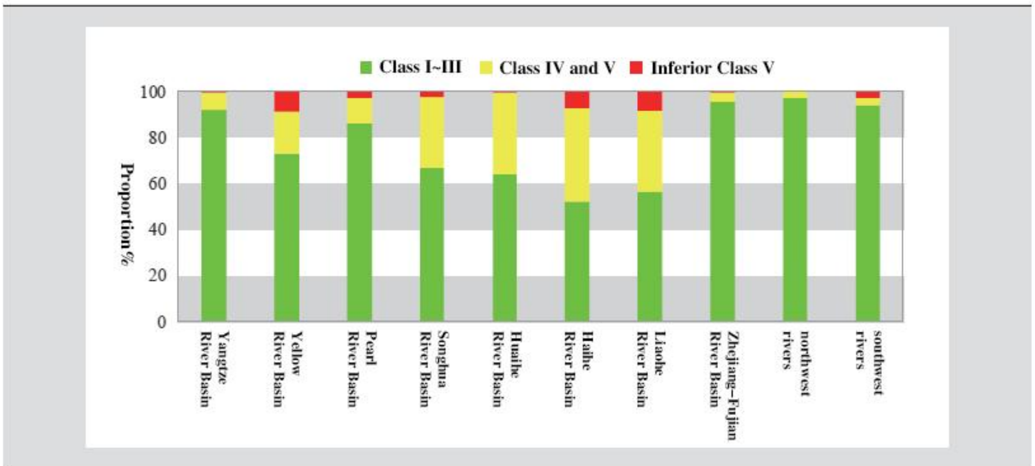

Fig.1-7 Water quality status of seven major river basins and rivers in Zhejiang and Fujian, rivers in the northwest, and rivers in the southwest in 2019 [5]

Strengthening water pollution control in the Yangtze River Delta region and promoting the green and sustainable development of the Yangtze River Delta and even China have become China's future development trends and strategic goals. However , with the rapid development of the Yangtze River Delta region , the dysfunction of the urban natural ecosystem has brought about a series of urban ecological problems, which have seriously affected the healthy and sustainable development of the city. How to take the development of cities and towns in the Yangtze River Delta as an opportunity to improve the quality of the urban ecological environment and the living environment is a major issue that we face and must solve.

On April 2, 2015, the State Council issued a notice on the water pollution prevention and control action plan, which generally requires the full implementation of the spirit of the 18th National Congress of the Communist Party of China and the spirit of the 2nd, 3rd, and 4th Plenary Sessions of the 18th Central Committee, vigorously promoting the construction of ecological civilization, in order to improve water quality. Environmental quality is the core, in accordance with the principle of "water saving priority, space balance, systematic governance, and two-handed efforts", implement the "safety, clean, and healthy" policy, strengthen source control, coordinate waterways, and take into account both rivers and seas, and implement separation of rivers, lakes and seas. Scientific governance of river basins, sub-regions and stages shall be carried out, and water pollution prevention and control, water ecological protection and water resources management shall be systematically promoted. The Chinese government has fully realized the serious problems caused by the deterioration of the urban ecological environment in the Yangtze River Delta region, and has put forward the goal of striving to build an "ecological civilization" and a "beautiful China" in due course. Ecological civilization covers a wide range, and it is specifically implemented in urban planning and construction, and the construction of water resources system is one of the important contents.

With the increase of human water consumption and sewage discharge, the water availability and self-purification capacity of natural water bodies no longer have absolute advantages compared with them, the amount of water resources and the capacity of the water environment have become more scarce, and water problems have gradually evolved into resources. The coexistence of water shortages of various types, engineering types and water quality types, frequent occurrence of droughts and floods, involving social stability and ecological security, and complex problems coupled with land resource utilization, food production and security issues , the degree and scope of its impact are in With the continuous expansion, the water problem has increasingly become one of the most important resource and environmental problems.

Influenced by the extensive economic growth model and the lack of public awareness of protecting water resources for a long time, the water environment in the Yangtze River Delta region is overwhelmed. Facing the increasingly severe and complex water problems and the huge pressure of sustainable development of human society and economy, it is urgent to establish a more "green" and "sustainable development" ethical values to view the relationship between human and water, and to integrate water resources. The planning , utilization and protection of human beings are truly linked with the human socio-economic system, and finally the relationship between people and water is properly handled, so that "human beings learn to survive in a limited water resources environment". From the perspective of building a regional "sustainable development" pattern, carry out overall planning, allocation, utilization, conservation and protection of water resources , reasonably meet the water demand for rapid social and economic development , and maintain the healthy and sustainable development of the regional ecological environment.

1.1.3 Research purpose

On the basis of the idea of integration of academic achievements, the "sustainable development" theory is applied to the countermeasures of sewage recycling and water resources planning, deepening and improving the existing water resources planning theory, and forming a water resources planning based on the concept of "sustainable development theory" theory.

Taking rural in Zhejiang as the main research object , through the analysis of urban water resources and utilization characteristics , the concept of "sustainable development" is extended downward, and more attention is paid to water resources system problems and special urban conditions; while water resources planning expands upward, Combined with the concepts of "sustainable development" and "smart water affairs" , and at the same time horizontally combining urban characteristics, an urban water resources planning method based on "sustainable development" is formed, which changes the current situation in which the water resources system passively responds to social and economic development. Strategies and schemes for overall planning, optimal allocation, efficient utilization, conservation and protection of water resources are proposed to provide methodological guidance and experience for the sustainable planning of urban water resources in Zhejiang .

The main content to be explored in this paper is the optimal allocation of regional water resources for sustainable development. The so-called optimal allocation of water resources for sustainable development is to take the sustainable development strategy as the guiding ideology , and use the system analysis theory and optimization technology to optimally allocate the limited water resources in each sub-region and each water sector, so as to achieve the optimal allocation of water resources . Obtain the best comprehensive benefits of the coordinated development of society, economy and environment.

Its research significance is :

(l) Promote the rational and effective use of water resources.

The optimal allocation of water resources does not increase water supply nor reduce water demand , but it maximizes overall benefits. This is because the optimal allocation of water resources is aimed at maximizing comprehensive benefits , using optimization methods and technologies , and reducing the occupancy of the water sector with large unit consumption of water resources through industrial structure adjustment . , The saved water resources will be used in the water sector with high water resource utilization rate, small unit consumption and high comprehensive benefit, so that water resources can be used reasonably and effectively. Minister Wang Shucheng of the Ministry of Water Resources pointed out in his speech on "Water Rights and Water Market" that improving water resources utilization efficiency and realizing sustainable use of water resources through optimal allocation of water resources is the primary task of China's water conservancy work in the 21st century [6] .

(2) Promote the coordinated development of society , economy , resources and environment .

Development is an eternal theme, and one-sided economic growth does not necessarily mean development . The economic growth-oriented water resources allocation method has achieved rapid economic growth, but it has brought ecological damage and environmental pollution, posing a threat to the survival and development of human beings . Only the coordinated development of society, economy, resources and environment is the best development model. The coordinated water resource allocation method for sustainable development is to promote economic growth and social prosperity while protecting the ecological environment , thereby ensuring the realization of sustainable development.

(3) Promote the transformation of engineering water conservancy into resource water conservancy .

The core of resource water conservancy is the optimal allocation of water resources . The optimal allocation of water resources is the most economical, the fastest way to study the optimal allocation of water resources is to explore important technical means of water resources and water resources. At the same time, it also allows science and technology to penetrate into water resources management work, improve the scientific awareness and management level of managers , and promote engineering water resources to resources. Water transformation.

(4) It has certain reference value for the allocation of other resources.

Water resources are one of the natural resources . Any resource has certain value and use value, but it is limited by a certain amount . Other resources also have the problem of reasonable and effective allocation. The problem of optimal allocation of resources has certain similarities and differences. It has a certain reference value for solving the configuration problem of other resources .

(5) Studying how to strengthen rural water environment protection

It is the need of the concept of green development, the need for the harmonious coexistence of man and nature, the need to ensure the sustainable, stable and coordinated development of the rural economy and society, and the need to ensure the health of rural residents. It is of great significance to improve the quality of rural environment and promote the sustainable development of rural economy, society and environment.

1.2 Status and models of rural wastewater treatment abroad

The level of urbanization in developed countries is relatively high, the public has a strong awareness of environmental protection, and the development policies and measures for sewage treatment such as environmental economic policies, regulations and standards, governance technologies, supervision and law enforcement, and education and training are also relatively complete. Divided by the total population or density of living, "rural" is only a relative concept compared to "city", the difference is that the living environment in rural life is often more beautiful and comfortable than that in the city to which it belongs.

1.2.1 United States

The United States has basically completed the integration of urban and rural areas more than 50 years ago, and in the 1980s, the comprehensive coverage of rural sewage treatment facilities was achieved. The United States has a relatively complete system in terms of regulatory system and financial subsidy system, as well as in terms of technical mode and operation mode, which has played a better role in guaranteeing the sustainable operation of its rural sewage treatment facilities [7-10].

1) Policy measures

① Legal system

Since 95% of the population of the United States currently lives in cities and towns with a population of more than 50,000, the rural and urban areas of the United States adopt the same legal system for sewage treatment [8-11]. Relevant laws mainly include the Clean Water Act , the Safe Drinking Water Act, the Coastal Zone Act Reauthorization Amendments and the Water Quality Act Act), etc. Programs and projects related to the above laws mainly include: Nonpoint

Source Management Program, Water Quality Standards Program, Total Maximum Daily Load Program, Water Resources Protection Program (Source Water Protection Program) and National Pollutant Discharge Elimination System Program (National Pollutant Discharge Elimination System Program) [7-10].

②Financial support

The main source of cost for rural sewage treatment in the United States is government investment. The way the United States provides financial support for local sewage treatment is more stable and sustainable than the annual allocation of local governments. It is relatively less susceptible to changes in local fiscal policies, and can achieve a certain amount of accumulation through proper financial management and operation. It is a financial support method that is more suitable for the US economic environment. In addition, states can also combine their own characteristics to reduce the cost of installing and using sewage treatment facilities for residents and communities and increase their enthusiasm through financial support programs or projects such as loans, tax breaks, and special support grants [7-10] .

③Rural planning

The overall rural planning in the United States attaches great importance to the construction of environmental protection facilities such as sewage treatment. Perfect sewage treatment facilities basically solve the problem of water pollution and provide a good environmental guarantee for rural social and economic development. The project approval and planning and design scheme of the project are usually discussed by the relevant government personnel, planning and design personnel and local residents by holding a meeting, demonstration meeting, etc. First, the government personnel or planning and design personnel discuss the project intention, planning and design scheme. After explaining it, and then soliciting the opinions of residents, etc., and finally making revisions, the final plan is determined after many iterations [7-10].

2) Process technology

Due to the scattered distribution of residences in suburban areas and villages in the United States, sewage pipelines are generally not constructed in a centralized manner. Decentralized Wastewater Management (DWM) is mainly considered [11-15], which mainly adopts the septic tank-soil adsorption process. [11] (see Figure 1-8). This process is generally based on households , build a relatively deep septic tank in each household, and lay a lead pipe at the top of the septic tank about 20 mm from the ground . The branch pipe (which has many small holes in it) is released under the grass. The septic tank -soil adsorption process not only “digests” the sewage, but also plays the role of irrigating the grassland [10].

In addition, the high-efficiency algae pond system is also widely used in rural America, which is a further upgrade of the traditional stable pond , which has a higher removal rate of conventional pollutants, and can also harvest aquatic plants that can be used as high-quality fertilizers. This technology basically does not require electricity consumption, the operating cost is low, and it is easy to manage and maintain [7-10].

In addition to the above-mentioned two ecological treatment technologies, which are widely used in the United States, there are also process technologies such as biological turntable and activated sludge method [16].

3) Operation management

The actual characteristics of its rural sewage, the United States promulgated the "Management Guidelines for Decentralized Treatment Systems" in 2003. According to the different local environmental sensitivity, five operation management modes are proposed that gradually weaken with the degree of centralized management, mainly including centralized operation. , centralized operation, licensed operation, agreement maintenance and owner autonomy [7-10] , these five operating modes are suitable for areas with different environmental sensitivity [17].

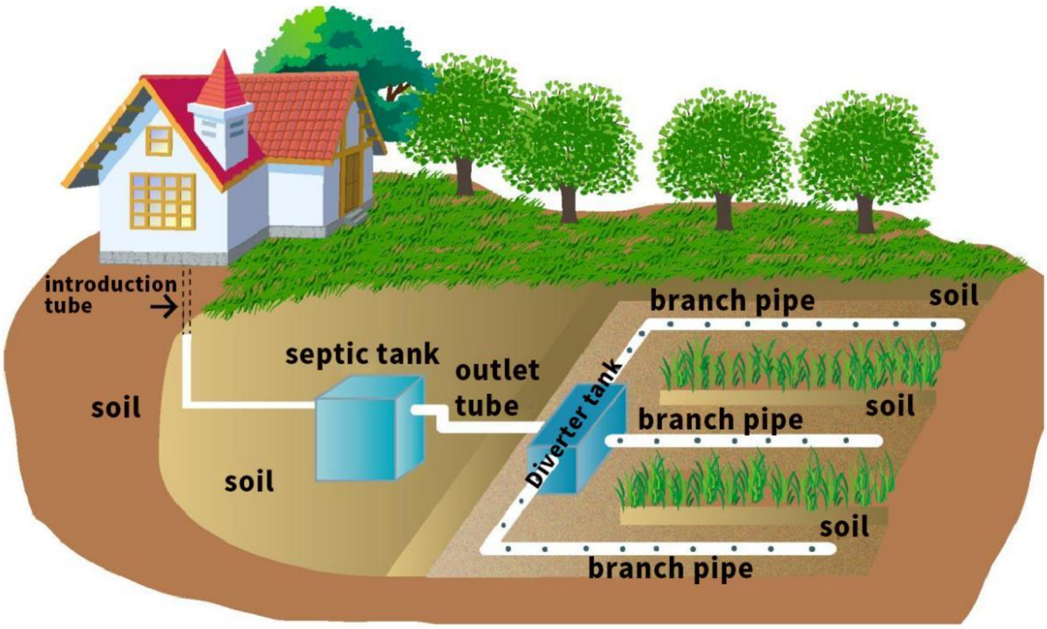

Fig.1-8 Schematic diagram of septic tank-soil adsorption process [15]

1.2.2 Japan

Similar to the United States, the treatment of sewage in rural Japan has basically achieved nationwide coverage [18]. The reason why Japan's rural sewage treatment is better is that the supporting laws are relatively simple and practical; from the perspective of financial subsidies, Japan is mainly based on government investment, and the promotion efforts are relatively large; the rural planning is relatively reasonable; It is relatively standardized; there are also relatively detailed specifications for the operating model, and the responsible subject is very clear [18].

1) Policy measures

① Legal system

In terms of the legal system of rural sewage treatment in Japan, unlike the United States, which adopts the same legal system for urban and rural sewage treatment, Japan has a legal system framework that is different from urban areas specifically for rural areas, and the "sewage system" adopted by cities. Law", and rural areas adopt the "Septic Tank Law" [18].

Japanese septic tanks can be traced back to the 1950s and 1960s. The purpose of the Japanese septic tank act is to promote the qualified treatment of domestic sewage through the use of septic tanks, maintain good water quality and healthy living environment in public water bodies, and improve public health. In addition, the Septic Tank Act also strengthens the specifications for various stages of septic tank production, installation, operation and maintenance, and decontamination, and comprehensively considers the professional competence certification and training of practitioners [18].

②Financial support

Japan has increased its investment in rural environmental governance since 1975. The government generally invests about 30% of the investment to increase efforts to complete rural domestic sewage and other treatment facilities [18]. At present, Japan adopts a subsidy method for rural purification tank installation projects . The local government bears 26.7%, the state subsidy is 13.3%, and the remaining 60% is borne by the users themselves. At the same time, Japan is also trying to introduce social capital in construction and operation [18], mainly in the following three ways:

(1) The first is that the government is responsible for the investment, design and construction of sewage treatment facilities, and the follow-up operation and management are handled by a professional third party;

(2) The second type is funded by the government, but the relevant design, construction and specific operation are handed over to the enterprise;

(3) The third type is that the enterprise is completely responsible for investment, construction and operation management. In this way, the government will provide users with financial subsidies to reduce the investment cost of sewage treatment facilities. Comparing the above three methods, the government's investment has gradually decreased from allocating fiscal budget for the construction, operation and maintenance of sewage treatment facilities to only providing partial subsidies.

③Rural planning

The development of rural planning in Japan mainly experienced the narrowing of the urban-rural gap (the first stage: 1973-1976), the construction of a rural settlement society with regional characteristics (the second stage: 1977-1981), and the participation of residents (the third stage: 1982). ~1987), building independent and distinctive areas (fourth stage: 1988-1992), and using regional resources to improve the comfort of rural life (fifth stage: 1993-present). This shows that the process of rural construction in Japan is gradual, and it also reflects the differences in the key content of construction in Japan at different stages of development [18].

2) Process technology

Different from the use of ecological treatment technology for rural sewage in the United States, the main facility for rural sewage treatment in Japan is the purification tank [19]. According to the scope of service objects, the sewage treatment facilities in Japan can be classified into: Night Soil Storage Tank, separate purification tank (Tandoku-shori). Johkasou) purification tank system (Johkasou System), rural sewage treatment system (Rural Sewerage System), and sewage treatment system (Sewerage System) and other five methods [20] (see Figure 1-9), as follows:

①Night manure storage tank: This method mainly stores manure and urine through the tank, and then transports it to the manure and urine treatment plant for centralized treatment and resource utilization.

②Separate purification tank: The applicable object is feces or toilet sewage. Japan has used this method to install about 4.37 million individual purification tanks .

③ Purification tank system: Each household uses an independently installed combined purification tank, and the comprehensive domestic sewage generated by each household is uniformly treated by this combined purification tank and then discharged into natural water bodies such as nearby rivers. The generated sludge is transported by vehicles to special treatment facilities for treatment or resource utilization.

④ Rural sewage treatment system: The domestic sewage of the residents and the sewage produced by the agricultural production activities of the farm are collected into a large purification tank for centralized treatment through the unified sewage pipelines laid in the countryside . The treated tail water can be directly discharged into nearby natural water bodies, and the sludge is transported to special treatment facilities by vehicles for centralized treatment.

⑤ Sewage treatment system: unified treatment through sewage treatment plant.

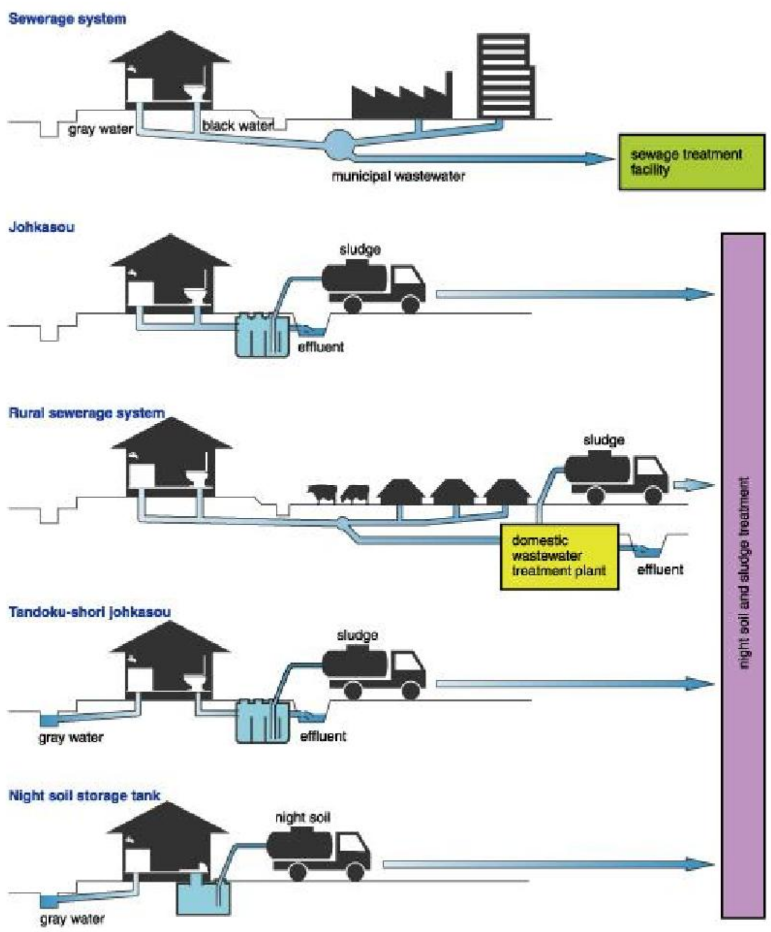

Fig.1-9 Classification Chart of sewage treatment system in Japan[18]

Both feces or toilet sewage can be treated through separate septic tanks and night fecal storage tanks, but some "grey water" is also produced and discharged directly without treatment [19]. Since these two methods of treating domestic sewage will still cause a certain amount of environmental pollution, it has been banned at present. In addition, according to the treatment capacity, the purification tanks used in Japan's rural sewage treatment can be divided into large (≥ 100 m³ / d), medium (between 10 m³ / d and 100 m³ / d), and small (≤ 100 m³/d). 10 m³ / d) and other three scales.

The process technology of sewage treatment in Japan also adopts biological turntable, activated sludge method and other process technologies [16]. For the treatment of sludge generated in the purification tank , there are mainly three methods: microbial fermentation to make fertilizer, land use in the form of cement raw materials, and direct incineration after dehydration.

3) Operation management

In Japan, the main body of responsibility for rural sewage treatment is very clear, and the specific work is mainly carried out by each household, third-party institutions and enterprises. Among them, the role of third-party institutions and enterprises is mainly responsible for the quality acceptance and regular inspection during operation of sewage treatment facilities that have been applied by households and installed after being approved by the government [20]. The Japan Environmental Sanitation Education Center (JECES), as a third-party organization, has played an important role in the development of the core technology of the septic tank system and the formulation of technical standards and specifications for the septic tank system. It provides technical advice to citizens on sewage treatment plans. service, and thereby promote the installation of the septic tank.

1.3 Review of domestic and international research

1.3.1 Research history

In the 1940s, with the rapid advancement of the industrialization process and the rapid social and economic development of European and American countries , the shortage of water resources and the deterioration of the water environment became increasingly prominent, which seriously restricted the further development of the social economy. The water problem began to attract widespread attention in these countries. . At that time, the viewpoints and methods of using a combination of mathematical methods and professional knowledge to deal with problems were more and more applied in urban management and decision-making, resulting in a new field of applied mathematics such as operations research. In conjunction with other methods, significant progress has been made, gradually forming a system analysis theory that is independent of operations research and focuses on applications [21, 22, 23]. The research on water resources planning develops gradually with the increasingly complex and prominent water problems and the rapid development of systematic analysis methods.

The American Water Resources Commission first reviewed the development, utilization and protection of water resources, which aroused the general attention of American universities as early as 1950. In 1955, Harvard University began to formulate a water resource outline to study the characteristics of modern water resources engineering and its methods in planning, design and management. The method takes various functional benefits of water as the goal, and through screening and analysis and calculation, finds a logically reasonable scheme that can quantify and optimize the planning, design and management of water resources system engineering. At the same time, California State University also began to study the problem of water resource system optimization, and was the first to propose a system analysis method that applied dynamic programming to multi-objective reservoir scheduling. Subsequently, Colorado State University and others also started related research [24]. In the 1970s , the Massachusetts Institute of Technology, the University of California, etc. all adopted the system analysis method, and did a lot of work in solving water resource planning and design. At the same time, the former Soviet Union, Canada, the United Kingdom, France and other countries have successively studied water resource issues with systematic analysis methods [25]. After about 30 years of development, water system planning has begun to be applied in several basin and regional planning in some countries.

In the 1960s, the Chinese Academy of Water Resources and Hydropower Science began to use the systematic analysis method to study the optimal dispatch of domestic reservoirs, but it was not until the late 1970s that the systematic analysis method was widely used in water resources planning research. In the 1990s, the planning or analysis of water resources system reached an unprecedented peak. But then the research and application of water resources planning became more and more limited and tended to the sophisticated mathematical method, but lost its initial comprehensive, holistic and systematic thinking.

1.3.2 Research progress

In recent years, with the rapid development of analysis theories, calculation methods, data collection or output methods of planning results, and data management technologies, many new water resources system planning methods have emerged, such as the integrated planning and management methods of water resources and water environment, GIS-based water resource system planning or water quality management methods, artificial neural network-based water resource system planning methods, and various water resource system planning and algorithms for uncertain problems, etc.

1) Integrated planning of water resources

Integrated planning of water resources is a planning model that has been widely advocated in recent years. It is also called integrated planning, integrated planning or overall planning in China. It is an innovation for the planning steps of the entire water resources system. Water resource integration planning focuses on the iterative coordination of conflicts among various objectives, among various interest groups, among various regions, and among various components of the water resources system. Due to the different water resources in different places , the existing problems are different, the specific composition of the water resources system is also different, and the integrated planning of water resources also has different forms and contents. Integrated planning is an integrated form of utility planning that pays attention to both demand management and supply management and conducts a minimal cost analysis of them. Integrated water resources planning is defined as “balancing the conflict of interests between various subsystems in the basin, as well as various departments, groups and individuals in the development, utilization and protection of water resources through various means , to seek water quality and water quantity acceptable to all parties. planning strategy”, so it has better feasibility. There are three main ways of integration : integration of opinions of different water resources agencies [26,27]; integration between water resources planning and land planning [28,29]; integration between water resources development and utilization and environmental protection [30,31]].

The water quality management plan for the Danshui River Basin formulated by the Taiwan Water Resources Commission is an integrated planning model [30]. Letey et al. developed a strategic river basin water resource planning method that integrates water quantity management and water quality management into a decision support system [25], which was applied to the Piracicaba watershed in the state of Sao Paulo, Brazil. The calculus model adopts joint application to comprehensively evaluate various water resources planning schemes.

In a word, the integrated planning of water resources is an open planning method, which incorporates the management of water resources system, technological innovation , and social and economic development planning into the planning of water resources system. With the improvement of environmental protection requirements, it becomes increasingly important.

2) Water resources system planning method based on GIS (GPS)

1980s, GIS was applied to water resource or water environment planning and management. After entering the 1990s, the application is increasingly widespread, it has gradually developed into a general means of water resources planning, and has formed a specific research field [32]. A geographic information system is a computer system that is compatible, stored, managed, analyzed, displayed and applied geographic information. It is an application technology for analyzing and processing massive geographic data. Zhao Yuxia and Zhao Junlin believe that the application of GIS technology in regional water environment management mainly has two fields: storage, display, query, statistics and output of various regional data related to water environment management, such as regional key pollution discharge, section water quality It can be combined with various evaluation models, planning models, water quality models and other social and economic models to integrate into a regional water environment management information system, decision support system or expert system. Provide a basis for regional water environment management decisions; by comparing the prediction results of the above systems with the real system, the original model can be evaluated and revised in turn.

Wltkinsetal. studied the application of GIS in groundwater flow model theoretically, including the function of GIS, the embedding method of groundwater model in GIS, the user interface of GIS-Ground-Water model, etc. Some practical lessons. According to their research, the application of GIS to the groundwater flow model has the advantage of providing a platform for developing groundwater models, easily testing the model and visualizing the output of the results. Disadvantages such as high and complex graphics technology and analysis technology. To make GIS more effective and user-friendly to understand and use in groundwater flow management, three steps must be taken: design the finite difference of the finite element model using GIS-compatible input and output file formats; develop the GIS model-interface Model-interface module; exploring ways to embed models into GIS [36].

Greece and Cruise applied ARC/INFO GIS software to build a geographic information system for the urban catchment area of Baton Rouge, Louisiana [35]. The system is mainly used to simulate the hydrological and hydraulic conditions of urban surface runoff and its flow in the drainage network in the above-mentioned study area. Among them, the characteristics of the catchment area (such as terrain, soil, land use, permeable and impervious areas, storm discharge pipes, channel systems, etc.) are layered in the form of geocoding , and the attribute information of each layer is then built into a data attribute table. The entire catchment area is represented by an irregular triangular network, the excess rainwater is determined by the method of the number of curves, and the flow is calculated by the kinematic wave model. The authors first identified the hydrological response units, then expressed their location information in coordinates, and combined with other models to build a comprehensive model. The authors also demonstrate the simulation and management capabilities of GIS at different scales (such as parcels, polygons, blocks, and multiple blocks) , showing that the scale used in the modeling phase (i.e., the size of the response area) has a significant impact on forecasting The runoff response is affected to some extent.

Taher and Labadie combined GIS with a decision support system to study the optimization problem of water distribution network [36]. Yang MD used a combination of remote sensing, GIS and water quality models to evaluate and predict the water quality of the Te -Chi Reservoir in Taiwan, which solved the traditional water quality evaluation requirements for water quality monitoring. The disadvantages of comprehensive monitoring of lakes [37]. They decompose the water quality image pixels obtained by remote sensing through a water quality monitoring model embedded in the ERDAS imaging system, then calculate the band ratio of the satellite image, develop a regression model for the satellite image, and finally extract the water quality from the satellite data. The variables are displayed on the corresponding main map, so that the water quality status can be visually evaluated.

GIS is being used more and more widely in water resource system planning, and has formed a specific water resource system planning model, which is closely related to water quality planning and management, soil erosion assessment, ecological risk assessment of river basins, hydrological models, non-point Combining the estimation of source pollution load with applications in management, flood control, ecological restoration and other fields [38,39] can greatly enrich the content of water resources system planning, and improve the scientific , accurate and rational of water resources planning. sex. If combined with Internet technology, it can also realize remote access to the water resources status and development and utilization systems, planning and management measures of a specific area, and further realize the real-time sharing of data [40]. Abel et al. have carried out research on using the Internet in water quality planning to improve the accessibility (Accessibility) of spatial data and spatial data processing, and the results show that the prospect is very broad [41]. But at present, GIS is limited to focus on a certain part of the planning steps of water resources and water environment system, which is also its shortcoming, which needs to be effectively overcome and improved.

3) Application of artificial neural network in water resource system planning

Artificial neural network is a new type of computing system in the field of artificial intelligence. The current application in water resources planning is mostly reflected in hydrology (such as flow forecasting, runoff simulation, parameter identification and complex nonlinear input - output time series simulation, etc.) and the simulation and optimization of reservoir system operation. Jain et al. applied ANN to the UpperIndravadi projects in Nowrangpur and Kalahandi districts in Orissa, India. The project is a cross-basin project targeting hydropower and irrigation.

A study by Neelakantan and Pundarikanthand used a simulation - optimization approach to develop a planning model for reservoir operation [42,43]. The method was applied to the Chencai city water supply system in India. The method is divided into three stages, in which, in the first stage, a backward-propagating neural network is trained to simulate a water supply reservoir system; in the second stage, the neural network simulation model is used as a sub-model with A Hooks-Jeeves nonlinear optimization planning model is connected, and then the combined neural network simulation -optimization model is used to screen the operation strategy of the reservoir; in the third stage, according to the neural network simulation -optimization analysis selected can generate The optimal or near-optimal objective function value of the operating strategy, using the traditional simulation - optimization model to further improve the results. The research results show that the neural network -based simulation - optimization model compares satisfactorily with the traditional simulation - optimization model.

Gabtys and Bargiela applied the fuzzy neuron system to study the uncertainty of water volume and water pressure in the water supply pipe network system and the prediction of the operation state of the pipe network. Make full use of the computational efficiency, learning ability and pattern recognition ability of neural network , and make full use of fuzzy method to process uncertain and fuzzy data.

The above research shows that the use of artificial neural network for simulation has many advantages, such as the data used do not have to conform to Gaussian distribution, they can even be very irregular seasonal changes; because ANN is a nonlinear model , it can adapt to the situation with limited data; the whole system It is relatively stable and can cope with data interference or incompleteness, so it will be used more and more in all aspects of water resources system planning. Combining with other methods will greatly broaden the application scope of artificial neural network in water resources system planning.

4) Hierarchical optimization control planning of water resources system

Hierarchical optimal control is a planning method proposed for large-scale system control problems. Large-scale systems generally refer to systems with large scale, many levels, complex relationships, many influencing factors and random characteristics. General analysis methods are not effective for these large-scale systems, and must be controlled in the form of decomposition, coordination or decentralization.

Because the water resource system has many characteristics of the above-mentioned large-scale system, the hierarchical control of the large-scale system has become a relatively main planning method for water resources system planning, especially when it comes to the macro-social economy. It is also called the decomposition and coordination model of water resources system in specific application.

Zhu Wenbin studied the model of coordinated management planning of water resources development and utilization and regional economic system [44]. The author regards water resources development and utilization and regional economic development system as a complex large system, and decomposes it into two water supply systems, surface water and groundwater. In the surface water supply system, the management cycle is decomposed into several time periods, and each time period is used as a subsystem ; in the groundwater water supply system, it is divided into several sub-regions according to the hydrogeological conditions of the aquifer and the degree of development and utilization, and each sub-region is used as a sub-region. Subsystem: In the regional economic system, the administrative area is divided into several sub-areas, and each sub-area is a subsystem. Establish the optimal management model of each of the above subsystems, then coordinate according to the correlation equation between the subsystems, and finally set up the overall coordination model at the highest level according to the overall goal of the coordinated development of the entire water resources development and utilization and the regional economy. Coordinate the development of water resources The relationship between the development and utilization of water resources and the regional economy is realized, and the purpose of coordinated management of the development and utilization of water resources and the regional economy is realized. The whole decomposition and coordination has a three-level structure. In the overall coordination model, the objective function is to maximize the total benefit, and the constraint condition is that the balance of supply and demand is not lower than a predetermined level; in the surface water system model, the objective function is to maximize the power generation benefit of the system, and the constraint conditions include various In the water balance, the coordination variable is the sum of the inflow flow and the discharge flow of the power station, and the feedback variable is the water supply of other users; in the groundwater model, the minimum groundwater supply cost is taken as the objective function, and the allowable value of water extraction, water content In the regional economic system model, the minimization of the deviation between the actual target value and the ideal value of the water sector is used as the objective function, and the actual amount of water resources that can be obtained by each sector is used as the constraint value. Various algorithms are used in the calculation process.

Lu Huayou et al. took the water resources system of Yiwu City as the research object, established a large-scale system decomposition and coordination model, and proposed a method of hierarchical simulation selection, in order to solve the optimization planning problem of the complex water resources system in the area with multiple water sources, multiple users and multiple guarantee rates. Examples are provided. The whole decomposition and coordination model is similar to the literature, and it is also divided into three layers. The first layer is the second-level subsystem, such as each water supply partition, the second layer is the first-level subsystem, including several larger areas, and the third layer is Coordination layer for the entire system .

The core of hierarchical control of large systems is decomposition and coordination. Since a complex large system is decomposed into several parts that are both interconnected and independent of each other, it can greatly reduce the difficulty of solving the simulation and optimization problems of large systems, but obviously, There is still a certain distance between this method and the complete system method. The key to realizing the optimal control and planning of large-scale systems is to seek the coordination between each decomposed component and between each component and the superior module. In the case of improper decomposition or oversimplification of the actual problem, the planning method of decomposition and coordination may lead to wrong conclusions, which should be noted.

5) Water resource system planning considering climate change factors

In recent decades, although there are great differences in the prediction and analysis results of the global climate change trend and its effects , most scholars generally agree that the global climate is changing, and this change will definitely affect the global or global climate change. The amount of regional precipitation and the spatial and temporal distribution of water resources and their distribution characteristics are important basis for the planning of water resources system. In fact, many models and algorithms are mainly reflected in the processing of hydrological change data and uncertainty. Although there are different opinions on the impact mechanism and effect, climate change will definitely have an impact on hydrological change, and the planning and management of water resources system cannot ignore the short-term or mid-term and long-term effects of climate change on various hydrological parameters, water use patterns and crop growth characteristics. influences.

Venkatesh studied the impact of climate change on the investment and benefits of water projects, and applied Bayes- Monte Carlo decision analysis to study the impact of climate change on the benefits of construction projects that control the water flow of Lake Erie. The results show that if climate change is considered The impact of changing factors does make a difference; climate change will affect optimal planning strategies as much as any other uncertainty.

Daily GC believes that climate change may not only change the quantity and distribution characteristics of water resources, but also have a considerable impact on vegetation, soil and the environment as a whole, but also affect the water demand and water use methods of municipal, agricultural, industrial and other departments. The impacts of climate change are multifaceted and water systems must be planned and managed in an interdisciplinary and intersectoral manner.

Labanova [40] believes that a static and deterministic approach is generally adopted in water resources management and planning, without considering the dynamic, heterogeneous and non - static nature of water resources, and in the context of global climate change , the hydrological status will be in a great uncertainty change, so the existing method is not feasible, it is necessary to change, develop new model analysis and design methods to meet the new planning and design needs. He proposed a five-step response strategy: on the basis of determining large-scale global warming, decompose the existing complex time series into several uniform subsections of different scales; for each uniform time series Subsections identify a model; generalize stochastic time models into distribution functions and extrapolate them to future water resource management; integrate global warming factors in water time series based on possible scenarios of climate change or ultra-long-term forecasts Extrapolate to the future ; identify a common calculation result for future water resource planning and management.

Lins and Stakhiv , a senior expert from the US Corps of Engineers, objectively analyzed the impact of climate change on water resource management and whether it needs to be considered in actual water resource management in this context [39].

Yohe [40] et al. gave a simple method framework to help researchers determine the planning and management options under the influence of climate change. The method is to increase the influence factors of climate change on the basis of the "first generation" impact adaptation analysis. For a new impact and adaptation analysis, the authors propose the use of a vulnerability indicator assessment system that requires the identification of those extreme impact variables and the corresponding adaptation of water resources and other relevant aspects.

general, the research on water resources planning and management is increasingly taking into account macro-economic and human factors, so as to plan the water resources system from the perspective of water use, and on the other hand, more and more attention is paid to the use of cutting-edge technologies. Data processing and analysis techniques and computer techniques to more accurately analyze hydrological sequences and their uncertainties. In fact, the research on water resources planning is often a comprehensive application of various methods.

1.4 Research content and framework

1.4.1 Research content

With the rapid development of China's social and economic development, the speed of urbanization construction has been accelerating, and various environmental pollution problems have gradually emerged. China has about 604 million people living in the countryside, it is estimated that about 50 million cubic meters of domestic sewage can be produced every day, and, the amount of water and drainage of rural life is increasing. However, due to the rural sewage collection and treatment facilities have been relatively lagging behind the construction of the city, a large number of rural sewage is directly discharged every day because it is not collected and treated. The accumulation of these sewage in the environment over time, far beyond the environmental capacity of its discharge river and lake water bodies, resulting in most of China's watershed water environment has been polluted to varying degrees, and the phenomenon of "water is dirty" and "water body black odor" is common, which has become This has become an important bottleneck that restricts the construction of ecological civilization in China's rural areas and the realization of a well-off society. This shows that the future of rural sewage treatment market demand is huge.

Among them, Zhejiang province is economically developed, with the increasing urbanization of Zhejiang province, the demand for various types of water resources is increasing, resulting in an oversupply of water resources. In particular,Zhejiang province vigorously develops industry, which brings more waste water while increasing water consumption, increasing the risk of water environment pollution. The rapid development of industrialization in Zhejiang province and the change in the lifestyle of rural residents, coupled with the larger total size of the rural population and more dispersed living, have caused serious damage to the local rural ecological environment. The garbage generated by villagers in their daily lives, pollutants brought by agricultural production and industrial waste from township enterprises have caused varying degrees of damage to the water environment in rural areas. Moreover, the treatment of domestic and industrial sewage rural wastewater seems more complicated compared to urban sewage treatment, so the pollution of the water environment is more serious. And in rural areas, constrained by the dual economic structure of urban and rural areas and centralized development policies, the lack of water infrastructure and the great development of rural enterprises, bringing such as water shortages, unsafe drinking water, water pollution and arbitrary disposal of wastewater and a series of problems, the rural water environment is under enormous pressure.

Therefore, the effective prevention and control of rural water environment pollution will become one of the difficulties and challenges facing the sustainable development of rural areas. At present, whether it is the technical model or the business model, there are few mature models available abroad for China's rural wastewater treatment. Based on this, this paper, based on the theory of "sustainable development", starts from the concept and role of wastewater resource utilization, applies the theory of "sustainable development" to the study of countermeasures of wastewater resource utilization and water resources planning on the basis of the integration of disciplinary results, deepens and improves the existing Based on the integration of disciplinary achievements, we apply the theory of "sustainable development" to the study of countermeasures for wastewater resourceization and water resources planning, and deepen and improve the existing water resources planning theory, and form a water resources planning theory based on the concept of "sustainable development "theory.

Taking the rural areas in Zhejiang province as the main research object, through the analysis of rural water resources and their utilization characteristics, the concept of "sustainable development" is extended downward to pay more attention to water resources system issues and rural special situations; while water resources planning is extended upward, with "sustainable development " "intelligent water" concept, while horizontally combined with the local characteristics of rural areas, the formation of "sustainable development" based on the rural water resources planning methods, to change the current situation of water resources system passive response to social and economic development. At the same time, we draw on some successful experiences of rural water pollution management in foreign countries, and combine them with the actual situation of rural areas in Zhejiang province to propose countermeasures and suggestions suitable for local rural water pollution management and water resources planning, so as to provide methodological guidance and experience for sustainable planning of rural water resources in Zhejiang province , which in turn can provide vivid research materials for rural water pollution management in the south of China, and provide a good basis for China.In turn, it can provide fresh research materials for the management of rural water pollution in southern China, and provide a systematic and complete reference basis for the management and planning practice of rural water environment in China.

1.4.2 Research framework

Research background	**CHAPTER ONE** Research background and purpose of the study		
Method	**CHAPTER TWO** Theories and methodology of wastewater recycling and planning		
Status analysis	**CHAPTER THREE** Analysis of the status quo and countermeasures of water pollution in Zhejiang rural areas		
Investigation analysis and application discussions	**CHAPTER FOUR** Investigation on water pollution data for water protection measures—case study on shangyu	**CHAPTER FIVE** Technology research of wastewater recycling Paper: Journal of Water Process Engineering. IF: 7.34	**CHAPTER SIX** Study of wastewater planning —case study on shangyu
Conclusion	**CHAPTER SEVEN** Conclusion and prospect		

Fig.1-10 Research framework

In Chapter 1， RESEARCH BACKGROUND AND PURPOSE OF THE STUDY. Firstly, the background and purpose of the study are outlined. The background to the issue of optimising water resources systems is presented from a number of perspectives, and the significance of the research is pointed out. A comprehensive overview of the global water resources crisis and the water resources situation in China is presented, together with an analysis of the current situation and models of rural wastewater management of international. It also provides an overview of the history and progress of domestic and international research. Finally, the content and framework of the study are presented.

In Chapter 2， THEORIES AND METHODOLOGY OF WASTEWATER RECYCLING AND PLANNING . Briefly introduces the theory of sustainable development, the theory of wastewater resourceisation and the theory of water resources planning. Based on an analysis of the characteristics of water resources in Zhejiang, the current water problems and their harmful effects on socio-economic development are identified and corresponding countermeasures are proposed. On the basis of the integration of disciplinary results, the theory of "sustainable development" is applied to the study of the countermeasures of wastewater resourceisation and water resources planning, deepening and improving the existing water resources planning theory, and forming a water resources planning theory based on the concept of "sustainable development "theory.

In Chapter 3， ANALYSIS OF THE STATUS QUO AND COUNTERMEASURES OF WATER POLLUTION IN ZHEJIANG RURAL AREAS. Wastewater treatment is the basis of water resources recycling and a prerequisite for better implementation of wastewater resource utilization, which is related to the survival and development of human beings. Nowadays, the situation of water recycling in Zhejiang is not optimistic, water resources are wasted and polluted, and water conflicts are also very acute. First of all, the current situation of water pollution in Zhejiang and the current situation of rural sewage treatment systems are analysed. The existing policy measures and difficulties in the treatment of rural wastewater are pointed out, and measures are proposed to address the problems in the resourceisation of rural wastewater and the recycling of water resources .

In Chapter 4， INVESTIGATION ON WATER POLLUTION DATA FOR WATER PROTECTION MEASURES — CASE STUDY ON SHANGYU. An case study of water protection measures, taking Shangyu as an example. An overview of the water environment as well as a survey of water pollution is investigated first. Then strategic analysis of water protection are carried out. Finally, the current situation of water resources development and utilization and the spatial distribution of drinking water sources are proposed.

In Chapter 5， TECHNOLOGY RESEARCH OF WASTEWATER RECYCLING. Analyzed the requirements and uses of wastewater recycling and typical technology for wastewater recycling. Studied the use of membrane separation technology in the recycling of water resources and the conversion of salt in wastewater into resource.A combination zero liquid discharge of RO, ED and BMED for salt concentration and acid/base production, with optimal operating parameters, is proposed to process the cold-rolling wastewater. And the electrodialysis bipolar membrane technology was applied to the high-salt leachate recovery process of Shangyu rural landfill.

In Chapter 6，STUDY OF WASTEWATER PLANNING —CASE STUDY ON SHANGYU . A case study of wastewater planning using Shangyu as an example. Firstly, on the basis of an overview of the social-economic and water resources profile of Shangyu, the results of wastewater resourceization are analysed. This is followed by a survey of the current drainage situation and recommendations for the development and use of water resources in Shangyu .Formation of a flow chart for planning the main network of the sewage system in Shangyu .

In Chapter 7， CONCLUSION AND PROSPECT.

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Chapter 2

THEORIES AND METHODOLOGY OF WASTEWATER RECYCLING AND PLANNING

CHAPTER TWO: THEORIES AND METHODOLOGY OF WASTEWATER RECYCLING AND PLANNING

2.1 The relationship between water resources and sustainable development

The essence of sustainable development is to properly handle the coordinated development of population, resources, environment and economy. Water is the supporting condition for sustainable development. From the perspective of its roles in population , environment and economy , its importance is reflected in : ① Water is the source of life and an indispensable and precious resource for human beings and all living things to survive. Resources; ② Water is the basic element of the ecological environment and a necessary condition to support the normal operation of living systems and non-living environmental systems. If there is no water or lack of water, the vitality of the earth, ecology and biodiversity will not be maintained, and the ecological environment will be destroyed ; ③ Water is an important natural resource and material basis for the economic construction and social development of a country or region. Industrial and agricultural production activities must have the participation of water.

2.1.1The relationship between water resources and population

Water is the source of life. Water is the material basis for human beings and all living things to survive and develop. Primitive life originated from water , and through evolution from aquatic to terrestrial, they cannot do without water anytime, anywhere. Water is the medium of all life's metabolic activities. The entire connection and coordination of life activities, the transportation of nutrients, the transportation of metabolites, the excretion of waste, and the transmission of hormones are closely related to water. At the same time , in the process of life, the living body dissipates the continuously generated heat to the body through the evaporation of water to keep the body temperature constant. Insufficient or dehydrated water can lead to physical incoordination, disruption of normal physiology , and even death .

In modern society , human beings have an increasing demand for water, and the increment of water resources consumed each year far exceeds the increment of consumption of other resources. With the improvement of people's living standards , the per capita water demand continues to increase. According to the survey and analysis 11 , the current per capita water consumption in large cities is 10-150 L / d, the highest is 200-250 L/d, and the lowest is 70-100 L /d ; the per capita water consumption in small and medium - sized cities is relatively low, generally 50 - 70 L/d, the minimum is around 30L/d .

In recent years, due to the increase of urban population and the improvement of living standards in China, the average annual growth rate of domestic water consumption is 3% to 5%, or even faster. In short, the pressure of economic development and population increase on water supply is enormous.

2.1.2The relationship between water resources and ecological environment

Water resources are the basic elements of the ecological environment and an integral part of the structure and function of the ecological environment system . There is an organic connection between water in its existing form and various elements in the system, forming the morphological structure of the ecosystem; water, in its form of movement, acts as a carrier of nutrients and energy transfer , running continuously, distributing nutrients and energy step by step, Thus , the nutritional structure of the system is formed : the endless movement of water in the ecosystem will inevitably generate material circulation and energy exchange between the system and the external environment , thus forming the function of the system. The position and role of water in the structure and function of the ecosystem cannot be replaced by any other element .

Water is a recoverable and renewable natural resource . It reciprocates between land, ocean, space and land through the water cycle , supporting the operation of material circulation, energy conversion and information transmission. Although all substances in the biosphere are in endless circular motion in different forms , the participation of water is inseparable from the circulation of any substance . The development and utilization of water resources can change the environmental situation in two aspects: if the development is reasonable and appropriate, it can improve the ecological environment , and even turn the desert into an oasis; if the development and utilization are improper, it will cause environmental deterioration and pollution.

2.1.3 The relationship between water resources and economic and social development

Water resources are an important material basis for the development of a country or region , especially in the low and middle development stages . Industrial and agricultural production activities, like living systems, are inseparable from the supply of water , and with the development of productivity , the water demand will increase greatly . The history of human development shows that human society inhabited by water in the early stage, and human civilization also emerged and developed from the basin of large rivers. Some famous large cities in modern times were also built by water and sea . This situation actually demonstrates the importance of water resources to the development of a region and a city.

One hand , due to the development of social economy, the demand for water resources continues to increase. When the certain carrying capacity of water resources is exceeded , it will cause great pressure on water resources . For example, economic development will lead to an increase in the discharge of waste water and aggravation of water pollution. The water crisis brought about by social and economic development, in turn, restricts industrial and agricultural production and affects social and economic development.

Other hand , with the development of society and the advancement of science and technology , the ability of human beings to treat sewage and improve the environment is also improving. Similarly , with economic development, there will be greater economic strength to improve the water resources system, such as providing more funds for sewage treatment, improving water supply and conveying systems, and building water conservancy projects. These indicate that social and economic development can also promote the rational use of water resources .

To sum up , water is an irreplaceable resource needed by human beings. From the perspective of the relationship between water resources and sustainable development , it is necessary to not only ensure the continuity and persistence of water resources development and utilization, but also make water resources sustainable. The development and utilization of it try to meet the needs of the continuous development of society and economy. The two must work closely together. Without sustainable development and utilization of water resources , there can be no sustainable and stable development of social economy. On the contrary , if the needs of social and economic development are not supported by the water resources system , it will react to the water resources system , affecting or even destroying the sustainability of water resources development and utilization .[1]

2.2 Sewage Resource Theory

2.2.1 The concept and function of wastewater recycling

Recycling of water resources is the key to solving the shortage of water resources. There are three main ways: adopting water-saving measures, diverting water from outside the basin, moderately exploiting groundwater, and recycling sewage. Among them, water-saving measures are conservative and will not increase water volume; water transfer outside the basin and groundwater extraction projects are large, time-consuming, and improper implementation may even lead to a series of man-made damage to the natural ecological environment, which is not worth the gain. According to the data, 80% of the water supply in villages and towns is converted into sewage after collection and treatment, of which 70% can be recycled again. This means that through the reuse of sewage, the available water volume of villages and towns can be increased by more than 50% while the existing water supply volume remains unchanged. From this , it can be seen that the recycling of sewage, that is, the recycling of sewage in villages and towns, is an inevitable choice to promote the recycling of water resources, which can effectively ensure the sustainable use of water resources.

Sewage recycling refers to the process of converting village sewage into material materials that can meet the requirements of people's production and living activities. The amount of sewage in villages and towns is large, concentrated, and the water quality is relatively stable. Reusing the treated sewage for industrial, municipal, agricultural and other fields to realize the recycling of sewage can reduce the total amount of new water development and is a means to make up for the lack of water resources; it can reduce the The total amount of pollutants discharged to achieve a virtuous cycle of water resources between the natural system and the social system. At the same time, it can also promote the development of environmental protection industries such as technology research and development, design, new materials, complete equipment manufacturing, and related services developed around sewage treatment. [2]

2.2.2 Feasibility of wastewater recycling

The renewable use and recycling of village sewage can not only alleviate the shortage of water resources in villages and towns, but also reduce the damage to the water environment, and at the same time, it can also bring considerable social, environmental and economic benefits. This strategy has been adopted by many countries in the world and is a necessary strategy to solve the water problem. At present, the capital basis and technical conditions for the utilization of wastewater in China are basically in place. First, sewage treatment capacity has been rapidly enhanced. During the "Eleventh Five-Year Plan" period, the total number of sewage treatment plants that have been put into operation and the sewage treatment plants under construction and their sewage treatment capacity are already comparable to those of the United States, which will enable China to rapidly reduce the number of sewage treatment plants and developed countries in terms of sewage resources. Second, sewage reuse has been practiced for more than 20 years , and great breakthroughs have been made in technology research and development, process design, complete equipment manufacturing, etc. aspects are also constantly being improved. Many experts and scholars have conducted research and demonstration on the management system, policies and regulations and traditional concepts. The research has concluded that the following three points are the key to the reuse of sewage: First, the unified management of water resources should be implemented. According to the characteristics of water resources and international management experience, it is necessary to strengthen the state's ownership management of water resources.

The second is to implement administrative management and departmental industry management on the sewage recycling system, and improve the relevant standards, policies and regulations for sewage utilization as soon as possible.

The third is to reform the water price policy. Water price is an important economic lever in water resources and plays an important guiding role in the allocation and management of water resources. It is necessary to clearly formulate the corresponding water price policy and water price system in my country at this stage. For example, the economic advantages of wastewater reuse in villages and towns in China have gradually emerged, and the financial cost of wastewater reuse is 2/3 less than that of seawater purification. With the tightening of water resource constraints, the price of water supply in villages and towns is gradually rising, and there is already a profit space for reclaimed water resources. Especially at present, the country has unprecedentedly strengthened the macro-control of water resources, and the profit space of reclaimed water will be rapidly enlarged. Show a broad market prospects.

2.2.3 Reuse of wastewater

(1) Public utilities and environmental water.

Such as garden watering, spraying roads and replenishing municipal landscape waters, flushing water (such as car washing, toilet flushing); improving deteriorating environments (improving water quality through wetlands), building new wetlands, replenishing river water to protect wildlife habitat or maintain Aesthetic value of lakes.

(2) Water for industrial production.

It can alleviate the contradiction of industrial water, especially circulating water, which accounts for 70% to 80% of industrial water, and more than 90% of cooling water in power, chemical and other industries . However, attention should be paid to the industrial reuse of reclaimed water: first, to ensure the guarantee rate of water supply, and never stop production due to the water cut off of reclaimed water; second, to ensure the hygienic quality of industrial products and industrial water systems; third, as cooling When adding water, it must be ensured that the industrial cooling water system will not be affected by indicators such as sewage water hardness and microorganisms.

(3) Agricultural irrigation water.

Part of the treated sewage used for agricultural irrigation can not only replace precious freshwater resources, but also provide certain nutrients for crops, which is beneficial to the growth of crops. The effluent treated by the urban sewage treatment plant must be harmless before being used for agricultural irrigation.

(4) Underground refilling water.

After several times of intensive treatment, urban sewage can be discharged into urban or suburban lakes and reservoirs nearby, and groundwater is supplemented by surface water leakage to achieve a balance of its culvert and prevent the groundwater level from being excessively lowered . [3]

2.2.4 Algorithm and technology model of wastewater recycling

（1）Algorithm of water functional area pollution carrying capacity

According to the water quality status of rivers in Shangyu City and the situation of point and surface pollution sources, water function zones are demarcated , water quality targets for water function zones are drawn up, and the pollutant capacity of water function zones is calculated. On this basis, study the countermeasures of water environment protection in Shangyu City, and take engineering and non-engineering measures to gradually restore the self-purification capacity of rivers in Shangyu City.

①Water function zoning

According to the water environment conditions and favorable to the economic and social development of Shangyu City , the main rivers in the city are divided into : 1 protected area, 1 reserved area , 3 drinking water source areas, 5 industrial water areas, 8 agricultural water areas , 2 landscape recreational water areas .

②The formulation of water quality targets for water function zones

The method of formulating the water quality target of the water functional zone is : the water quality standard of the functional zone shall be controlled according to Class III ; specifically, it shall be formulated according to the two indicators of CODcr and NH_3-N. After comparing the current water quality status of the water function zone with the water quality category indicators of the leading functions of the functional zone , it is formulated in two cases: when the current water quality does not meet the water quality category of the water function zone, the water quality protection target is formulated , and the target can be achieved in stages; When the water quality has met the water quality category of the water function zone, the water quality protection target shall be formulated in accordance with the principle of not increasing the pollution load of the water body .

③Calculation of pollution holding capacity of water functional area

Pollutant holding capacity of the water function zone refers to the maximum allowable load of pollutants that meets the water quality target requirements of the water function zone. Generally, a one-dimensional water quality model is used for calculation of rivers, and it is assumed that the pollutant discharge outlets are evenly distributed along the river in the same functional area , and the following formula is used to calculate :

$$[M]=86.4\times0.365\times(Cs- C0 \exp(-KL/ u)(QKL/u)/(1-\exp(-KL/u))$$

In the formula : m is the pollutant holding capacity of the river reach (t/a); Cs is the target water quality (mg/L); C0 is the initial section concentration (mg/L); Q is the design flow (m^3 / h); u is the average flow velocity under the design flow rate (m/s); k is the comprehensive self-purification coefficient of pollutants (1/d); L is the length of the river section (m).

Q adopts the average flow rate of the dryest month with a 90% guarantee rate; in the centralized drinking water source area , the average flow rate of the dryest month with a 95% guarantee rate is adopted.

Plain river network is determined according to the design water level of the 90% guarantee rate . Therefore, when the water level is low, the flow rate is relatively small, and the flow rate is almost zero. The calculation of its pollutant holding capacity only considers the pollutant holding capacity of a part of the water volume of the water body , and the calculation formula is: [M]=3.65KVCs. In the formula: V is the volume of the water body in this reach (m^3), and the meanings of other symbols are the same as before. K value: CODCr and NH_3-N are 0.10 ~ 0.20/d and 0.05 ~ 0.25/d respectively.

（2）BMED Technology and Resourcefulness Process Research Methodology

In this study, a combination zero liquid discharge of RO, ED and BMED for salt concentration and acid/base production, with optimal operating parameters, is proposed to process the cold-rolling wastewater. As shown in Fig.2-1, the cold-rolling wastewater firstly is pretreated by ion-exchange resins (IER) for absorbing the Mg^{2+} and Ca^{2+} in the wastewater.Then the IER effluent was concentrated via RO process. In order to achieve solution with high-saline, the solution was concentrated with a two-stage ED process.The effects of voltage drop, membrane type and volume ratio were investigated through concen- tration factor,energy consumption and water transport. Furthermore, the effluent from two-stage ED dilution solution could be treated by RO process again. The ED concentrate solution, which enriches Na_2SO_4, can be used for the BMED process to recycle the NaOH and H_2SO_4. However, before the treatment of BMED process, the ED concentrate solution was processed by ion-exchange resins for the treatment of Mg^{2+} and Ca^{2+} again. Subsequently, the parameters such as membrane type and volume ratio between feed and acid/base compartment were studied during BMED process. A small amount of acid and base could be used to regenerate and transform the exhausted cation-exchange resins as well.The findings of this study would not only enrich reference for the treatment of cold-rolling wastewater, but also provide guidance for optimization process.

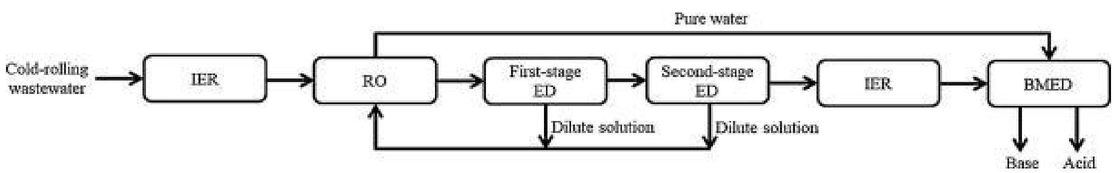

Fig.2-1. The scheme for the treatment of cold-rolling wastewater.

The concentrations of Na+, K+, Ca^{2+}, Mg^{2+}, Fe^{3+} were measured by ICP-MS (Elan DRC-e, PerkinElmer, USA), respectivity. The concentra- tions of SO^24- and Cl- were measured by ion chromatography (792 Basic IC, Metrohm, Switzerland).The solution conductivity was analyzed by a conductivity meter (S220 type, Mettler Toledo, Switzerland).Theconcentration of NaOH was measured with a standard H_2SO_4 using methyl orange as indicator.The H_2SO_4 concentration was determined by measuring a standard NaOH using phenolphthalein as indicator. Voltage drop and current were recorded directly from the power supply.

2.2.5 Main problems in the process of wastewater recycling

The process of wastewater resource utilization in my country has just begun, and there are still many problems [3-6].

①The construction of reclaimed water utilization facilities does not match the development of the city .

China is currently in the rapid development stage of urbanization. The construction of urban reclaimed water utilization facilities often lags behind the overall layout and development speed of urban infrastructure construction, and the needs of reclaimed water users are often not met.

② A complete management system for wastewater resource utilization has not yet been established

At present, many provinces and cities in my country have not established a unified management mechanism for reclaimed water resources. There are many drawbacks in the production and operation of reclaimed water and maintenance of the pipeline network, and the management entities such as the production, operation and supervision of reclaimed water facilities are not clear, and there are also unclear responsibilities and rights. The development of reclaimed water utilization enterprises lacks motivation.

③Price and market mechanism are yet to be formed

The reclaimed water charging system has not been established, the reclaimed water charging standards and charging methods are not clear, and the charging mechanism is not standardized. The reclaimed water charge lacks the basis of market-oriented operation, which affects the development of reclaimed water utilization. The main body of the cost of reclaimed water for public use, such as water supply for river landscape environment, urban public greening water, and road watering water, has not been resolved.

④ Laws and regulations need to be improved

At present, there are 5 laws and regulations on sewage recycling and reuse issued by China, including: " Water Law of the People's Republic of China", "Water Pollution Prevention and Control Law of the People's Republic of China", "Urban Water Conservation Management Regulations", "Water Pollution Prevention and Control" Regulations for the Implementation of the Law" and "Interim Measures for the Management of Urban Reclaimed Water Facilities". The National Standardization Committee has also formulated relevant standards for sewage recycling and reuse : "Serial Standards for Urban Sewage Recycling and Utilization", " Design Specifications for Reclaimed Water in Buildings" and "Design Specifications for Sewage Recycling and Utilization Engineering". At present, the policies and regulations related to the utilization of wastewater resources are not perfect and lack systematization. The supporting regulations and policies for the utilization of reclaimed water need to be further improved. Lack of laws and regulations on planning, investment, construction, operation, and management of the reclaimed water industry.

Through independent research and development, the introduction of advanced technology and other means, increase scientific and technological investment in related industries, make full use of various resources of universities, scientific research institutions and related industries, and research and develop process treatment suitable for the current situation of sewage recycling in China through scientific and technological innovation of production, education and research. Technology and supporting equipment products, and strive to improve the industrialization level of China's sewage resource utilization market.

2.3 Water resources planning theory

2.3.1 Basic concepts of water resources planning

(1) Water resources system

The water resources system refers to the water resources within a certain range, and in order to achieve the goal of water resources development , it is composed of several water resources , engineering units and management technology units that are interconnected, restricted and interacted with each other. machine unity. On the one hand , the natural water resources system characterized by the hydrological cycle plays a decisive role in the composition and source of the water resources system ; on the other hand , the macro- socioeconomic system with human activities as the main body The system will play a dual role of construction and destruction at the same time in all aspects of water use , such as the proportion of water use in each part and investment funds . From the perspective of the development history of water resources and the current water resources management background and problems , placing the water resources system within a broader natural and socio -economic system will not be enough for a comprehensive and systematic It is of great practical significance to understand the sustainable utilization of water resources and to carry out water resource planning rationally . [7,8]

Various types of water in the water resources system are interconnected and transformed into each other according to certain laws , reflecting obvious overall functions , hierarchical structures and specific behaviors. The unity has synergy and order inside, and exchanges matter and energy with the outside . The main water sources in the water resources system are atmospheric water, surface water , soil water and groundwater, as well as treated sewage and water transferred from outside the system . Various water sources are linked and transformed into each other under certain conditions . For example, rainfall infiltration and irrigation can supplement soil water , and after the soil water is saturated , it continues to infiltrate to form groundwater ; while groundwater forms phreatic evaporation to supplement atmospheric water due to soil capillary action , and can also pass through lateral Seepage into rivers and lakes to replenish surface water. Likewise , surface water replenishes atmospheric water through evaporation on the one hand , and soil water and groundwater through river and lake infiltration on the other. Therefore , different water resource utilization methods will affect the composition ratio, geographical distribution and transformation characteristics of various water sources in the water resource system [9,10] .

According to the law of formation and transformation of water resources , a water resources system can contain one or several basins , water systems , rivers or river segments . The zoning of groundwater resources is usually consistent with the zoning of surface water resources . Obviously , according to the above zoning principle, a water resource system can be further divided into several subsystems , and at the same time, it is also a subsystem of a larger water resource system . Therefore , the water resources system has an obvious hierarchical structure

[11] .

A water resource system has several integral functions . Water itself is not only necessary for human survival , but also a certain quality and quantity of water supply is an important material basis for the development of the national economy . The huge potential energy contained in the natural runoff can be accumulated and converted into electric energy by using dams and turbines ; on the one hand , the reservoirs can store floods to reduce disasters and develop irrigation [12] ; Benefit, the lake can develop aquaculture and tourism . In terms of ecological environment , water can regulate the climate, maintain the ecological stability of forests and grasslands , and maintain the biodiversity of wetlands .

The basic condition for the sustainable utilization of water resources.

(2) Supply, use and management of water resources

The water resources system consists of the supply, use and management of water resources [9]. The supply of water resources is composed of a pipe network system, water purification facilities and some ancillary facilities, which are not only limited by the amount of water available in nature, but also limited by engineering technology and investment funds. In practice, according to the amount of water resources and water supply capacity, it can be divided into two situations: one is that there is water availability but there is not enough economic and technical guarantee, which generally occurs in developing countries and regions, or is called engineering water shortage. [11]; the other is that the amount of water supply is not subject to economic and technological constraints, but is limited by the amount of water available.

The use of water resources is the part that human beings are most concerned about and have the closest relationship with. The forms of water use can be divided into domestic, industrial, agricultural, ecological environment and river use. Ecological water use plays an extremely important role in maintaining biodiversity and the integrity of the ecological environment. Domestic water use is affected by many factors such as local climatic conditions, water use habits, sanitation facilities, and residents’ cultural quality, as well as distribution methods, income levels, and geographic locations. The increase in water use caused by temperature conditions often does not match the hydrological conditions. One of the main causes of seasonal supply and demand imbalances. In recent years, with the improvement of living standards, people's demand for non-traditional water closely related to life is also increasing [12]. Basic industrial water mainly includes process water and product water, and the water consumption has a great relationship with the type and nature of the industry; agricultural irrigation water depends on the irrigation method, the type of crops grown and the weather conditions. Human water use activities can be divided into two basic situations according to their utility to human beings: one is the basic water consumption. Including basic human life water, food production water and ecological environment water. The second is the water demand for improving the overall quality of life, including direct water use and indirect water use. The above two parts of water demand are combined together, and together they represent the complete needs of human survival and development.

In recent years, two-way feedback considering water resources ←→ water use has begun to appear. Water demand management has been widely adopted by countries around the world to relieve water supply pressure, and has been regarded as an important part of the sustainable development of water resources. From 1980 to 1995, due to the adoption of water demand management measures in the United States, the water consumption did not increase even though the population continued to grow, but the per capita freshwater consumption dropped by 21%. Calculated in real terms of GDP, the price of water also dropped dramatically38 %. It can be seen that effective water demand management, especially strengthening water conservation and improving water use efficiency, can effectively alleviate the water demand pressure caused by population growth and its agglomeration effect.

(3) Water resources planning

An overall plan, measure and arrangement for the development of water resources, prevention and control of floods, protection of the ecological environment, and improvement of the comprehensive utilization of water resources within a certain area . Purpose of water resources planning: rationally evaluate, allocate and dispatch water resources, develop and utilize water resources in a planned way to support social and economic development, improve the natural ecological environment, and achieve a coordinated development of water resources, social and economic development, and natural ecological and environmental protection . Target.

The basic task of water resources planning : According to the national or regional economic development plan , ecological and environmental protection requirements , and the demand for water resources of all walks of life, combined with the conditions and characteristics of water resources within or between regions , determine planning goals , formulate Develop governance plans , propose project scale and development sequence plans , and put forward reasonable suggestions on ecological environmental protection, social development scale, economic development speed and economic structure adjustment.

Main content of water resources planning : including calculation and evaluation of water resources quantity and quality, division and coordination of water resources functions , analysis of water supply and demand balance and scientific allocation of water resources, water resources protection and disaster prevention planning And the corresponding water engineering planning.

According to the different scope and requirements can be roughly divided into the following types : basin water resources planning, inter-basin water resources planning , regional water resources planning and special water resources planning . Specifically , the regional water resources planning refers to the planning formulated to guide the development and utilization of water resources within the region . Coordinate with each other , improve social and economic effects, maintain a good ecological environment, and promote and maintain regional sustainable development [14] .

planning is a special plan that integrates regional water source , water supply , drainage , water purification treatment and comprehensive utilization . Therefore , certain working principles and steps must be followed in the planning process to better ensure that water planning is coordinated with the development of cities or towns in the region, and promote regional development in space and time sequence . Development is coordinated with various constructions .

2.3.2 Water resources planning methodology

(1) Principles of water resources planning .

When formulating water resources planning, as far as possible, fully consider the coordination of economic and social development, full utilization of water resources , and protection of ecosystems; Economic and environmental benefits. It is necessary to follow certain principles: the principle of overall planning and taking into account the parts; the principle of systematic analysis and comprehensive utilization; the principle of making planning plans according to time and place; the principle of feasibility of implementation.

Water resources planning is an integral part of the overall planning of national economic construction and land improvement planning. The construction goals, strategic priorities, strategic deployments and relevant guidelines and policies formulated by the state for a certain period are the basic principles that must be followed in the formulation of water resources planning. In addition, in order to make full use of water resources, meet the development needs of all aspects to the greatest extent, and achieve the greatest social and economic effects with the smallest investment, the following specific principles should be followed in the planning [16]:

① Starting from the overall situation, distinguish the primary and secondary, make overall plans, and coordinate with each other.

The development and utilization of water resources involves the rights and interests of the relevant regions and many economic sectors. We must focus on the overall optimality, comprehensively consider the priority of development and management of various projects, and coordinate between the benefits and the elimination of hazards, as well as between the various water departments. Through unified planning, taking into account or meeting the requirements of all parties, protecting or improving the natural environment, and obtaining the maximum social and economic benefits of the overall plan.

② Comprehensive development and comprehensive utilization.

According to the natural and social characteristics of the planned area, we should strive to combine the elimination of harm with the benefit, and adopt comprehensive measures to achieve comprehensive results. The planning measures should be as far as possible to achieve multiple uses of one water, more benefits from one library, multiple functions of one material, and comprehensive and multi-effects. For example, for a certain amount of water, generate electricity first and then supply water; for a certain storage capacity, it is necessary to combine flood control and prosperity; the same bottom-hole structure can be used for flood discharge, downstream water supply, sand flushing, emptying the reservoir and construction diversion, etc. The same planning scheme should not only serve the economic sector, but also provide multiple effects for the region to improve the environment and increase the welfare of the people.

③ Adjust measures according to the time and local conditions.

According to the natural and economic laws of the planning area, effective planning measures should be selected from various aspects, including water conservancy measures and non-water conservancy measures such as agriculture and forestry. engineering measures.[5-7]

(2) Workflow of water resources planning

① Determine the planning goals .

Establish planning goals and directions , which are the basis for formulating specific plans or measures later . Planning objectives are often formulated according to the specific conditions and development needs of the planning area.

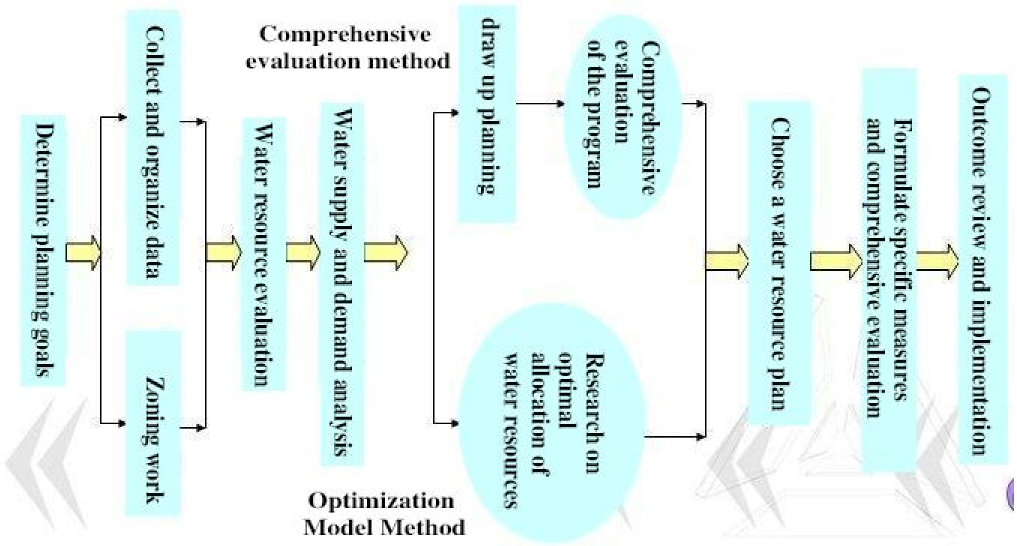

Fig.2-2 Water resource planning chart

②Data collection, arrangement and analysis .

To be collected for water resources planning include relevant economic and social development data , hydrometeorological data , geological data , water resources development and utilization data , and topographic and geomorphological data . The accuracy and level of detail of the data will depend on the method used in the planning work and the requirements of the planning objectives . In the process of data collection , the data should be sorted out in a timely manner , including data merging , classification , reliability testing , and reasonable data interpolation . In addition , after the data is collated , data analysis should be carried out, which is convenient to identify the problems existing in the planning area , and to compare and contrast with the water resources planning goals.

③ Zoning work .

Regional division , also known as " zoning work " , is to break down the complicated planning problems into parts and study them step by step , so as to avoid the contradiction of uneven distribution of water resources and differences in utilization degree due to the excessive planning area , which affects the planning effect . In the process of zoning , topographic and geomorphological factors should be considered , and it should be consistent with the administrative division as much as possible . When zoning by water system , consider the integrity of the water supply system in the area . In general , the zoning should focus on river basins and water systems , while taking into account the water supply and demand system and administrative zoning . For areas with poor water resources , large water demand, and prominent contradiction between supply and demand, the zoning should be finer.

④ Evaluation of water resources .

The content of water resources evaluation mainly includes water resources quantitative evaluation and quality evaluation . Reasonable water resource evaluation plays a very important role in correctly understanding the water resource system status of the planning area and scientifically formulating the planning scheme . The evaluation of the quantity of water resources includes the study of the laws of hydrological elements in the study area , the calculation of the amount of precipitation, the amount of surface water resources , the amount of groundwater resources , and the total amount of water resources . The evaluation of water resources quality includes sediment analysis , chemical characteristics analysis of natural water , and evaluation of water resources pollution status [17,18,19] .

⑤ Analysis of water supply and demand .

Water supply and demand analysis is to predict the annual water supply and water demand of the river basin at different levels , and balance supply and demand on the basis of analyzing the characteristics of water resources in a region or a river basin and the status quo of development and utilization, combined with the economic and social development plan of the region or river basin. Analyzed and proposed ways to alleviate the contradiction between supply and demand of water resources in major water-deficient areas and cities .

⑥ Formulate and formulate plans .

According to the planning objectives , requirements and data collection , the planning scheme is drawn up . The proposed plan should reflect the views and needs of all parties as far as possible. By establishing a mathematical model and using computer simulation technology , the proposed scheme is tested and evaluated, and the structure , function , state and benefit of the alternative scheme are further improved , until all constraints are satisfied and the target is achieved. The optimization scheme of the function reaching the extreme value.

⑦ Implemented concrete measures and comprehensive evaluation .

According to the selected planning scheme , formulate corresponding specific measures , and conduct a comprehensive evaluation of social , economic and environmental criteria , and finally determine the water resources planning scheme. A comprehensive evaluation of the selected planning option is actually a comparison of the post-implementation with the pre-implementation to determine what positive and negative impacts may be produced.

⑧ Results review and implementation .

According to the recommended scheme proposed above , the development , utilization , management , allocation , conservation and protection of water resources should be considered as a whole, and the overall layout , implementation scheme and management model of water resources development and utilization should be studied and put forward . In addition , with the change of external conditions and the deepening of people's understanding of the water resources system itself , it is necessary to modify, supplement and improve the planning scheme appropriately.[8,9]

2.3.3 The application limitations of water resources planning theory

(1) Theoretical limitations .

The aforementioned research status at home and abroad briefly introduces the development process of water resources planning theory . The theory of water resources planning is based on the traditional natural resources theory to carry out related work , and gradually increases the guiding ideology of sustainable development , and integrates some ecological research results . From the perspective of water resources planning results , there is still a lot of room for improvement by integrating multidisciplinary results . In recent decades, the rapid development of ecology and environmental science has formed many research results, and the progress of some related sciences , such as urban science and meteorology , can greatly improve the theory of water resources system planning . Complete and supplement . For example , restoration ecology has put forward various reasonable protection measures for the ecosystem based on a reasonable ecological space layout , which can be applied to the ecological restoration of the water environment ; the principles of environmental science have found that water resources can be to play a major role in ecological security . Comparing the development of related disciplines , the main limitations of water resources planning theory are : in the theoretical development of water resources system planning , the integration of the available results of related disciplines is low ; the guiding ideology of water resources planning theory It is necessary to upgrade from being completely obedient to the current social and economic development to the idea of sustainable development that is safe and healthy for the ecological pattern.[10-14]

(2) Application limitations .

① Lack of active guidance .

existing urban water resources planning in our country is often regarded as one of the professional planning of the overall urban planning . Similar to fill-in-the-blank planning, it is in a passive position and lacks active exploration.

② Lack of effective contact with various departments .

At present , water resources planning often mainly focuses on the planning and layout of water sources and water supply systems based on urban spatial structure and industrial layout . . In fact , the overall urban planning and ecological planning , environmental protection planning, resource and energy planning , etc. are different branches at the same level. It is necessary to coordinate the relationship between various departments to establish water resources planning and ecological planning , resources, environment and other related planning macro-links.

③ Lack of regional coordination .

general urban planning , the object of water resources planning is narrow , mainly concentrated in the central urban area, and there is a lack of overall cognition and overall thinking on regional water resources . As an important research object of water resources in central urban areas , its functional characteristics and planning points are very important . There is no doubt about this . However , reasonable water resources planning must be demonstrated from a regional perspective . Considering regional water resources and the laws of natural , economic and social development and their interrelationships , regional overall allocation , utilization and protection of water resources should be carried out to maximize ecological and environmental benefits and economic and social benefits.

④ Lack of characteristic use and grasp .

For example , rural mountain cities in China are widely distributed , mountain cities have complex topography , special geological structure , and the distribution of water resources and the layout of water resources development and utilization are very different from those in plain cities. Moreover, most of the mountain cities are located in the upper reaches of the river basin , and most of them belong to the water resources ecological protection zone. More consideration should be given to the characteristics of mountain cities in water resources planning . But so far , it is still extremely rare to carry out water resources planning research in combination with rural geographical features .

⑤ Lack of water resources system value and function reflection of water resources system.

The water resources system is also a part of the ecosystem . The ecological function and value of the water resources system itself has not received due attention, and the relevant planning is limited to principled regulations , lacking good implementability and operability . Studies have shown that while highlighting its ecological functions and values , it can still better meet human requirements for water supply . Carry out planning according to conditions and realize its due value.

⑥ Lack of protective concept .

During the period of rapid urbanization in China , most cities pursued direct economic value , which resulted in serious damage to the water resources ecosystem . The ability to put forward higher requirements , such development is obviously unsustainable . Therefore , in the process of urban development , the concept of giving priority to prevention and giving priority to environmental protection should be implemented , and the protective concept of sustainable development should be systematically implemented .

The formation of the above problems is also related to China's national conditions. China is a developing country . In recent years, China has unilaterally pursued high- speed economic development . Water resources planning is often completely subordinate to industrial planning, and the ecological environment has been destroyed . Bad serious price . In addition , China's vast territory , topography , climatic conditions , water resources distribution and utilization are diverse and complex , and water resource planners need to comprehensively analyze local natural attributes and Ecosystem characteristics need to be comprehensively dealt with various changes , which greatly deepens the difficulty of related planning and research. Therefore , the improvement of relevant theories and the exploration of practice still require long-term efforts to achieve.

To sum up , it is necessary to further update and improve the theories and methods of water resources planning , improve the integration and applicability of water resources planning theories, and enhance the practicability and operability of water resources planning methods.[15-19]

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Chapter3

ANALYSIS OF THE STATUS QUO AND COUNTERMEASURES OF WATER POLLUTION IN ZHEJIANG RURAL AREAS

CHAPTER THREE: ANALYSIS OF THE STATUS QUO AND COUNTERMEASURES OF WATER POLLUTION IN ZHEJIANG RURAL AREAS

3.1 Analysis of the current situation of water pollution in rural areas of Zhejiang

3.1.1 Basic characteristics of rural water pollution

Zhejiang Province is located in the south wing of the Yangtze River Delta on the southeastern coast of China. The province's land area is 104,300 square kilometers, of which the mountainous area accounts for 72.58%, the water area accounts for 5.66%, and the flat land area accounts for 21.76%. Sloping and complex terrain. The complex terrain has resulted in the spread of rivers and abundant water resources in Zhejiang Province, so that the quality of water environment has always been the focus of people's lives. Since the reform and opening up, the development path of Zhejiang Province has been an extensive development path with high investment, high energy consumption and high pollution. While achieving economic achievements with an average annual growth rate of per capita GDP of 12%, it also paid a huge ecological and environmental price. Although the environmental protection work in Zhejiang Province has been gradually carried out since the 1980s and achieved certain results, the environmental protection work focuses on cities, and the proportion of rural environmental protection investment is too low. The problem of pollution in rural areas is still serious, especially the situation of water pollution in rural areas has not improved significantly. According to the "2021 Zhejiang Ecological Environment Status Bulletin" issued by the Zhejiang Provincial Department of Ecology and Environment, the overall quality of surface water in the province is excellent , but some river tributaries and some river sections that flow through cities and towns are still polluted to varying degrees. And some lakes have a certain degree of eutrophication, and the reservoirs are dominated by mesotrophs. The bulletin pointed out that the main pollutant indicators in the water body are total phosphorus, ammonia nitrogen and chemical oxygen demand. According to the statistics of the monitoring results of 296 provincially controlled sections in the province, 4.8% of the sections have water quality lower than the surface water environmental quality class III standard . The specific water quality conditions are shown in Figure 3-1 and Figure 3-2 .[1-5]

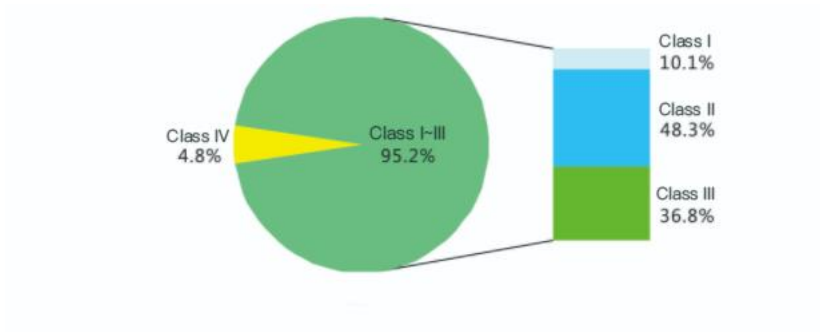

Fig. 3- 1 Surface water quality status in Zhejiang Province [5]

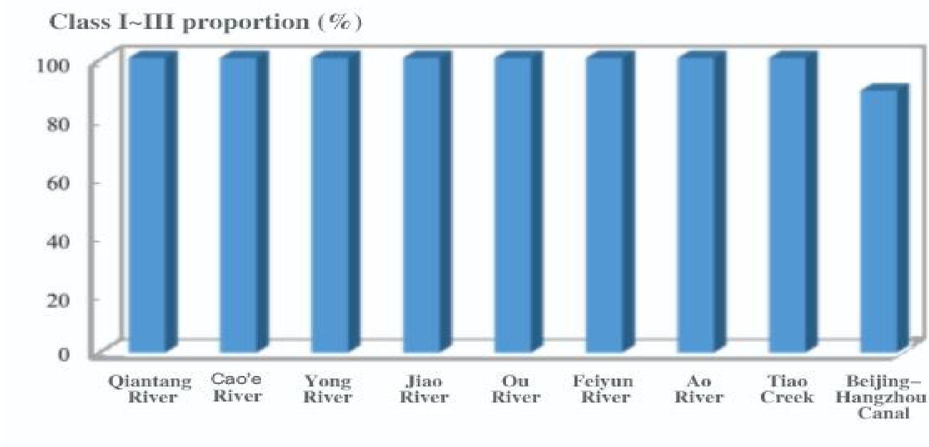

Fig. 3-2 The water quality of river systems in Zhejiang Province meets or exceeds the Class III standard [5]

According to statistics from the Zhejiang Provincial Department of Rural Agriculture, by the end of 2017, there were 915 townships in Zhejiang Province, with a rural population of 39.3829 million. If an average of 100 L of domestic sewage is discharged per person per day, the amount of domestic sewage generated in Zhejiang Province in 2017 will reach 3.9383 million tons. If these sewage are not treated in time, the living environment of rural residents will be polluted in a large area. Therefore, it is necessary to strengthen the treatment of rural domestic sewage. Zhejiang has a large population in rural areas, and most of the rural areas in the province are located in mountainous and semi-mountainous areas, and are widely distributed. The water habits of different regions are quite different. Most of the water used in plain and rural areas comes from tap water. The main sources of sewage are kitchen sewage, domestic washing sewage and toilet flushing water. In addition to using tap water, residents in mountainous and semi-mountainous areas still have the habit of using well water and river water for washing, scouring and other activities; and some rural areas in mountainous areas still use dry toilets or raise livestock and poultry, resulting in a large amount of sewage. . At the same time, due to the rapid development of rural tourism in various regions, a large number of homestays and farmhouses have emerged in response to the situation, and the sewage brought by such industries is mainly catering sewage, which contains more oil, and the water quality and water volume fluctuate greatly. sewage treatment becomes more difficult. The collection and treatment of rural domestic sewage is an indispensable link in the construction of new rural areas. The treatment of rural domestic sewage needs to consider the quality of sewage, the characteristics of water quantity and the capacity of the water environment, and we need to take immediate action.[6]

A comprehensive comparison of village sewage and urban sewage in China shows that village sewage is much more complicated than urban sewage . From the aspects of quantity, total volume, water quality, water quantity and scale, the overall performance is “four big and one small”.

1） The demand for sewage treatment plants (stations) in villages and towns is large.

According to the National Bureau of Statistics, China has more than 650 cities, more than 1,700 counties, about 20,000 organic towns, about 50,000 townships, more than 600,000 administrative villages, and more than 2.5 million natural villages. At present, China has more than 4,000 sewage treatment plants (relatively centralized), while the number of villages and towns sewage treatment plants (stations) (relatively scattered) will be measured in tens of thousands.

2） The total amount of sewage produced in villages and towns is large.

The total population of villages and towns in China is more than 820 million, accounting for 6,000 of the national population. The total drainage volume exceeds 60 million m^3 / d, which is calculated to account for about 1/20 of the sewage volume.

3） The quality of sewage in villages and towns varies greatly.

The water quality of village sewage is complex and the types of pollutants are diverse, mainly including : domestic sewage, catering wastewater, food processing wastewater, aquaculture wastewater, slaughtering wastewater, chemical wastewater and other industrial wastewater. Due to the influence of the industrial structure of villages and towns, regional characteristics, seasonal changes and other factors, the concentration of pollutants in the sewage of villages and towns fluctuates greatly, and the concentrations of ammonia nitrogen and total phosphorus are generally higher.

4） The amount of sewage in villages and towns fluctuates greatly.

The generation of sewage in villages and towns is mainly concentrated in the morning, middle and evening of each day, and the time variation coefficient is about 3~5 (1.2~1.6 in the city); the daily variation coefficient is about 2~3 (1.11.50 in the city), and there is a large amount of water during holidays.

5）The water volume in working days is small .

The difference between the peak season water volume and the off-season water volume of individual tourist villages and towns is dozens of times ; the seasonal changes in water volume are also relatively large, and the water volume in the rainy season increases significantly. (S> The designed daily treatment scale of a single village and town sewage treatment plant (station) is small. The village level is about 30300m^3 /d and generally does not exceed 500m^3 /d; the town level is generally 500~5000m^3 / d , generally no more than 1 10,000 m^3 / d; while the city is generally above 10,000 m^3 / d.

To sum up, the model of rural sewage treatment in China cannot simply be applied to the urban model. The technical challenges, construction challenges, and operational management challenges of rural sewage treatment are more complicated than urban sewage [16-32].

3.1.2 Analysis of the causes of rural water pollution

From the perspective of the environmental ecosystem, any pollution is fundamentally the result of the discharge of pollutants exceeding the self-purification capacity of the environment within a certain period of time. The environmental self-purification capacity of the ecosystem is limited, and the rapid development of contemporary rural areas in the process of modernization produces a huge amount of pollutants. Converted into emissions, exceeding the upper limit of the environmental carrying capacity, thereby causing environmental pollution.

The problem of water pollution in rural areas in Zhejiang is the conflict between the rapid increase in the total amount of sewage in the development process of rural areas in Zhejiang and the low level of water pollution control and limited sewage treatment capacity in rural areas in Zhejiang.

1) Direct causes of water pollution problems

The direct cause of water pollution is mainly the rapid increase in the total amount of sewage in rural Zhejiang. On the one hand, it is the increase in the amount of domestic sewage caused by changes in the lifestyle of the 33 million or so rural population in Zhejiang; on the other hand, the extensive and rapid development of the rural economy in Zhejiang The increase in the amount of sewage in various industries brought about by the development.

① Rural life pollution. Rural domestic sewage refers to the sewage produced by rural residents in their lives, which can be mainly divided into kitchen waste sewage, toilet flushing sewage, washing and bathing sewage, etc. Rural domestic sewage has the following characteristics:

A. There are many and scattered emission sources: Due to the relatively wide space in rural areas and the scattered distribution of villages, the sources of domestic sewage pollution are scattered and numerous, and it is difficult to collect and process them in a centralized manner;

B. The composition of sewage is complex: With the improvement of villagers' living standards and the modernization of their lifestyles, the composition of rural domestic sewage is becoming more and more complex. Generally speaking, the content of COD in rural domestic sewage is 250~400mg/L, the content of suspended solids is 100~200mg/L, the content of ammonia nitrogen is 30~60mg/L, the content of total phosphorus is 2.5~5mg/L, and the content of bacteria is 5x105 ~5x106pcs/L;

C. Large changes in water quantity and quality: The change coefficient of water quantity and quality of rural domestic sewage discharge is large, which is affected by the living habits of local residents. Generally speaking, there is a peak period in the morning, noon and afternoon. With the development of rural economy, the total amount of domestic sewage in rural areas in Zhejiang Province has shown different degrees of growth. With the gradual modernization and urbanization of lifestyles, the water consumption for washing and bathing has increased. The replacement of traditional organic fertilizers by chemical fertilizers has made most of the manure water traditionally used for field fertilization and irrigation into useless wastewater. The annual untreated rural domestic sewage in Zhejiang Province is about 670 million tons.

② Rural industrial pollution. Rural industrial pollution is a typical point source pollution. The pollution point is fixed and the pollution is harmful. In the more developed rural areas of Zhejiang, there is basically rural industrial pollution. Agro-industrial pollution is not only an associated product of the development of rural industries, but also affected by the transfer of urban industrial pollution.

A. Rural industry develops itself.

Since the reform and opening up, Zhejiang's private economy has been at the forefront of the country, especially rural township enterprises, which started early and developed rapidly, and have become an important part of Zhejiang's economic development.

With the rapid economic development, due to the lack of environmental control, the development of rural industries has caused huge pollution to the rural environment of Zhejiang. "Every village ignites, every house emits smoke" is a true portrayal of the early development of Zhejiang township enterprises. In the early stage of development, the spontaneously formed rural industrial self-employed or enterprises had the characteristics of "small, scattered, low and chaotic", with small scale, scattered distribution, low industrial level and chaotic enterprise management. The rural economy has expanded from the traditional processing industry of agricultural and sideline products to the more polluting industries such as small hardware, small textiles, small printing and dyeing, small plastics, and small household appliances. The industrial structure of heavily polluting industries has a high proportion. Local governments have loosened and delegated power to township and village enterprises and provided a good policy environment, but they lacked effective control over the pollution discharge behavior of township and village enterprises.

Due to the lack of effective environmental assessment, supervision and assessment systems, industrial pollution in rural areas in Zhejiang was once very serious. Since then, the Zhejiang provincial government has implemented a centralized policy for township enterprises to treat industrial sewage in a centralized manner, which has achieved certain results. At present, some rural areas still have the phenomenon of inadequate supervision of sewage treatment, sewage treatment plants are not up to standard, and even the problem of concentrated pollution has occurred. On the other hand, emerging small and medium-sized enterprises emerge in an endless stream. Many enterprises have approved construction in violation of regulations and lack supporting sewage treatment facilities. In order to save costs, some enterprises have built sewage treatment facilities but do not operate them. They only operate when the relevant departments come to check, in order to avoid Government environmental regulation. The situation of spontaneous industrial pollution in rural areas is still serious.

B. Urban polluting industrial transfer.

With the process of urbanization in Zhejiang Province, the urban planning is further adjusted, and the urban environmental protection system is gradually improved. Under the background of the industrial structure adjustment of "returning the second to the third" in the city, some industries with heavy pollution, high energy consumption and poor efficiency are gradually moving to rural areas. transfer. In the vast rural areas, on the one hand, under the influence of the subjective consciousness of local cadres and villagers valuing economy over environmental protection, these transfer enterprises are introduced without distinction; Factors attracting the transfer of urban polluting industries.

In addition, some urban industrial production wastewater and urban domestic sewage are directly discharged into rivers without treatment, causing serious pollution to downstream rural areas. A part of urban solid waste is often transported to rural areas for landfill due to the limitation of garbage disposal capacity. These behaviors not only pollute the rural surface water, but also pollute the rural groundwater, soil and even the entire ecological environment, posing a serious threat to the health and safety of the villagers.

③ Agricultural production pollution. Agricultural production has always been a major water user. Agricultural production pollution in Zhejiang Province is mainly caused by planting production pollution and aquaculture production pollution.

A. Plantation pollution.

Plantation pollution is mainly caused by excessive use of pesticides and fertilizers. At present, the contribution rate of chemical fertilizers to grain production in my country's agricultural production has reached about 40%. Zhejiang Province has "seven mountains and one water and two parts of land". Under the circumstance of limited arable land, the extensive use of chemical fertilizers and pesticides has indeed made a great contribution to increasing grain output and ensuring food security. However, excessive and unreasonable application of chemical fertilizers and pesticides will cause serious non-point source pollution to the surrounding environment and ecosystem. Some fertilizer nutrients are not effectively utilized, and enter the surrounding and groundwater bodies through surface runoff, seepage leaching, particle adsorption, etc., which will cause problems such as eutrophication and pollution of water bodies.

B. pollution from aquaculture.

Breeding industry pollution is mainly caused by the direct discharge of manure, feed residue, washing wastewater, etc. produced in the process of livestock and poultry breeding. Although the Zhejiang government has been committed to the control of aquaculture pollution in this area recently, the main pollutant indicators in the canal watershed in recent years are chemical oxygen demand, ammonia nitrogen, and total phosphorus. It can be seen that the pollution in this area is mainly organic pollution. Industrial pollution is still serious.

④ Service industry pollution. With the development of the rural economy, the tourism service industry, especially the "farm stay", has developed rapidly in rural areas of Zhejiang Province. While promoting the development of rural economy and accelerating the adjustment of rural industrial structure, the tourism service industry has become a new source of water pollution in rural areas. As most of the "farmhouses" are mainly for farmhouse sightseeing and catering services, their locations are mostly close to mountains and water, and are close to rivers and reservoirs; the catering sewage produced by "farmhouses" contains a large amount of solid residues and vegetable oils. In the absence of effective treatment measures and government supervision, most of the catering sewage is directly discharged into the river, which will cause greater pollution to the surrounding environment and the downstream areas of the river, and some even threaten the water quality of drinking water sources.

2) Analysis of the problem of water pollution in rural areas of Zhejiang

①The understanding of the sustainable development of the river basin is not enough .

For a long period of time, whenever we talk about social development and the national economy, we often only care about the growth indicators of the economy, but ignore the consumption of resources and the cost of the environment. Although the Party Central Committee and the State Council have proposed to implement the scientific concept of development in depth and promote the strategy of sustainable development, these abstract administrative thinking cannot play a rapid role in the field of consciousness. Many people still think that economic interests are paramount. They exchange environmental pollution for economic benefits. This is because people have not yet realized that the natural environment and us are a unified whole. It can be seen that the scientific concept of development needs to be further implemented and implemented.

②High concentration of polluting industries

The Yangtze River Delta region is a highly concentrated area of heavy chemical industry, textile, papermaking and other industries in China. In 2014, the production of chemical fibers in the Yangtze River Delta accounted for 76.2% of the country's total output, the production of chemical pesticides accounted for 34.6% of the country's total, and the total output value of the textile and paper industries accounted for 33.9% and 21.6% of the country's total. The pillar industries in the triangle area, taking Jiangsu as an example, in 2014, the total output value of the heavy chemical industry accounted for 73.4% of the total industrial output value. The high concentration of heavy and chemical industries has brought huge pressure on water pollution in the Yangtze River Delta. As the largest source of industrial wastewater discharge, heavy chemical industrial wastewater discharge accounts for more than 80% of the total industrial wastewater discharge in the country. Among the 7 major petrochemical industry bases that the country has recently built, 3 are located in the Yangtze River Delta region (Jiangsu Lianyungang, Shanghai Caojing, Zhejiang Ningbo). In the future , the water pollution pressure of Zhejiang Province located in the Yangtze River Delta will further increase.

③The rapid advancement of industrialization and urbanization

The rapid advancement of urbanization has led to a large number of people and industries gathering in cities, increasing the demand for water in production and living, and increasing pollutant emissions, especially the increase in nutrients such as nitrogen and phosphorus, as well as chemical pollutants. Oxygen deficit increased, resulting in frequent occurrence of water eutrophication. For example, the total amount of wastewater discharge in Zhejiang Province increased from 2.13 billion tons in 2000 to 4.18 billion tons in 2014 , far exceeding the self-purification capacity of the water environment, resulting in huge pressure on Zhejiang 's water environment and water ecological protection.

At the same time, the rapid advancement of urbanization has occupied a large amount of ecological space, and the most direct manifestation is the occupation of ecological land such as cultivated land. The large-scale occupation of cultivated land for construction land increases the impervious area of the underlying surface of the land, which makes it easier for surface pollutants to accumulate into the water body , as shown in Figure 3-3 , and also reduces the environmental self-purification capacity. It can be seen that the increased intensity of human activity disturbance caused by rapid economic and social development and urbanization is one of the important factors aggravating regional water problems. Urban population and traffic are dense, and urban capacity is oversaturated , making the environment pay a heavy price for urbanization.[7-12]

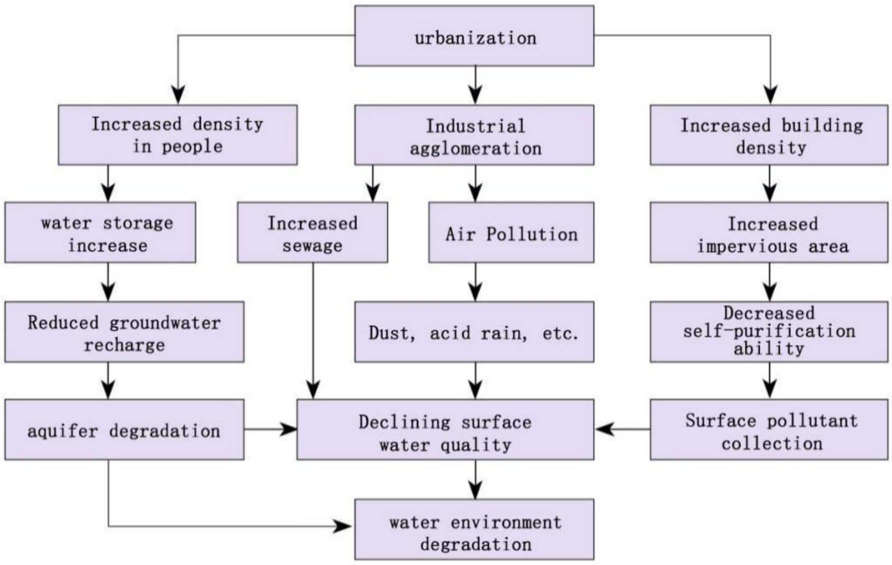

Fig.3-3 The impact mechanism of urbanization and industrialization on the water environment [7]

④ Relevant laws and regulations are not perfect

Although China has already implemented the "Water Pollution Prevention and Control Law" in 1984, the "Environmental Protection Law" was officially promulgated in 1989. In 1995, the "Interim Regulations on the Prevention and Control of Water Pollution in the Huaihe River Basin" was officially unveiled as China's first watershed water pollution prevention and control law. Apart from this, there were no relevant provisions on the prevention and control of water pollution for the rest of the trans-regional rivers. Use partition management . Compared with China, the water pollution-related laws in other countries appeared earlier, such as the "River Pollution Prevention and Control Law" in the United Kingdom ; in Japan, a river basin monitoring and evaluation system was established in 1996, and its river basin is a unit governance law "Specific River Pollution Prevention and Control Law". In the same year, the Act on the Prevention of Obstruction of Water Systems and Watercourses and Special Measures for the Protection of Water Source Quality was implemented.

⑤ Weak law enforcement in the prevention and control of river water pollution

The formulation and enforcement of laws are equally important and indispensable. The enforcement capability of local environmental law enforcement departments seriously affects the governance of local river pollution. An important reason for the frequent occurrence of river pollution problems is that the enforcement capabilities of local environmental law enforcement departments are too weak. The lack of local government attention and local protectionism are the key factors that cause the government's weak enforcement. Local protectionism refers to the government's indulgence of polluting enterprises. Many local enterprises, especially the old ones built along the river, have been helped by the government for many years. These enterprises are also one of the important financial sources of the government. If these enterprises are closed down due to pollution problems, the financial sources of the local government will be reduced. This also makes the local government indulge them without too much influence on the local production and environment, and the environmental problems in other areas that the company may bring are not considered by the local government.[13-15]

3.2 Current Situation Analysis of Rural Sewage Treatment System

3.2.1 Rural status quo of rural sewage treatment system

1) Toilet

At present, water-flushing toilets have become more popular in areas with better economic conditionsin China; however, most of the rural toilets are still dry toilets, some rural toilets have been converted to water-flushing toilets, and some rural toilets are or will be converted to water-flushing toilets toilet. It is foreseeable that the transformation of toilets in villages and townsin China from dry toilets to flushing toilets may be a trend in future development. For toilet flushing, some rural areas (such as Baifu Village, Tongzhou District, Beijing) have achieved good separation of "black water" (feces and urine) and "grey water" (drainage from bathing, laundry, and vegetable washing) at the source. However, the septic tanks used to store "black water" still have problems such as leakage [33].

2) Drainage pipes

At present, the drainage pipelines of towns and villagesin China have two forms: rain and sewage combined system and rain and sewage separation system. However, most rural areasin China do not build drainage pipelines, but discharge sewage through roads and ditches. Some rural areas have drainage pipelines, but most of them are rainwater. It is not uncommon for the mixed flow of rainwater, sewage and groundwater to occur due to the confluence of sewage and poor construction quality. In addition, due to the long design of the sewage pipe network in some villages and towns, the investment and operation and maintenance costs have greatly increased.

3) Processing facilities

At present, some townships in various regions of my country have built sewage treatment facilities, and the township sewage treatment facilities in areas with better economic conditions (such as the Yangtze River Delta region) have basically achieved full coverage; the penetration rate of sewage treatment facilities in rural areas is still relatively low. Low level, as mentioned earlier, only Zhejiang has basically achieved full coverage, while the construction of facilities in areas such as Beijing and Hainan has just begun.

4) Drainage outlet and receiving environment

At present, the drainage outlets and receiving environmental objects of village sewage treatment facilitiesin China are basically ditches, rivers, ponds or lakes near villages and towns, and the coastal areas are directly discharged into the sea, and there is little consideration for the regeneration and resource utilization of village sewage.

As can be seen from Fig. 3-4, the amount of centralized treatment of rural domestic sewage has increased year by year, and the province is continuously promoting the construction of centralized treatment facilities for rural domestic sewage. According to statistics, the province carried out the construction of rural domestic sewage treatment facilities in 20477 administrative villages from 2014 to 2016, of which a total of 15253 administrative villages have been transferred to operation and maintenance, accounting for 74.49%.

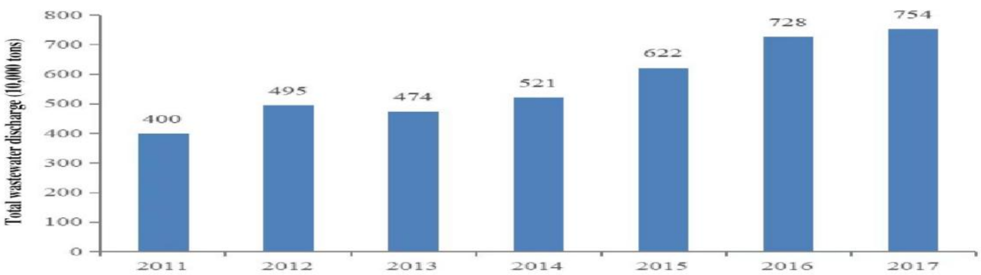

Fig.3-4 Sewage discharge from centralized treatment facilities

3.2.2 Rural sewage treatment and resource utilization technology route selection

1) Principles of village sewage treatment process design

① localization. The selection of technical routes must take into account the geographical differences of villages and towns, and make corresponding design adjustments for different areas, different terrain, different geographic and climatic conditions, and the level of economic development.

②Prioritize the use of resources. Sewage is a valuable "second source of water", should give priority to the treatment of village sewage and local resource utilization, especially for the northern and western water shortage and arid areas of China.

③ High efficiency and low consumption. Process design to meet the national and local requirements of the village sewage treatment discharge standards, is conducive to improving the surrounding environment, but also to achieve lower energy and material consumption inputs.

④Easy to manage. Village sewage treatment facilities should be as simple as possible, easy to manage and operate and maintain, and can effectively play its role for a long time.

According to the characteristics of rural sewage, the rural sewage treatment system is divided into household-level, village-level and town-level sewage treatment systems of three different degrees of concentration. [37-46]

2) Household-level sewage treatment and technology route selection

The technical route of source control should follow the guiding principles of local classification, local treatment and resource utilization of sewage. For black water, through non-flushing or "water-saving" sanitary toilets, septic tanks, biogas tanks and other facilities, the black water generated by each household will be collected and stored, and when the storage limit is reached, it will be transported to the centralized treatment and disposal site by suction truck, and after composting and harmless treatment, it can be returned to the field or applied to the forest in the form of fertilizer, thus realizing The resource utilization of black water.

For gray water, wastewater such as laundry, vegetable washing and bathing is collected through a pipe network to a small sewage treatment device or a small artificial wetland, and after treating the wastewater in situ, it can be used for watering flowers, plants and trees, and the surplus can be used as road splashing or other reuse. The source control technology route for single-family or joint-family is shown in Figure 3-5. Household level domestic wastewater treatment technology route is suitable for most rural and less developed township areas . [47-65]

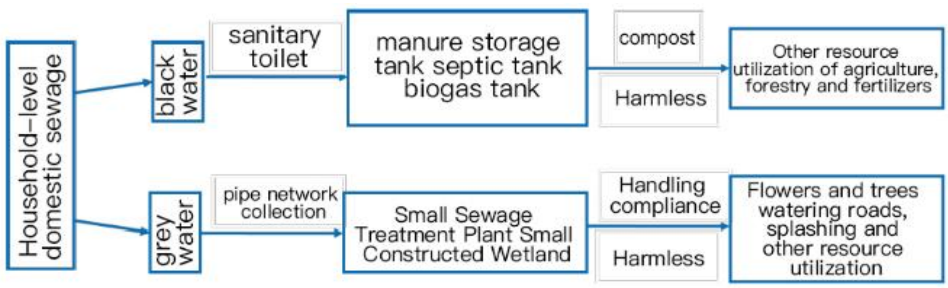

Fig.3-5 Household level domestic sewage source control technology route

(3) Village level sewage treatment and resourcefulness technology route selection

For the village level sewage treatment technology route, firstly, consider to realize the first separation of black water and gray water in each household drainage at the source, then, give priority to the collection of gray water (or black water + gray water) discharged from each household through the diversion system pipe network, and temporarily adopt the collection of combined flow system pipe network if the conditions are not available. The sewage is collected through the pipe network to the treatment station for purification, and the purified sewage can be used for irrigation of trees and plants, reuse of landscape water bodies and river recharge, etc. The technical route of village-level sewage treatment is shown in Figure 3-6. The village-level sewage treatment system is suitable for new rural areas, suburban areas and rural areas with good economic conditions and towns with average economic conditions.[65-75]

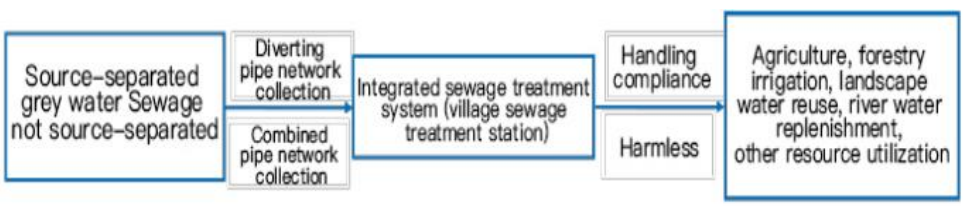

Fig.3-6 village-level sewage treatment technology route

4) Town-level sewage treatment and resourcefulness technology route selection

Town-level sewage treatment technology route design compared with village-level, raw sewage water source, pipe network collection and resource utilization direction is basically the same, the main difference is due to the different scale of sewage treatment, town-level sewage treatment plant should be equipped, standardized, modular system, which is conducive to shorten the construction cycle, and convenient to expand the capacity. Town-level sewage treatment technology route as shown in Figure 3-7. Town-level sewage treatment system is suitable for the township with better economic conditions and small towns with faster urbanization development.[76-87]

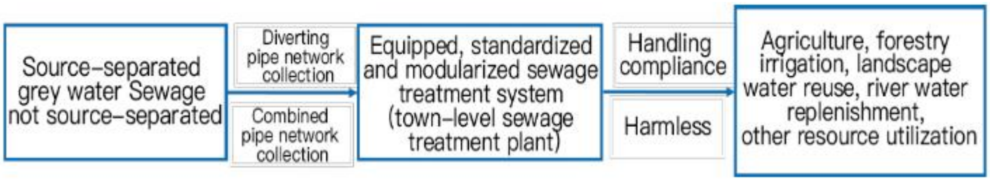

Fig.3-7 Town-level sewage treatment technology

3.3 Current policies and measures for rural sewage treatment

3.3.1 Laws and regulations、technical policies、design specifications and guidelines

China's current laws related to water pollution control have formulated various regulations on water pollution control including villages and towns at the macro level [17]. Various national ministries and commissions have successively issued some technical policies and supporting measures related to the treatment of sewage in villages and towns . However, technical policies for sewage treatment at different levels in rural areas and townships are relatively lacking. At present, the technical (design) specifications related to rural sewage treatment are mainly "Technical Specifications for Rural Domestic Pollution Control" (HJ574-2010), while the treatment of township sewage mainly refers to "Outdoor Drainage Design Specifications" (2014 Edition). There are also problems such as relative lack of norms and guidelines for village and town sewage treatment and lack of consideration of local conditions.

3.3.2 Discharge standards for rural sewage pollutants

The data released by the Ministry of Environmental Protection in 2015, in addition to national standards (referred to as national standards), at the level of local standards (referred to as landmarks), there are 24 currently valid domestic sewage treatment-related discharge standards that meet the filing requirements (details). See Appendix A). Among the many discharge standards for sewage treatment, there is no discharge standard specifically for the treatment of domestic sewage in villages and towns at the national level. Some places either implement the same standards as local cities or watersheds, or uniformly adopt national standards, which leads to the deviation of the water quality standard requirements of villages and towns in China from the actual situation, especially between rural and townships. There is no overall consideration of the emission standards, and there is obviously a "one size fits all" phenomenon. Among the local standards in Beijing, Hebei, Shanxi, Zhejiang, etc., Beijing has the most stringent requirements for the discharge standards of village sewage treatment, which are basically equivalent to or close to the surface water quality standards of Class IV water; on the contrary, Zhejiang has the most relaxed discharge standards. It is between the national standard first-level B and the second-level standard; while Hebei and Shanxi 's requirements for village and town sewage treatment and discharge standards are basically the same as those of the national standard. This further shows that the discharge standards of most villages and townsin China are basically still based on the national standard requirements, and are seldom combined with the actual conditions such as the characteristics of villages and towns' sewage and the level of economic development.

It can be seen that the existing policies and measures of sewage treatment process design specifications, guidelines and pollutant discharge standards in China are mainly aimed at urban sewage treatment, and it is difficult to meet the actual needs of process equipment for rural sewage treatmentin China. If the current national design specifications and discharge standards are directly used to design village sewage treatment facilities, it will inevitably lead to large design scale, complex process flow, high investment and operating costs, difficult construction and implementation, and difficult operation and management [16].

3.3.3 National and local financial support

According to the industry's preliminary forecast on the rural sewage treatment market, in 2016, the annual output value of China's rural sewage treatment reached more than 42 billion yuan; by 2020, the annual output value of China's rural sewage treatment will double on the basis of 2016 , reaching 840 million yuan. By 2025, the annual output value of sewage treatment in villages and towns in China will exceed the sum of the annual output value of the two years in 2016 and 2020, reaching more than 130 billion yuan. Compared with the huge market demand for sewage treatment in villages and towns, the current financial support of the Chinese government for sewage treatment facilities in villages and towns is still a drop in the bucket, and the active participation of civil society capital is urgently needed.

3.3.4 Village sewage treatment planning

At present, most of the villages and townsin China lack systematic planning for sewage treatment, which lacks connection with the development of villages and towns. In addition, due to scattered projects, it is difficult to form a management scale effect, and there are also problems such as lack of long-term management mechanism, imperfect project management system, and management costs crowding out construction funds [18,19].

3.3.5 Other supporting policy measures

In addition to the macro-level guiding policies and measures of the state and various ministries and commissions, various localities have also issued some implementation policy documents and measures. The second "three-year action plan" is to promote the sewage treatment capacity and water resource recycling level in Beijing [20]. The document clearly proposes the working paths and supporting policies of sewage treatment facilities and their supporting pipeline networks in rural areas, and provides support for Tongzhou and Daxing. And Fangshan and other districts and counties have laid the foundation for speeding up the marketization process of rural sewage treatment.

To sum up, under the guidance of national macro policies and measures, although various ministries and localities in China have issued many policies and measures, there are still a lack of supporting policies for the implementation of relevant projects, the implementation of specific measures is not in place, and the responsibility sharing mechanism is not clear. Inconsistent technical standards, lack of financial support, emphasis on construction rather than operation management, lack of unified planning [5] and other problems. Therefore, the complexity of supporting policies and measures for sewage treatment in villages and townsin China still needs to be further studied.

3.4 Difficulties of rural sewage treatment and proposed solutions

It is estimated that at present, less than 30% of the villages and towns in the country have built sewage treatment facilities, but the operation status of the completed village and town sewage treatment facilities is not optimistic. There are more than 80% of villages and towns sewage treatment plants (Stations) cannot operate normally according to the design load, and at least about 50% of the village sewage treatment plants (stations) are already "basking in the sun". The reason for this phenomenon is mainly due to the problems of sewage collection, difficulty in meeting the technical equipment standards, and lack of professional operation and maintenance personnel in the process of village sewage treatment in China. the objective situation that it cannot be established and maintained”.

3.4.1 Difficulty in collecting rural sewage

Due to the lack of overall planning of the water supply and drainage system in the construction process of most villages and towns, the collection of sewage generated by them is very difficult, the construction and implementation are difficult, and the investment cost is high.

For villages and towns that are difficult to collect sewage, for villages and towns to be built, special planning and design for water supply and drainage should be strengthened in the early stage of village and town construction; for existing villages and towns, measures should be taken according to local conditions, and technical methods of decentralized on-site treatment and resource utilization should be adopted [88,89]] to minimize the length of the pipe network.

3.4.2 Difficulty in reaching the standard of total nitrogen and total phosphorus

There are tens of thousands of villages and towns scattered all over the country. Due to the large regional differences in the country, there are plains, hills, mountains and basins; and the geographical and climate of the country is ever-changing, and villages and towns are located in various climatic zones, from tropical to cold, rainy to dry. From warm plains to extremely cold plateaus, this requires high adaptability to different village sewage treatment processes and equipment [94]. At the same time, restricted by factors such as land occupation, construction and operation costs, the current village sewage treatment technology and equipment in China There is a common problem that some indicators such as total nitrogen (TN) and total phosphorus (TP) are difficult to meet the standards.

order to solve the difficulty of meeting the standards of TN, TP and other indicators of process equipment , priority should be given to low-carbon treatment and resource utilization of village sewage [95]. If it is used for irrigation of farmland and forest land, it is not necessary to remove TN and TP . Very good fertilizer. Secondly, for environmentally sensitive areas, on the one hand, consider increasing the process flow and strengthening advanced treatment to ensure that TN, TP and other indicators meet the standards; and for environmentally non-sensitive areas, on the premise of meeting the local environmental capacity control requirements, the emission standard can be appropriately reduced .

3.4.3 Lack of professional technical management personnel

The characteristics of village sewage determine the need for a high level of refined technical organization and management, and facility operation and management requires a strong level of specialization, requiring professional technical management personnel to manage the operation and maintenance [92-95]. However , affected by factors such as the development level, geographical location, traffic conditions, remuneration, and working environment of the villages and towns, it is difficult to employ college students with professional education, which is also one of the important difficulties in the sewage treatment of villages and towns in China.

In view of the lack of professional technical management personnel in villages and towns, professional operation and maintenance enterprises can recruit personnel with lower education on the spot, and provide them with professional training to reduce the cost of operation and maintenance of sewage treatment facilities in villages and towns and improve the efficiency of operation and maintenance. Efficiency and quality.

Based on the above, it is not difficult to find that the phenomenon of "reconstructing light pipes" for village sewage treatment facilitiesin China is very serious. Due to the lack of a long-term operation mechanism during the implementation of the project, the early construction and later operation and maintenance are seriously separated. This is not only impossible. To achieve the purpose of effectively treating sewage, reducing pollution and beautifying the environment, it has caused a lot of investment waste. Therefore, it is necessary to explore and establish an effective management model for sewage treatment facilities in villages and towns.

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Chapter4

INVESTIGATION ON WATER POLLUTION DATA FOR WATER PROTECTION MEASURES — CASE STUDY ON SHANGYU

CHAPTER FOUR: INVESTIGATION ON WATER POLLUTION DATA FOR WATER PROTECTION MEASURES—CASE STUDY ON SHANGYU

4.1 Overview of water environment

4.1.1 Natural environment

Shangyu City is located in the northeastern part of Zhejiang Province , adjacent to Yuyao City in the east, Shengzhou City in the south, Shaoxing County in the west, Hangzhou Bay in the north, and the mouth of the sea. The total area of the city is 1402.6k ㎡. Among them, the land area is 1288.8K ㎡, and the water area of Hangzhou Bay is 113.8K ㎡. The topography of the city is high in the south and low in the north, with low mountains and hills in the south and water network plains in the north half of each point , commonly known as "five mountains, one water and four fields" . The rivers , streams and lakes belong to two major river systems: the Cao'e River and the Yaojiang River : the Cao'e River water system, in addition to the main stream of the Cao'e River, includes the southern low mountains and hills and the streams and lakes in the Dongguan Plain. There are mainly Yintan River, Xiaguan River, Fanyang River and Xiaoshun River. The plain rivers include the Xiaocao Canal and the entire Dongguan River Network. The Yaojiang River system includes streams and lakes in the Yubei Plain in the Fenghui Basin . The rivers in the plain include Shishili River, Shili River, Shibaili River , Yaojiang River, Yuyong Canal, Baili River, Baisong River, Gaixie River, Xiagai River , the central rivers of each hill in the tidal flat, Yantang River and the whole river. Yubei River Network . The lakes include Zaoli Lake , Dabo, Xixi Lake, Lips Lake , Baima Lake, Xiaoyue Lake, Dongbo Xipo , Pogang Lake , Kongjiaao Lake and so on .

4.1.2 River water quality

The evaluation standard adopts "Surface Water Environmental Quality Standard" (GB3838-2002). The water quality evaluation method adopts the single factor evaluation method. There are a total of 28 water quality monitoring stations under the main channels of all rivers in the city , with a total length of 323.4km of the assessed river. According to the annual average value, the length of rivers with surface waters I to III is 147.2 km, accounting for 45.5% of the total river length; %. The main items exceeding the standard are ammonia nitrogen, permanganate index, dissolved oxygen, 5d biochemical oxygen demand, volatile phenol , total phosphorus, and petroleum.

4.1.3 General situation of water resources and spatial distribution of existing water sources

According to the analysis and calculation of 45a hydrological data from 1956 to 2000, the average annual precipitation in Shangyu City is 1.86 billion m^3 ; the total water resources are 935 million m^3 , of which the surface runoff is 744.5 million m^3 , accounting for 79.6% of the total water resources ; the amount of shallow groundwater resources is 190.5 million m^3, accounting for 20.4% of the total water resources. The average water production is 72.5m^3 /k ㎡, and the per capita water resources are 1209m^3 , which is about 1/2 of the per capita water resources in Zhejiang Province ; the cultivated land water resources are about 1544m^3 / 667 ㎡ .

with a guarantee rate of 90%, the city's precipitation is 1.44 billion m^3 , and the river runoff is 505 million m^3 ; the total water demand of all sectors of the city's national economy is 396 million m^3 . The amount of water resources used in the city through water conservancy projects is 185 million m^3 , accounting for 36.6% of the city's river runoff ; the water volume of Changzhao Reservoir is 29 million m^3 ; the inflow water volume of Cao'e River is 44 million m^3 , accounting for 2.5% of the inbound water resources. %. The contradiction between supply and demand of water demand and water resources is prominent. In dry years, the city lacks 138 million m³ of water, accounting for 34.8 % of water demand, which is a relatively serious water shortage area .

1) General situation of groundwater resources

Groundwater in Shangyu City is basically shallow groundwater , and the reserves are not abundant. According to the "Shangyu City Water Resources Comprehensive Planning" [1] compiled by the Shangyu Municipal People's Government, the city's shallow groundwater has an average annual water resource of 190.54 million m³. The annual extractable volume is about 38.96 million m³.

The quality of shallow groundwater is evaluated according to the national standard "Quality Standard for Groundwater" (GB/T14848-93), and the quality of groundwater is classified as Class III to inferior to V. The quantity and water quality of shallow groundwater are shown in Table 4-1.

Table.4-1 Quantity and quality of shallow groundwater[1]

partition name	Groundwater resources (10,000/m3)	Minable volume (10,000/m3)	Groundwater properties	Evaluation results	Exceeded project
Dongguan Plain	1827				
Cao'ejiang District	10108	2655	Pore diving	III	
			Pore confined water	Bad V	Iron, ammonia nitrogen
Yubei Plain	3768	1133	bedrock fissure water	III	
Shilihe District	3320	108	Pore diving	IV	Ammonia nitrogen
Yaozhong District	31				
City total	19054	3896			

2) Overview of surface water resources

The rivers and lakes in Shangyu City belong to two major river systems, the Cao'e River and the Yao River . In addition to the main stream of the Cao'e River, the Cao'e River system includes low mountains and hills in the south and streams, rivers and lakes in the Dongguan Plain . There are mainly Yintan River , Xiaguan River , Fanyang River and Xiaoshun River . The plain rivers include the Xiaocao Canal and the entire Guandong River Network . The lakes include Qianzao Lake , Duanjiang Lake , Zhutong Lake , Linghu Lake , Shuicang Lake , Jianghu Lake , Xieqi Lake , Zhangting Lake , Kangjia Lake , Hejiachi Lake , etc.

The Yaojiang River system includes streams and lakes in the Yubei Plain in the Fenghui Basin. The rivers in the plain include Shishili River , Shili River , Shibali River , Yaojiang River, Yuyong Canal , Baili River , Baisong River, Gaixie River , Tidal Qiuzhong River , Yantang River and the entire Yubei River Network . The lakes include Zaoli Lake , Dabo , Xixi Lake , Lips Lake , Baima Lake , Xiaoyue Lake , Dongbo Xipo , Pogang Lake , Kongjiaao Lake and so on . [1 - 8]

① Cao Ejiang

The Cao'e River is one of the main tributaries in the lower reaches of the Qiantang River. . The main stream is 197km long, the average slope of the main channel is 3.0‰, and the drainage area is 6080k ㎡ (including 4418 k ㎡ above Cao'e). Cao'e River is a mountain stream above Dongshabu . The mainstream Chengtan River originates from Chengtangping Changwu, Shanghu Town , Pan'an City , and flows through Jingling , Chengtan , Shengzhou City, and Cangyan City in Xinchang City . It is called Cao'e River after going down to Nantian and right to Xinchang River; it goes down to the left to take Changle River, flows northward for about 4km, then takes right to Huangze River , flows through the Three Realms, enters Shangyu City at Longpu City, Shangyu City , and goes to Zhang Town, right to Nayintan River . And Xiaguanxi, to Zonaxiaoshun River in Shangpu , flowing through Haoba , to the north of Baiguan, turning northwest, and entering Qiantang River 15km downstream of Xinsanjiang Gate . The main tributary of the Cao'e River in Shangyu City is the Yintan River . , Xiaguanxi , Xiaoshunjiang, etc.

① Yintanxi

The Yintanxi River Basin is located in the remnants of the Siming Mountains in the hilly area in the south of Shangyu . Yinxitan originated from the southern slope of Qiluyan, Yuyao City, entered through Bailongtan Village, Lingnan Township , and merged into the Cao'e River in the south of Yuzhang Town. It belongs to the Cao'e River system. , In Yintanxi City, from Bailongtan Village, Lingnan Township , to the entrance of Cao'e River, the total length of the main stream is 23.4km, the river gradient is 13.6‰, and the drainage area is 71.7 k ㎡. In the city , Yintan River has tributaries such as Yaokeng River , Zhulian River , Zhucun River , Zhangshan River , Xu'ao River and Dingxing River .

③Xiaguan Creek

Xiaguanxi is a tributary of the lower reaches of the Cao'e River . The Xiaguanxi River Basin is located in the remnants of the Siming Mountains in the hilly area in the south of Shangyu . Xiaguanxi is located in the southeast of Shangyu City , at the junction of Shangyu and Yuyao, close to Siming Mountain. It originates from the west slope of Qizhuyan, Yuyao City. The upper part of the basin is the Siming Mountains , where the average annual precipitation exceeds 2000mm, which is the center of heavy rain in southeastern Zhejiang . Xiaguanxi starts from Shenwanqiao Village, Chenxi Township, and reaches the entrance of Cao'e River Confluence in Shangyu City. The main tributaries in the basin are Langjingxi (also known as Xikengxi), Shengxi, Beixiangxi (also known as Chenxi) , Ganxi , Shuangxi , Dongli Village tributary , Shadun Village tributary , Qi'ao Stream , Daxi (also known as Qianxi), Xiadaxi , Zhangxi, Banongxi . Among them, the two sides of Qi'ao River, the tributaries of Shadun Village and the tributaries of Dongli Village are basically mountainous forests, and there are villages along the two sides of the river.

④Xiao Shunjiang

Shengzhou, enters through Puchuanxia Village , and joins the Cao'e River at the Xiaojiangkou of Shangpu Town, with a total length of 69.3km and a drainage area of 547.9k ㎡. There is now Tangpu Reservoir on the Xiaoshun River. From the dam site of the Tangpu Reservoir to Xiaojiang Village (the entrance of the Cao'e River), the length of the river is 8.18km, the gradient of the river is 3.4‰, and the rainwater collection area is 90 k ㎡, accounting for 16.4% of the total basin area. Is a perennial stream.

Tributaries of Xiaoshun River are Huihu River, Jiangcun River , Changshan River , Daguo River and Xiazhang River . Among them , Huihu River is a tributary of Jiangcun River, and joins

Jiangcun River at Huihu Village, Changtang Town ; Xiazhang and Daguo Rivers originate from Longtangang in Shaoxing and Luojiajian in Tangpu Town merge near Xiazhang Village. The Changshan River joins Jiangcun River at the top of Changshan Mountain and flows into Xiaoshun River.

⑤ Yaojiang River System

The Yaojiang River is the southern source of the Yongjiang River . The mainstream Siming Mountain originates from the Miangang Mountains in Yuyao , flows through Liangnong , and exits the Siming Lake Reservoir where it joins the Tongming River (New River Estuary) . After passing through Yuyao, it reaches Ningbo and joins the Yongjiang River, with a total length of 107km. The Tongming River originates from the Liangao Mountain in this city, flows through the Fenghui Tongming Gate, and joins the Siming River at the Xinjiangkou, with a total length of 19.2km. The Shili River is a tributary of the Tongming River . The Shangyu section of the Yuyong Canal , the Baili River, the Baisong River, and the Xiagai River in the northern plain of Shangyu are all tributaries of the Yaojiang River, and join the Yaojiang River through Mazhu and Doumen in Yuyao . There are also 24 rivers in the northern sea flat enclosure belonging to the Yaojiang River system . The bottom elevation of Yantang River is mostly 0.1-0.6m, the side slope is 1:3, and the width of the river bottom is 16-20m. The width of the main channel for drainage can reach 25-36m. The total length of various rivers in the sea flat reclamation area is 180.9km. [9-14]

From Table 4-2, it can be seen that under the current conditions, the average annual water resources available in Shangyu is 389.85 million m³, and the available amount accounts for 42.7% of the river runoff [15].

Table.4-2 The annual average available water resources in Shangyu [25]

(Ten thousand m³)

partition name	river runoff	Availability of river runoff	Extractable groundwater	Reuse rate (%)	total available	Availability (%)
Dongguan Plain	9341	3912			3912	41.9
Cao Ejiang	40898	18601	2655	501	20755	50.7
Yubei Plain	27382	8507	1133	214	9426	34.4
Forty Mile River	13447	480435824	108	20	4892	36.4
Citywide	91213	35824	3896	735	38985	42.7

4.2 Investigation of water pollution

4.2.1 Investigation of point pollution sources

Point pollution sources are mainly formed by the discharge of wastewater from industrial and mining enterprises and the discharge of urban domestic sewage, and there are concentrated sewage outlets. Check the sewage discharge situation of about 128 major industrial and mining enterprises and the domestic sewage discharge situation of each township. The total discharge capacity of point source sewage is 43.434 million t/a, of which industrial point source sewage discharge accounts for 39.9%. The point pollution source pollutants chemical oxygen demand CODcr and ammonia nitrogen NH_3-N emissions are 13514.6t/a and 639.2t/a respectively. CODcr is dominated by industrial pollution, accounting for 55.7%; NH_3-N is all from life.

4.2.2 Estimation of river entry from point sources

The amount of wastewater and pollutants entering the water area of the functional area from the sewage outlet is collectively referred to as the amount of wastewater entering the river and the amount of pollutants entering the river. Only a part of the pollutants emitted by the pollution sources in the land area corresponding to the water function zone can eventually flow into the river waters. The proportion of pollutants entering the river to the total pollutant discharge is the pollutant entering river coefficient (pollutants entering the river /pollutant discharge).

For the sewage outfalls that have monitoring data on water quality and quantity , estimate the discharge of major pollutants based on the discharge of wastewater and water quality monitoring data. Calculation formula of major pollutant emissions :

W row = Q row × C row

In the formula : W row is the amount of pollutants entering the river ; Q row is the amount of wastewater entering the river ; C row is the concentration of pollutants entering the river.

For a sewage outlet with pollution source discharge data but no river discharge outlet data , the amount of pollutants entering the river is calculated using the river entry coefficient method :

pollutants entering the river = the coefficient of entering the river × the amount of pollutants discharged

The sewage directly enters the designated water function area , and its river entry coefficient is 1; if it is discharged into medium and small rivers outside the water function area , and then indirectly enters the water function area, the river entry coefficient CODcr is 0.85, and NH_3-N is 0.48.

According to the above investigation and calculation , the total amount of wastewater entering the river from point sources in Shangyu is 39.091 million t/a, of which the total amount of CODcr entering the river is 12422.6t/a, and the total amount of NH_3-N entering the river is 412.0t/a.

4.2.3 Investigation of surface pollution sources

The water pollution caused by soluble or solid pollutants entering the receiving water body through surface or underground runoff under the action of rainfall runoff in a large range , and there is no centralized sewage outlet. The process of non -point source pollution is complex and there are many influencing factors. The main investigation and analysis of rural domestic sewage and solid waste, the use of chemical fertilizers by farmers, the waste water of scattered livestock and livestock, and the surface runoff are as follows:

1) Survey on rural domestic sewage and solid waste discharge

rural domestic sewage, domestic garbage, and crop straw solid waste . That is, according to the rural population statistics , combined with the distribution of river systems in the region, estimate the river entry coefficient of regional domestic sewage and solid waste. The river entry coefficient of rural domestic sewage is selected according to two situations. From the rural septic tank to the local surface water body, the river entry coefficient CODcr is 0.75 , and NH_3-N is 0.9 ;

2) Investigation of fertilizer and pesticide use and pollution load

According to the water resources zoning survey, the application amount of chemical fertilizer and agricultural contract is calculated and converted into effective components (chemical fertilizer is calculated by nitrogen N and phosphorus P, and agricultural contract is calculated by organochlorine and organic phosphorus). Select the appropriate loss coefficient to estimate the loss of chemical fertilizers and pesticides. The river entry coefficient of the active ingredients of chemical fertilizers is taken as 0.1.

3) Investigation of Distributed Livestock and Poultry Wastewater Discharge

Intensive and large-scale breeding farms have been investigated by point pollution sources, and other large-scale decentralized breeding farms have been counted with townships as the basic unit. Select the appropriate excretion coefficient and loss coefficient to estimate the excretion and loss of pollutants in decentralized livestock and poultry breeding . The river entry coefficient of dispersed livestock and poultry breeding pollutants is taken as 0.1.

4) Survey of surface runoff pollutants

Surface sediments are mainly composed of garbage, atmospheric dust, accumulation of street garbage , animal and plant remains, fallen leaves and some traffic wastes. The total amount of pollutants produced by surface runoff caused by all rainfall in 1a is called the annual pollution load. The calculation of the annual pollution load is carried out by two methods: one is to calculate the sub-rainfall pollution load of each rainfall according to the average concentration of rainfall pollutants and the runoff of each rainfall in the whole year, and then the annual pollution load can be obtained. The other is to calculate the annual pollution load based on the average concentration of runoff pollutants and annual runoff of multiple rainfalls.

Table.4-3 Non-point source production and non-point source inflow in Shangyu

t/a

project	COD_{cr}	NH_3-N	Total nitrogen (TN)	Total phosphorus (TP)
Area source production	24171.3	4814.3	14790.5	6417.7
Non-point source into the river	2417.1	481.4	1479.1	641.8

According to the above investigation and calculation , the calculation results of non-point source production and non-point source inflow into the river in Shangyu are shown in Table 4-3.

4.3 Strategy analysis of water resources protection

According to the water quality status of rivers in Shangyu and the situation of point and surface pollution sources, water function zones are demarcated , water quality targets for water function zones are drawn up, and the pollutant capacity of water function zones is calculated. On this basis, study the countermeasures of water environment protection in Shangyu City, and take engineering and non-engineering measures to gradually restore the self-purification capacity of rivers in Shangyu .

4.3.1 Water function zoning

According to the water environment conditions and favorable to the economic and social development of Shangyu , the main rivers in the city are divided into : 1 protected area, 1 reserved area , 3 drinking water source areas, 5 industrial water areas, 8 agricultural water areas , 2 landscape recreational water areas .

4.3.2 The formulation of water quality targets for water function zones

The method of formulating the water quality target of the water functional zone is : the water quality standard of the functional zone shall be controlled according to Class III ; specifically, it shall be formulated according to the two indicators of CODcr and NH3-N. After comparing the current water quality status of the water function zone with the water quality category indicators of the leading functions of the functional zone , it is formulated in two cases: when the current water quality does not meet the water quality category of the water function zone, the water quality protection target is formulated , and the target can be achieved in stages; When the water quality has met the water quality category of the water function zone, the water quality protection target shall be formulated in accordance with the principle of not increasing the pollution load of the water body . [15 - 20]

4.3.3 Calculation of pollution holding capacity of water functional area

Pollutant holding capacity of the water function zone refers to the maximum allowable load of pollutants that meets the water quality target requirements of the water function zone. Generally, a one-dimensional water quality model is used for calculation of rivers, and it is assumed that the pollutant discharge outlets are evenly distributed along the river in the same functional area , and the following formula is used to calculate :

$$[M]=86.4\times0.365\times(C_s- C_0 \exp(-KL/u)(QKL/u)/(1-\exp(-KL/u))$$

In the formula : m is the pollutant holding capacity of the river reach (t/a); Cs is the target water quality (mg/L); C0 is the initial section concentration (mg/L); Q is the design flow (m^3 / h); u is the average flow velocity under the design flow rate (m/s); k is the comprehensive self-purification coefficient of pollutants (1/d); L is the length of the river section (m).

Q adopts the average flow rate of the dryest month with a 90% guarantee rate; in the centralized drinking water source area , the average flow rate of the dryest month with a 95% guarantee rate is adopted.

Plain river network is determined according to the design water level of the 90% guarantee rate . Therefore, when the water level is low, the flow rate is relatively small, and the flow rate is almost zero. The calculation of its pollutant holding capacity only considers the pollutant holding capacity of a part of the water volume of the water body , and the calculation formula is: [M]=3.65KVCs. In the formula: V is the volume of the water body in this reach (m^3), and the meanings of other symbols are the same as before. K value: CODCr and NH_3-N are 0.10 ~ 0.20/d and 0.05 ~ 0.25/d respectively.

Calculated according to the above design parameters and water quality model , the pollutant -holding capacity of the river network in Shangyu City is shown in Table 4-4.

Table.4-4 Pollutant-holding capacity of river network at different levels in Shangyu

t/a

project	current year	2020 horizontal year
COD_{Cr}	9937.48	11404.93
NH_3-N	1263.41	1042.93

4.3.4 Estimation of pollutants entering the river

Surface water quality protection should take the demarcated water functional area as the basic unit , and the ultimate goal of protection is to decompose the pollutant reduction in the water functional area to the corresponding land pollution source. The data of the current pollutant discharge and river entry are based on the results of the investigation and analysis of waste and sewage discharge , and are decomposed into each water function area. Selecting various typical water function areas , monitoring the pollutant discharge of all pollution sources within the corresponding land area and the pollutants entering the river from all sewage outlets in the water function area, the corresponding typical water function areas can be obtained. The river entry coefficient of the land area. According to the forecasted pollutant discharge amount in each planning level year and the corresponding river entry coefficient , the amount of pollutants entering the river in the planning level year can be obtained. According to the control indicators (CODcr , NH3-N), the current pollutant discharges of the sewage outlets and tributaries of the river corresponding to the planned control indicators of each functional area are calculated respectively , and then according to the sewage outlets and tributaries within the scope of each functional area According to the number of ports, the current pollutant discharge is accumulated , and finally the current pollutant discharge under the planned control indicators of each functional area is obtained. So as to find out the pollution load into the river.

In the current pollution discharge, CODcr is 37685.93t/a, NH_3-N is 5453.50t/a; among them, CODcr13514.61t/a in point pollution sources (industrial sewage CODcr is 7522.21t/a, domestic sewage CODcr5992.40t/a) , accounting for 36.0% of the total CODcr ; CODcr in the surface pollution source was 24171.32t/a, accounting for 64.0% of the total CODcr . CODcr is

39223.11t/a and NH3-N is 5642.37t/a in 2020 level annual pollution emissions .

current pollution load into the river coefficient , using the water quantity and water quality model, the monitoring of the sewage outfall into the river and the water quality monitoring results of the river for many years , are back-calculated to determine . The annual river entry coefficient at the planning level is determined according to the distribution characteristics of industrial pollution sources, the layout of the pipe network of sewage treatment plants, and the distribution of urban and rural populations : wastewater is 0.9, CODcr is 0.85, and NH_3-N is 0.45. The planning level year for the river entry coefficient of agricultural non-point source pollution sources is determined as follows: CODcr and NH3-N are both taken as 0.1.

According to the above analysis and calculation , the pollution load of Shangyu entering the river is shown in Table 4-5.

Table.4-5 The river pollution load table in Shangyu

t/a

project	current year	2020 horizontal year
COD_{Cr}	13904.55	14882.05
NH_3-N	788.24	845.69

4.3.5 Pollutant control and reduction

If the amount of pollutants entering the river exceeds the pollutant holding capacity of the water function area , it is necessary to calculate the amount of reduction in river entry and the corresponding reduction in discharge. Both emission reduction and emission control needs to be further allocated to the corresponding land areas. The difference between the amount of pollutants entering the river in the planning level year of the water function area and the corresponding pollutant-accepting capacity is the reduction amount of pollutants entering the river in the planning level year of the water function area . When the predicted result of the pollutants entering the river in the planning level year of the water function area is less than the pollutant-accepting capacity, in order to effectively control the amount of pollutants entering the river, the control amount of pollutants entering the river should be formulated for the water function area . Pollution of water function zone planning level year

The discharge control amount of the water function area can be obtained by dividing the control amount of dyes entering the river by the river entering coefficient . The reduction of pollutants entering the river in the planning level year of the water function area is divided by the river entry coefficient to obtain the emission reduction of the water function area (see Tables 4-6 and 4-7).

Table.4-6 Shangyu Pollutant Emission Control Scale

t/a

project	current year	2020 horizontal year
COD_{Cr}	20439.86	22408.15
NH_3-N	3146.13	3596.00

Table.4-7 Pollutant Emission Reduction Scale in Shangyu

t/a

project	current year	2020 horizontal year
COD_{Cr}	17246.08	16814.96
NH_3-N	2304.37	2046.36

In order to make the water quality targets of all functional areas in Shangyu meet the requirements of the planning level in 2020, CODcr and NH3-N need to be reduced, and get the amount that needs to be reduced in 2020 : CODcr is 6725.98t/a, NH_3-N is 818.55t/a.

4.3.6 Engineering measures

(1) Speed up the construction and renovation of sewage treatment plants. In 2004, the scale of sewage treatment plants was 100,000 t/d, and there were 66 key industrial polluting enterprises sewage treatment plants, which could reduce the CODCr in industrial sewage to 6437ta every year, accounting for 86.0% of the total industrial emissions . If 50% of the domestic sewage in the city enters the treatment plant, the CODcr in the domestic sewage can be reduced by 3000t/a, and the total CODcr in the industrial and domestic sewage can be reduced by 9437t/a, accounting for 70% of the entire point pollution source load. 25% of the load. The scale of the sewage treatment plant should be expanded as soon as possible to achieve a sewage treatment capacity of more than 250,000 t/d. At the same time, the supporting projects of the sewage interception pipeline network, the rain and sewage diversion project and the sewage interception project of key industrial pollution sources shall be implemented.

(2) Speed up the construction and improve the drainage system. The new drainage system adopts the rain and sewage diversion system , and the existing confluence pipeline adopts the interception and confluence system, and the diversion system is gradually established in the reconstruction of roads and old cities. Speed up the pace of construction of sewage collection system in the towns . Township domestic sewage treatment outside the scope of sewage treatment

plants shall be implemented in accordance with the principle of combining centralized and decentralized treatment. And consider building a sewage treatment plant jointly with the industrial agglomeration area as much as possible. The southern towns and towns with small population and scattered , should adopt various methods such as buried unpowered domestic sewage purification tank or wetland sewage treatment system.

(3) Engineering measures to improve water environment capacity and water self-purification capacity. It mainly includes water engineering scheduling, water diversion and sewage flushing, dredging and silt removal and other projects to improve the polluted water body. Aiming at the river network area of Shangyu City, carry out the river regulation project to improve the water storage capacity and the flood control and drainage capacity of the river. River dredging and dredging will significantly improve water quality ; upstream water enters the river, due to the accelerated flow rate, which is conducive to the degradation of the water body , the increase of dissolved oxygen, and the reduction of chemical oxygen demand, which is conducive to the improvement of the water ecological environment.

(4) Support waste incineration power generation projects. Start the construction of a municipal solid waste incineration power generation project with a processing capacity of 500t/d as soon as possible.

4.3.7 non-engineering measures

(1) Control rural non-point source pollution. Since the pollution load of rural non-point sources accounts for 64% of the total pollution load, the impact of rural non-point sources on water functional areas must be considered , and the use of chemical fertilizers in farmland should be reduced; the management of sewage discharge from animal husbandry and aquaculture should be strengthened , and the impact on water bodies should be Large livestock industries were relocated or closed.

(2) Reduce industrial pollution. Adjust industrial layout and industrial structure, implement cleaner production, meet emission standards, and shut down polluting enterprises. In accordance with the requirements of the total amount of pollutant discharge in each water function area, it shall undertake the responsibility for reducing pollutants from industrial pollution sources , and take comprehensive control measures to prevent and control water pollution.

(3) Establish a cascade water price system, and implement different water prices for special industries such as car washing and bathing industries and large water consumers. The annual total amount of water taken from the river for industrial water use in Hangzhou Bay Fine Chemical Industry Park is controlled : the current level will be controlled within 21 million t/a; the 2010 level will be controlled within 26 million t/a; the 2020 level will be controlled within 34 million t/a within.

(4) Strengthen the publicity of water resources protection laws and regulations, and enhance the public's awareness of environmental protection . Strengthen water quality monitoring in water function areas ; speed up the emergency response to pollution accidents and the construction of information systems.

With the economic and social development of Shangyu City , the problem of water environment has become increasingly prominent. Due to the substandard water quality of the river network , the degree of water shortage is aggravated, and further development is seriously restricted . The water conservancy department has the advantage of synchronizing water quantity and water quality in water resources management, and should undertake the task of water environmental protection technology research. On the basis of sufficient investigation and analysis , do a good job in water function zoning, calculation of pollutant-holding capacity, optimization of water distribution and water quality monitoring, etc. , to transform the qualitative protection and management of the water environment of river water resources into a qualitative and quantitative scientific protection management ; Moreover, under the condition of reducing costs, the carrying capacity of river water environment can be improved as much as possible and make it reach the goal of water function zone , so as to provide guarantee for the sustainable development of Shangyu's economy and society . [21-24]

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Chapter5

TECHNOLOGY RESEARCH OF WASTEWATER RECYCLING

CHAPTER FIVE: TECHNOLOGY RESEARCH OF WASTEWATER RECYCLING

5.1 The need for wastewater recycling

With the increasing shortage of water resources, the utilization of non-traditional water resources has attracted widespread attention from all walks of life. The coupling and complementary utilization of traditional water resources and non-traditional water resources can not only alleviate the contradiction between urban water supply and demand, but also improve the water environment and reduce water disasters, which has huge social and ecological benefits. The implementation plan of Zhejiang Province's "five-water treatment" clearly puts forward the goal of rural sewage recycling in Zhejiang: the utilization rate of sewage recycling should reach 20% by 2022.

At present, the tail water of sewage treatment in Shangyu District is directly discharged into the Qiantang River. Even if the treatment standard is raised to the first-class A standard, the water quality is still lower than the fifth-class water quality. If the use of reclaimed water is implemented in the tail water of the first-class A standard, the pollutants entering the water body can be reduced, so that the ecological environment of the receiving water can be protected and gradually restored. If Shangyu District realizes the utilization of reclaimed water in the future, it will not only alleviate the contradiction between supply and demand of water resources in the future, but also partially solve the problem of tail water discharge from urban sewage treatment plants. Therefore, the development of urban sewage recycling not only makes reasonable use of sewage resources, but also improves the ecological environment and promotes the harmonious development of water environment and social economy in Shangyu District.

5.2 Requirements and uses of wastewater recycling

Sewage regeneration is mainly used for industrial, agricultural irrigation, domestic miscellaneous water, recharge of groundwater, etc.

1) Recycling for industrial use: For a long time, Shangyu District has used a large amount of industrial water, accounting for more than 50% of the total water. Due to different uses, the water quality requirements are also different, and the nature of the discharged sewage is also different. It is uneconomical to require water quality to meet the needs of various engineering departments. If the reused water meets production standards and the cost of wastewater reuse is lower than the price of purchasing "fresh water" from off-site, it can be used as a production water source.

According to different uses of industrial water, the requirements for water quality vary greatly. The higher the water quality requirements, the higher the cost of water treatment. The ideal reuse objects are cooling water and low-quality process water (washing, ash washing, dust removal, direct cooling, etc.). When considering whether a process can utilize recycled sewage, it must meet the required water quality, and calculate the cost of reused sewage and its treatment, in order to maximize economic benefits.

2) Recycling for agricultural irrigation: From the perspective of my country or the world, agriculture is the largest water user, accounting for 2/3 of the world's total water consumption. The use of treated sewage for agricultural irrigation has many advantages and is an economical and practical method of wastewater disposal. The nutrients contained in the recycled water help plants grow and provide additional conditions for the recharge of underground reservoirs. However, if

the quality of sewage cannot meet the requirements, it will damage the soil structure, cause pesticides and heavy metals to accumulate in crops and soil, and reduce the quality of agricultural products. and yield. The limit of pollutants in the recycled water should be based on the type of crops, growth stage and hydrogeological conditions, and the water quality must meet the "Water Quality Standard for Agricultural Irrigation".

3) Recycling for urban domestic water use: At present, reuse water is mainly limited to uses that are not in direct contact with the human body. For example, greening, landscape water in parks, replenishing river water, flushing car toilets, replenishing water in wetlands, etc. Through the reuse of sewage, a good water environment is created for the areas, and the ecological water volume for maintaining the water body is supplemented.

4) Recycling for other uses: In addition to the above-mentioned recycling methods, there are other uses, but due to its poor technical and economic feasibility, it has not been valued and promoted, or even widely recognized, such as sewage reuse. For living and drinking water.

5.3 Analysis of typical process for wastewater recycling

From the perspective of process development, in the 1980s and 1990s, due to the continuous increase in the demand for reclaimed water, the innovation of the regeneration treatment process was also extremely rapid. In addition to the traditional three-stage treatment process, a variety of other treatment processes and units appeared.

At present, the relatively low-level urban sewage regeneration treatment process is used for agricultural irrigation or other low-level purposes after primary treatment; the most common is coagulation, sedimentation, filtration and disinfection after secondary treatment, used in urban Landscape, urban miscellaneous and some industrial water; the more advanced is the reverse osmosis membrane treatment process, that is, primary (intensified) treatment + secondary (intensified) treatment + coagulation + sedimentation + filtration + activated carbon adsorption + reverse osmosis + disinfection, This set of processes can meet the drinking water quality requirements stipulated by the World Health Organization. The city of Denver in the United States used this process to conduct a demonstration study of urban sewage recycling for drinking. Windhoek, the capital of Namibia in South Africa, adopts a double-membrane (ultrafiltration + reverse osmosis) treatment process to regenerate urban sewage and use it directly for drinking. It is currently the first and only urban sewage in the world after regeneration. for drinking water plants.

The concept of sewage regeneration discussed in this plan is based on the effluent of secondary treatment of urban sewage. The objects to be removed in urban sewage regeneration mainly refer to the pollutants that need to be removed for the effluent of secondary treatment to meet the corresponding water quality requirements. Based on the investigation of various reclaimed water quality and the needs of reuse users, the main removal objects of urban sewage regeneration treatment are SS, BOD, COD, TN, TP, viruses, bacteria, natural organic matter, a small amount of heavy metals, hardness, turbidity, dissolved inorganic substances Salt, these objects have their own corresponding indicators to reflect their concentration and pollution level. Combined with the experience of urban sewage treatment and reclaimed water treatment, drawing on some similar theories in water supply and industrial water treatment, the removal objects and commonly used treatment units of reclaimed water treatment are summarized in the following table:

Table.5-1 Wastewater recycling process

Process unit		Representative unit operations
Physical separation	Precipitation separation	Gravity sedimentation of sedimentable particles or floc particles from sewage by physical sedimentation methods: grit chamber, primary sedimentation tank Gravity Settling of Suspended Flocs: Secondary Settling Tank
	Filter separation	Removal of floc particles from secondary treated effluent through quartz sand or other filter media Direct filtration of secondary treated effluent: sand filter or other type of filter Filtration of coagulation effluent: sand filter or other type of filter
Biological treatment	Aerobic biological treatment	Removal of Dissolved Organic Matter and Suspended Solids from Wastewater by Microbial Metabolism Conventional Activated Sludge Process: Aeration Tanks Biofilm Reactor: Biofilter, Contact Oxidation
	Phosphorus and Nitrogen removal	Reduce nitrogen and phosphorus content in reclaimed water through functional design of microbial treatment system
		Biological dephosphorization and nitrogen removal: Through the combination of anaerobic, anoxic and aerobic reaction tanks, the physiological functions of phosphorus removal bacteria, nitrifying bacteria and denitrifying bacteria are used to remove nitrogen and phosphorus nutrients in sewage Chemical synergistic phosphorus removal: adding lyo salt and iron salt to increase phosphorus removal by biological treatment system
	Other biological treatments	Biological stabilization pond, artificial wetland, land treatment, etc.
Physical and chemical treatment	Chemical coagulation	The destabilization of colloidal substances and the formation of flocs are promoted by the addition of salts, iron salts, and polymeric molecules, and metal phosphate precipitates are formed at the same time, which are then removed by gravity sedimentation or filtration. Chemical coagulation and sedimentation of secondary treatment effluent: chemical phosphorus removal, suspended solids or colloidal material removal Chemical coagulation filtration of secondary treatment effluent: chemical phosphorus removal, suspended solids or colloidal material

		removal
	Lime treatment	By adding lime to settle cations, heavy metals, phosphates, suspended solids and colloidal substances, reduce scale formation, adjust pH, and inactivate pathogens
	Membrane Filtration	Removal of particulates and microorganisms in secondary treated effluent or chemically precipitated effluent by membrane filtration: microfiltration, nanofiltration, ultrafiltration
	Activated carbon adsorption	Removal of hydrophobic organic pollutants through physical adsorption on the surface of activated carbon
	Ion exchange	Efficient removal of cations (eg calcium, magnesium, iron) and anions (ammonia) by ion exchange resins
	Reverse osmosis	Removal of inorganic salts, soluble substances and pathogens through the separation of high-grade particles in aqueous solutions by different reverse osmosis pressures
Disinfection		Pathogens are removed and inactivated by chemical and physical methods to ensure public health and health Oxidative substances: chlorination, ozone, chlorine dioxide Radiation: UV disinfection Heat treatment: heat sterilization

The rural sewage recycling project is actually a complex and sensitive system project. It proposes to do special economic and technical analysis and research on the construction of the recycled water utilization project according to the characteristics of water resources and water consumption in Shangyu District. It is recommended to focus on the research on how to further treat the tail water of domestic sewage treatment after the treatment of Shaoxing Sewage Treatment Plant and Shangyu Sewage Treatment Plant to improve the quality and standard, as a large industrial water user with low water quality requirements (such as cooling water for thermal power plants, etc.), greening, Possibility, reliability and economy of miscellaneous water such as road watering.

On the other hand, it is necessary to speed up the reform of water prices and the opening of the water industry market, to form a reasonable price relationship between tap water, sewage and reclaimed water as soon as possible, and to diversify the investment subjects of sewage resource construction as soon as possible. At the same time, increase publicity and guide to change the concept of water use, and first of all, the concept of reclaimed water resources should be truly formed in terms of ideological concepts.

5.4 Membrane separation technology study in the recycling of water resources

5.4.1 Introduction

Currently ,water scarcity has become one of the main problems in our society ,as the global demand for fresh water for agricultural ,in- dustrial and the rapid development of the economy Seriously ,surface and groundwater contamination produced by the discharge of industrial wastewater further aggravates the problem of water scarcity [1,2].In many industrial sectors, steel industry produces a large amount of cold-rolling wastewater [3].The steel industry is one of the largest energy-intensive and water-intensive process industries.Fresh water is mainly used in facilities cooling process and environmental applica- tions， like the sanitary applications and wet gas cleaning, especially in integrated routes that produce steel from fossils and iron ore [4]. Therefore ,the wastewater generated by different processes always has specific characteristics ,and water treatment variability is mainly ascribed to the differences of process conditions. Cold-rolling waste- water discharged in steel industry is usually treated with aerobic MBR after floatation ,coagulation and sedimentation ,however ,the aerobic MBR effluent typically presents high inorganic salt contents [5,6]. As a consequence, the effective treatment of aerobic MBR effluent not only can restore important water pollution resource, but also reduce the amount of fresh water used by the industry .As a remedy ,due to its importance for environmental protection, zero discharge of industrial wastewater has been emerged as a hot topic .To achieve zero liquid discharge industrial wastewater desalination，three steps are necessary: desalination ,concentration and recovery of salts. In the previous works, vacuum evaporation was selected to treat the high-salinity solutions in order to produce separate streams of salts and freshwater, but the pro- cess consumed 20–25 kW h/ m^3 of power [7,8]. Pisarska et al. proposed the use of electro-electrodialysis for the treatment of wastewater from cyclohexanone production ,but the energy consumption for electro-electrodialysis limiting its range of applications [9]. Further- more, Na_2SO_4 is a cheap chemical at the market. The concentrate so- lution formed by salt recovery is energy consuming and the impurities inNa_2SO_4always make it unsaleable. Therefore, the improvement of salt value is also a considerable problem in the following studies.

Due to the application of more energy-efficient pumps and advanced membranes, membrane technologies processes are coming closer to the minimum energy consumption. Electrodialysis processes (ED),such as conventional electrodialysis (CED), selective-electrodialysis (SED) and bipolar membrane electrodialysis (BMED),are separation process for the concentrating and desalination of high-saline solution under the applied electrical potential difference, which has been widely used in seawater desalination and treatment of concentrated brine [10-13]. It is suitable for recycling salts and regenerating freshwater to avoid the discharge of concentrate solution to the environment. Zhou et al. presented a new technique for lithium recovery from primary resource by ED process [14]. Nazila et al. studied the lithium recovery from Na+-contaminated LiBr solution by ED [15]. Yan et al. carried out investigations on an ED membrane stack treating high-salinity solutions through multistage-batch ED [16]. As a consequence, the results indicated that ED has been emerged as a potential technique to process the polluted salts solution [17]. Furthermore, BMED has been investigated to convert various salts (such as NaCl, LiCl and Na2SO4) into their corresponding acid and base without other addition ofchemicals. Li et al. demonstrated the feasibility of HCl and $NH_3 \cdot H_2O$ generation for the recovery of ammonium chloride wastewater by BMED [18]. Qiu et al. carried out experiments on ED and BMED stack processing salt lake brine for the recovery of LiOH [19]. Meanwhile, reverse osmosis (RO) has been demonstrated to be the lowest cost energy and efficient technique to concentrate salts and simultaneously produce freshwater, such as iron and steel wastewater treatment [20]. Especially, integrating RO with ED has been investigated previously for brine water desalination, copro- duction of salt and water from seawater and for industrial water treat- ment. Qiu et al. presented a high-level process integrating RO and multi-stage ED for producing Li_2CO_3 from lithium-containing waste- water [21]. Zhang et al. evaluated the economics of hybridizing ED and BMED process for producing fresh water and sodium hydroxide from RO effluent [22]. Therefore, it is meaningful to treat cold-rolling wastewater discharged from MBR effluent and recovery of acid/base in a full-scale reclamation scheme with advanced integration technologies.

Herein, in this study, a combination zero liquid discharge of RO, ED and BMED for salt concentration and acid/base production, with optimal operating parameters, is proposed to process the cold-rolling wastewater. As shown in Fig.5-1, the cold-rolling wastewater firstly is pretreated by ion-exchange resins (IER) for absorbing the Mg^{2+} and Ca^{2+} in the wastewater.Then the IER effluent was concentrated via RO process. In order to achieve solution with high-saline, the solution was concentrated with a two-stage ED process.The effects of voltage drop, membrane type and volume ratio were investigated through concentration factor,energy consumption and water transport. Furthermore, the effluent from two-stage ED dilution solution could be treated by RO process again. The ED concentrate solution, which enriches Na_2SO_4, can be used for the BMED process to recycle the NaOH and H_2SO_4. However, before the treatment of BMED process, the ED concentrate solution was processed by ion-exchange resins for the treatment of Mg^{2+} and Ca^{2+} again. Subsequently, the parameters such as membrane type and volume ratio between feed and acid/base compartment were studied during BMED process. A small amount of acid and base could be used to regenerate and transform the exhausted cation-exchange resins as well.The findings of this study would not only enrich reference for the treatment of cold-rolling wastewater, but also provide guidance for optimization process.

5.4.2 Experimental

1） Materials

The cold-rolling wastewater was obtained from Baosteel in Shanghai Province,China.The main compositions of the cold-rolling wastewater are illustrated in Table 5-2.The used cation-exchange membranes were CMX (Tokuyama Co., Japan), FKB (FuMA-TechGmbH Co., Germany) and CMB (ASTOM Co.,Japan). The tested anion-exchange membranes were AMX (ASTOM Co., Japan), FAB (FuMA-TechGmbH Co., Germany) and AHA (ASTOM Co., Japan). BP-1E (ASTOM Co., Japan) was selected as bipolar membrane was. The main properties of the commercial membranes are given in Table 5-3. The membrane used in RO process was purchased from GE Power & Water Technologies.The solutions of NaOH and H_2SO_4 were made from analytical grade reagents (Aladdin, China). The material characteristics of RO membrane provided by the manu- facturer are presented in Table 5-4.The physical and chemical properties of 732 resins were given in Table 5-5.Deionized water was used in all experiments.

2 ）Experiment setup and process design

To avoid the phenomenon of membrane fouling caused by Ca^{2+} and Mg^{2+}, a deep removal process of IER is carried out in this study. In the following experiment, a laboratory-scale IER column (10 cm in diameter and 60 cm in height) into which a kind of cation-exchange resin (732, Solarbio Co., China) is contained for further removing Ca^{2+} and Mg^{2+}. Meanwhile, a magnetic pump is carried out to drive the cold-rolling wastewater from brine tank to effluent tank at the constant flow rate of 5 BV/h.

The units of RO experimental set-up contained retentate tank, permeate tank, membrane cell, manometer, rotameter and rotary vane pump. The RO membrane should be circulated by 2 % citric acid for 30 min before the experiment subsequently circulated by deionized water at an experimental pressure of 10 bar. During the operation of IER process, the retentate tank initially fed with cold-rolling wastewater from IER effluent tank. The cold-rolling wastewater would be concen- trated in retentate tank at an experimental pressure of 30 bar. After the experiment, the fresh water from RO permeate solution could be used in the process of resin regeneration.

Table. 5-2 The main compositions of the cold-rolling wastewater

Parameters	Wastewater
Na^{+} (mg/L)	1853.20
Ca^{2+} (mg/L)	254.01
Mg^{2+} (mg/L)	364.80
Fe^{3+} (mg/L)	0.03
$SO^{2-}{}_4$ (mg/L)	5988.54
Cl^{-} (mg/L)	87.21
Conductivity (mS/cm）	10.89

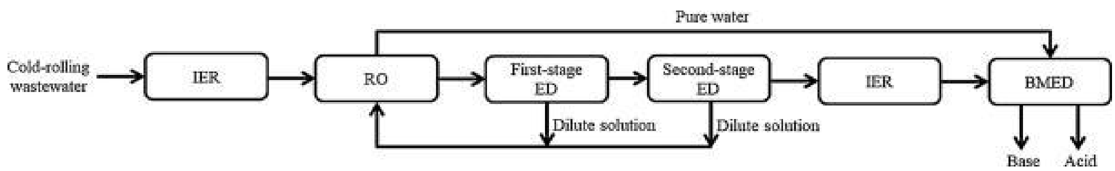


Fig.5-1. The scheme for the treatment of cold-rolling wastewater.

Table.5-3 Characteristics of ED and BMED membranes.a

Membrane type	Tickness (μm)	Ion-exchange capacity (meqg^{-1})	Area resistance (Ω cm^2)	Permeaselectivity (%)
AMX	120 − 180	1.5 − 1.8	2.0 − 3.5	>96
CMX	140 − 200	1.5 − 1.8	1.8 − 3.8	>96
AHA	150 − 240	1.5 − 1.8	2.6 − 6.0	>93
CMB	180 − 250	1.5 − 1.8	2.5 − 6.0	>97
FAB	130 − 160	>1.1	<3	>95
FKB	110 − 130	1.2 − 1.3	<5	>96
BP-1E	160 − 230	–	–	–

a The performance of membranes are collected according to the reference [23].

Table. 5-4 Material characteristics of the RO membrane.

Parameters	Strong acid cation-exchange resin
Membrane type	ULP1812-50
Material	Aromatic polyamide
Type	Spiral-wound
Effective area	0.32 m^2

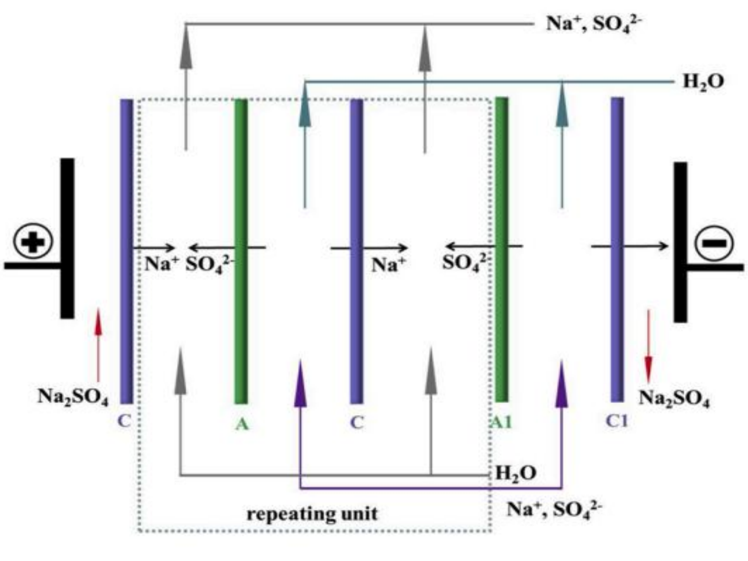
Table.5-5 Characteristics of the 732 resin.

Characters	Strong acid cation-exchange resin
Matrix structure	Crosslinked copolymer
Functional group	Styrene sulfonate group

Physical form	Amber colored moist beads
Particle size distribution	0.40 − 0.60 mm
Total exchange capacity	mmo1/mL≥1.90
Moisture content	40 − 50

The schematic of the ED and BMED stack were illustrated in Fig. 5-2. The operational two-stage ED stack was mainly divided into the following sections: (1) five repeating unit, each unit was composed of anion-exchange membranes (A = 189 c ㎡) and cation-exchange membranes (C = 189 c ㎡) in series; (2) each membrane was isolated by the spacers with thickness of 0.7 mm; (3) each unit was divided into a dilute compartment and a concentrate compartment; (4) the RO concentrate was added into dilute and concentrate tank, respectively; (5) 3% Na_2SO_4 solution was added into electrode tank. Similarly, the BMED stack was mainly divided into the following sections: (1) five repeating unit, each unit was composed of bipolar membrane (A = 189 c ㎡),anion-exchange membranes (A = 189c ㎡) and cation-exchange membranes (C = 189 c ㎡)in series; (2) each membrane was isolated by the spacers with thickness of 0.7 mm; (3) each unit was divided into a feed compartment, base compartment and acid compartment; (4)feed tank was fed with 16.36% salt solution from second-stage ED concentrate solution, base tank and acid tank were fed with deionized water; (5) 3% Na_2SO_4 solution was selected as the electrode rinse solution in electrode tank. Before the ED and BMED experiment, the solution in each tank should circulate about 30min to eliminate the gas bubbles on the membrane surface. In order to obtain a high-saline wastewater, a two-stage ED process was operated with different volume ratios between dilute and concentrate tank.

(a)



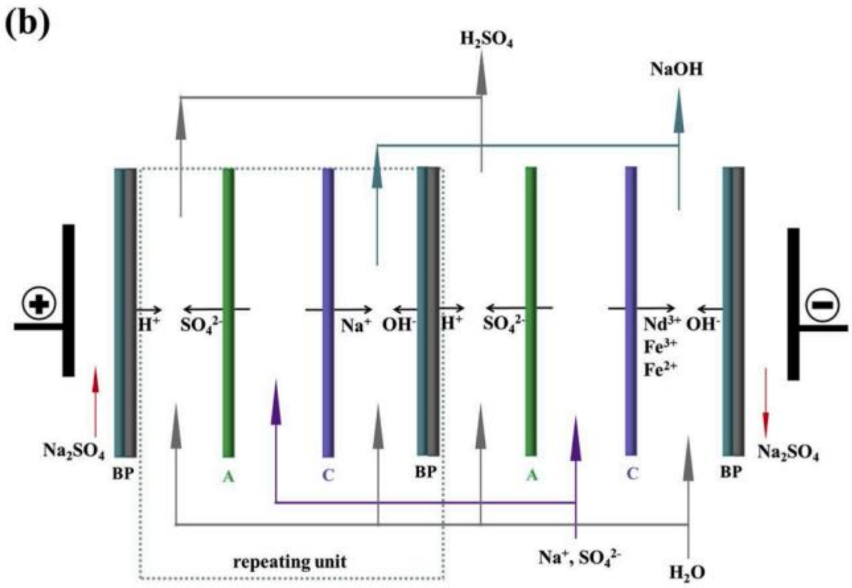


Fig . 5-2 ED configuration (a) and BMED configuration (b).

3 ）Analytical methods

The concentrations of Na+, K+, Ca2+, Mg2+, Fe3+ were measured by ICP-MS (Elan DRC-e, PerkinElmer, USA), respectivity. The concentra- tions of $SO^{2}{}_{4-}$ and Cl- were measured by ion chromatography (792 Basic IC, Metrohm, Switzerland).The solution conductivity was analyzed by a conductivity meter (S220 type, Mettler Toledo, Switzerland).Theconcentration of NaOH was measured with a standard H2SO4 using methyl orange as indicator.The H2SO4 concentration was determined by measuring a standard NaOH using phenolphthalein as indicator. Voltage drop and current were recorded directly from the power supply.

4） Data analysis

The current efficiency η (%) of ED was defined as Eq. (1) [24]:

$$\eta = \frac{z\,(C_t V_t \text{ -} C_0 V_t)\,F}{N\,I\,t} \times 100\% \tag{1}$$

where C0 and Ct(mol/L) are the concentration of Na2SO4 at time 0 and t, respectively; V0 and Vt (L) are the solution volume in the concentrate tank at time 0 and t, respectively; F = 96,485 C/mol indicates the Faraday constant; N = 5 represents the number of repeating unit; I (A)indicates the applied current.

The energy consumption E (kWh/ m³) of ED can be defined as Eq. (2):

$$E = \int_0^t \frac{U_t I d_t}{V_d} \tag{2}$$

where Ut (V) is the voltage drop across the ED stack at time t, respec- tively; Vd is the initial volume of the dilute solution.

The average flux of Na2SO4 can be defined as Eq. (3):

$$J_{ED} = \frac{C_t\ V_t}{N\ A\ t} \tag{3}$$

where A is the effective membrane area.

The water transport (WT, %) was calculated as Eq. (4) [25]:

$$WT = \frac{V_0 - V_t}{V_0} \tag{4}$$

where V0 and Vt (L) represent the solution volume in the concentrate tank at time 0 and t, respectively.

5.4.3 Results and discussions

1 ）Pretreatment of cold-rolling wastewater via IER/RO process

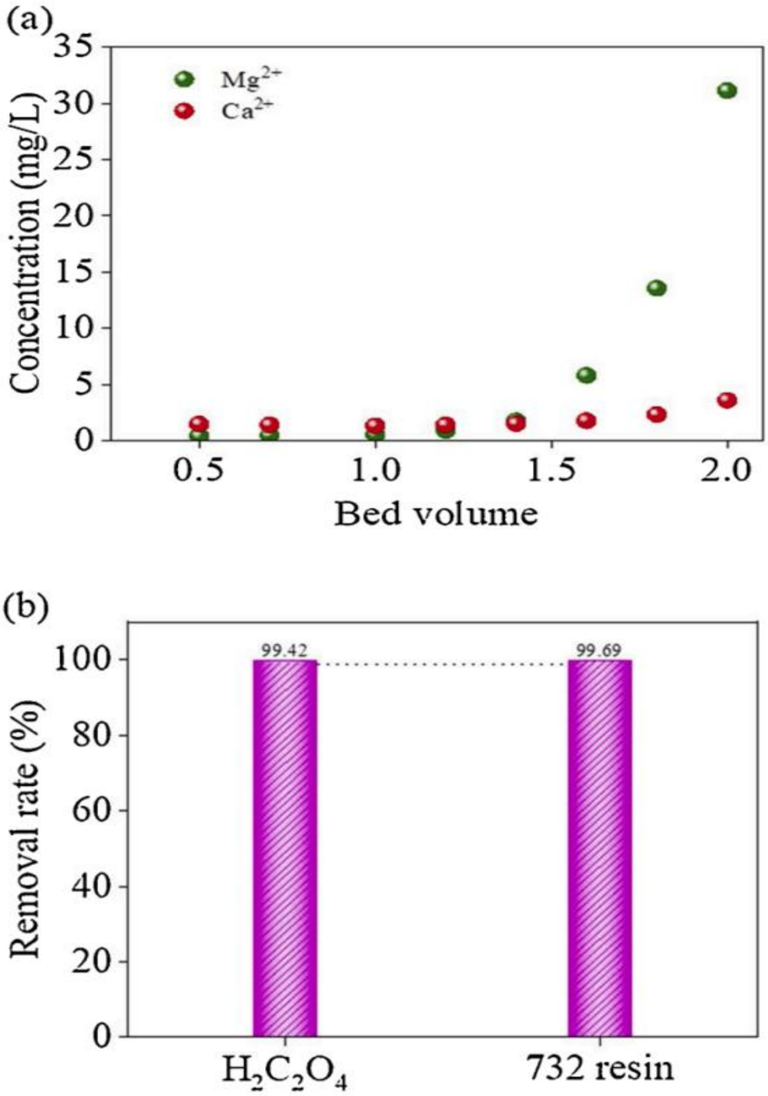
According to the reference, RO filtration process can be defined as a cost-economic procedure to preliminary treat the wastewater with low conductivity [25]. In the following experiment, breakthrough curves of Ca^{2+} and Mg^{2+} were analysed by processing of cold-rolling wastewater.

After the IER process, the resin was washed by fresh water from RO process. And then, the resin was regenerated with 4% H2SO4 solution from BMED process. Furthermore, the IER effluent was introduced into the RO retentate tank for achieving a high-saline solution. The influence of operating pressure (30 bar) on the concentration factor and permeate flux during RO filtration operation was studied. The initial volume of 10 L cold-rolling wastewater was added to the retentate tank, and the following experiment was stopped when the conductivity of retentate approached 35 mS/cm.

Fig.5-3a shows the Ca^{2+}/Mg^{2+} breakthrough curves for the resin at different bed volumes.The results showed that the experimental time for the breakthrough point was significantly affected with increasing the bed volume of cold-rolling wastewater, which indicated that the measured resin capacity was limited below 1.6 BV. This is because there were not enough active sites on the resin to adsorb so much Ca^{2+}/Mg^{2+} from the cold-rolling wastewater.Furthermore the comparison of IER with chemical precipitation was displayed in Fig. 5-3b. It can be observed that the removal rate of Ca^{2+}/Mg^{2+} by using H2C2O4 was 99.42%, while the removal rate of Ca^{2+}/Mg^{2+} achieved by used resin was 99.69%. Obviously, the byproduct of CaC_2O_4 and MgC_2O_4 may pollute the environment via chemical precipitation,but the application of resins effectively avoided the problem. In the following experiments,considering the concentration of Ca^{2+}/Mg^{2+} would be enriched by ED again, IER should be conducted to treat thewastewater in order to mitigate the membrane fouling during BMED process.

Fig.5-3c shows the temporal evolution of permeate flux and concen- tration factor after 100 min filtration. It can be seen that the permeate flux presents a decreasing trend as a function of time, simultaneously, the concentration factor increasing with time. The decline of RO permeate flux in a continuous working mode is caused by the contributions of the increment of the osmotic pressure in the retentate tank [26].

Moreover, RO produces the permeate solution with low conductivity (fresh water),and the retentate solution of Na_2SO_4 could be used as the ED feed solution for deep concentrating. According to the experimental data,the final salt concentration was 3.17 times higher than the initial wastewater salt content, and the average permeate flux approximately reached a high value of 35.9 L/㎡ h.



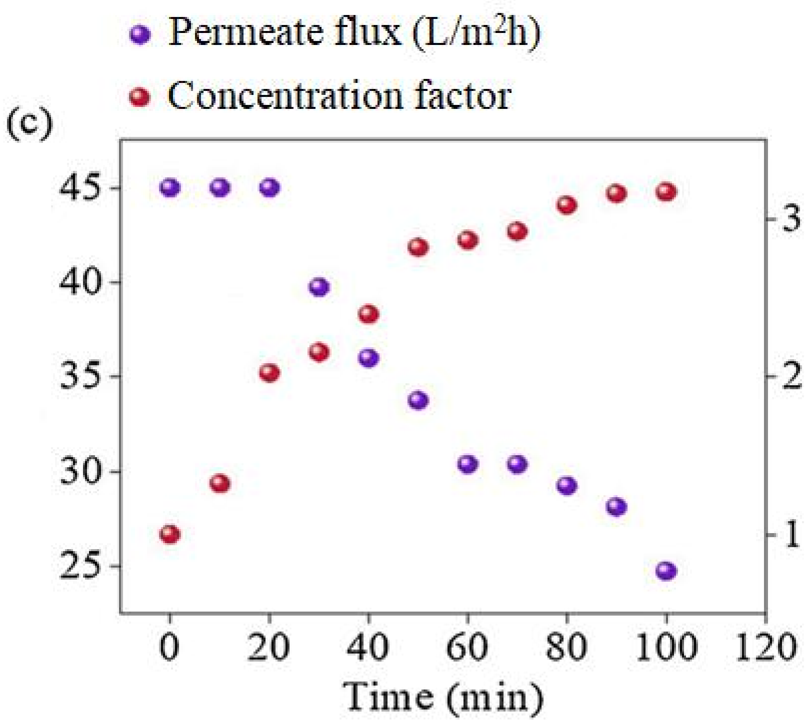
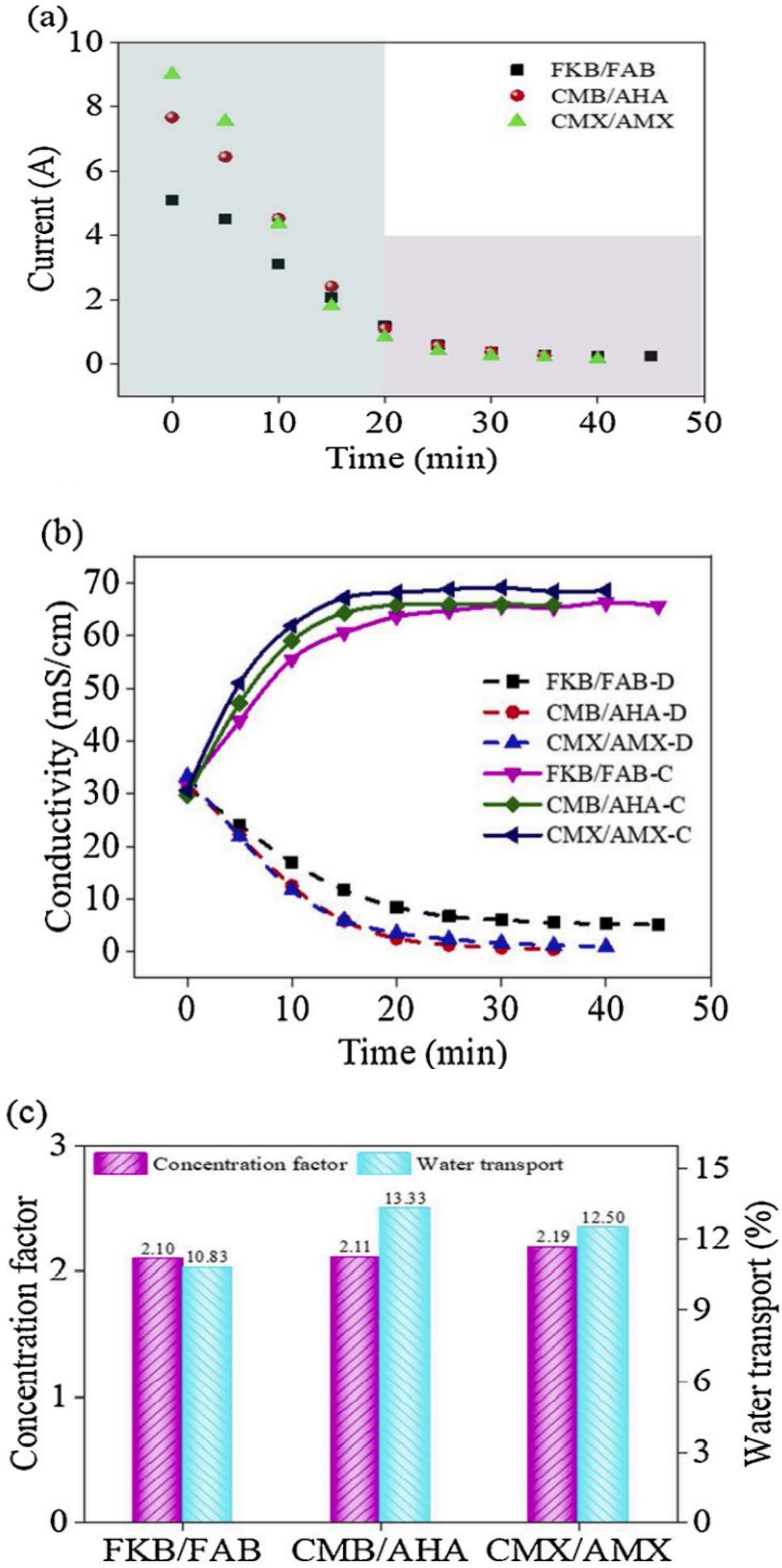


Fig. 5-3 (a) Breakthrough curves for the 732 resin, (b) removal rate via chemical precipitation and 732 resin, (c) permeate flux and concentration factor in RO process.

2） Two-stage ED process for salt concentration

A.First-stage ED performances of membrane type

The ED stack performance is mainly affected by the membrane per- formances . In agreement with the different functional groups and polymer skeleton structure of membranes ,they exhibit different desa - lination and concentrating abilities [27]. In this section, three types of commercial membrane stacks were used in ED process. The initial volumes of dilute and concentrate solutions were selected as 600 mL and 300 mL, respectively. The voltage drop applied on the ED stack was fixed at 10 V. Fig. 5-4a illustrates the current change for various membrane stacks, i.e., FKB/FAB, CMB/AHA and CMX/AMX. During the ED process, it was found that the current across the ED stack exhibits a downward trend. The current declined sharply during the initial phase of experi- ment, which was mainly due to the decrease of Na_2SO_4 conductivity in the dilute compartment. Subsequently, the current curve reached a stable state in the subsequent phase after 30 min of experimental time. The reason for this phenomenon suggests that the resistance of the membrane stack is almost constant at the latter period of experiment. The relationship between the membrane type and conductivity of dilute


(a)
FKB/FAB
CMB/AHA
CMX/AMX
Current (A)
Time (min)
(b)
FKB/FAB-D
CMB/AHA-D
CMX/AMX-D
FKB/FAB-C
CMB/AHA-C
CMX/AMX-C
Conductivity (mS/cm)
Time (min)
(c)
Concentration factor
Water transport
2.10
10.83
2.11
13.33
2.19
12.50
Water transport (%)
FKB/FAB
CMB/AHA
CMX/AMX

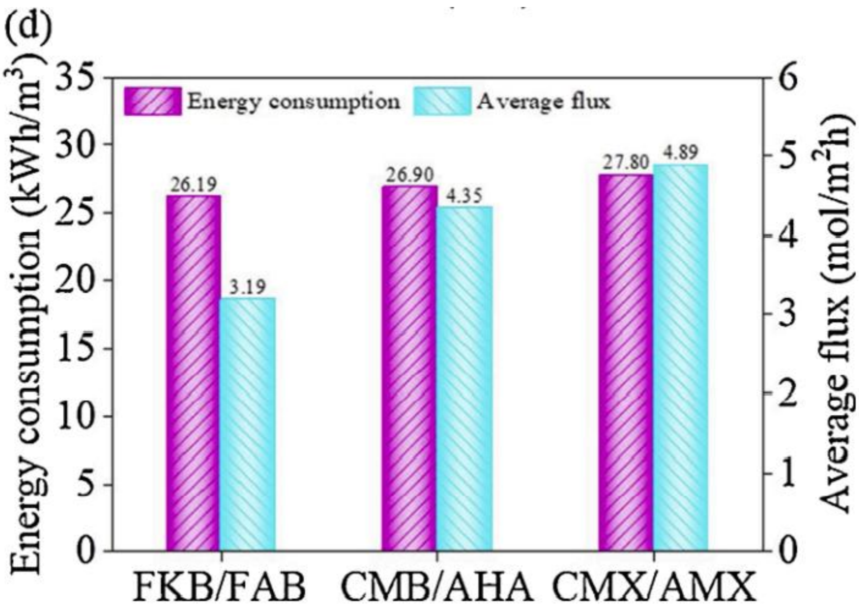


Fig. 5-4 Effect of membrane type on the concentrating process: (a) current, (b) conductivity of dilute and concentrate solution, (c) concentration factor and water transport, and (d)energy consumption and average flux.

and concentrate solution is illustrated in Fig. 5-4b. The feed solution conductivity of dilute compartment decreases with the migration of Na^+ and SO_4^{2-}. Meanwhile,the conductivity of concentrate solution displays a relatively slow upward trend at the latter period of experiment, which is ascribed to the higher concentration-gradient between the concentrate and dilute compartment. With the migration of Na+ and SO_4^{2-} , the phenomenon of co-ions leakage across the ion-exchange membranes was occurred subsequently. This has been verified by many previous literature reports [28].

Fig. 5-4c illustrates the influence of membrane type on the concentration factor and water transport.It can be seen that that CMX/AMX stack shows a better concentration factor (2.19) than the other membrane stacks.Furthermore, the water transport of CMB/AHA stack is higher than the other membrane stacks. Obviously, the phenomenon of water transport significantly affected the concentration factor. The occurrence of water transport in ED process is usually caused by two reasons.On the one hand, the concentration-gradient-osmotic is caused by concentration difference between concentrate and dilute compartment. On the other hand, electro-osmosis is promoted by the transport of hydrated ions under an electrochemical potential gradient [8,29]. Because the concentration-gradient of the three membrane stacks are very similar, the differences between concentrating factor and water transport are caused by electro-osmosis. According to the literature, the electro-osmosis is directly related to the membranes compactness. The ion-exchange membranes with a dense structure can effectively minimize the phenomenon of water migration, thereby increasing the concentration factor [30] .

Fig.5-4d illustrates the influence of membrane type on the energy consumption and Na_2SO_4average flux.The energy consumption for FKB/FAB stack approached a lowest value at

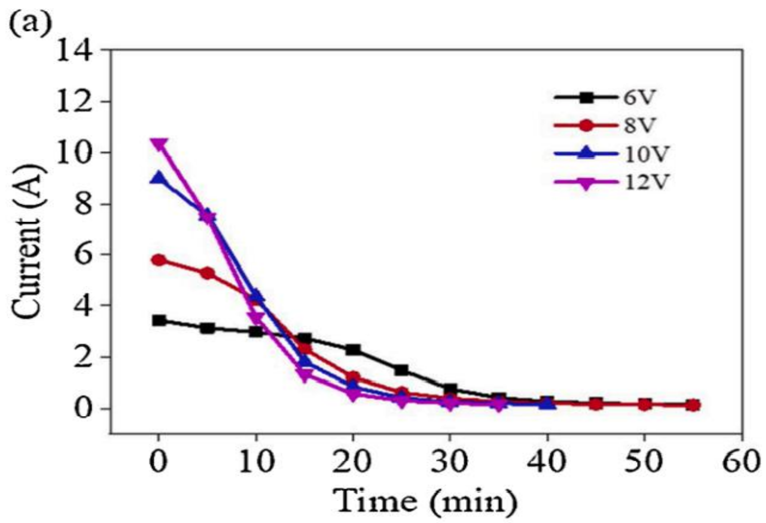
26.19 kW h/ m^3, comparing to 26.90 kW h/ m^3 and 27.80 kW h/ m^3 for CMB/AHA and CMX/AMX stack,respectively. A possible reason for this effect is mainly caused by the lowest water transport observed for FKB/FAB stack.Meanwhile, a highest Na_2SO_4 average flux of 4.89 mol/㎡ h could be obtained by CMX/AMX stack, which is higher than the obtained values for other membrane stacks. According to mass flux continuity principle in ED concentrating process,the Na_2SO_4 average flux is proportional to the transport number of membrane and current across the membrane stack.

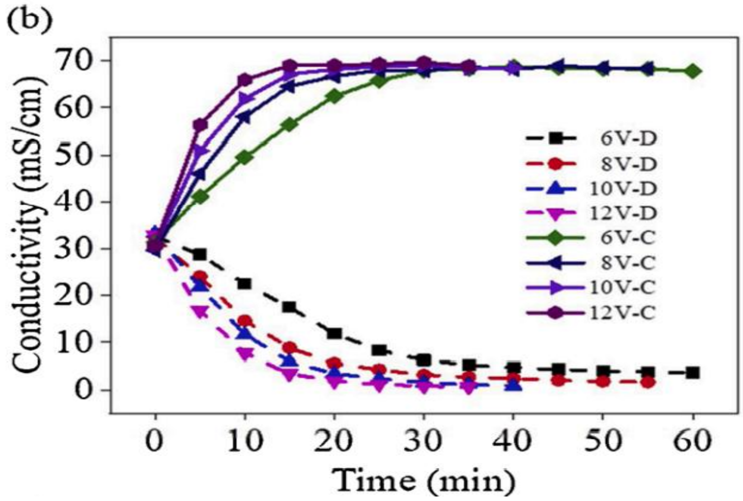
The current applied on the CMX/AMX stack was the highest compared to the other two membrane stacks.Therefore, CMX/AMX stack achieved a relatively high average flux by considering the similar transport number of different ion-exchange membranes.Considering the higher concentration factor and Na_2SO_4 average flux, CMX/AMX stack is more suitable for Na_2SO_4concentrating in further experiments.

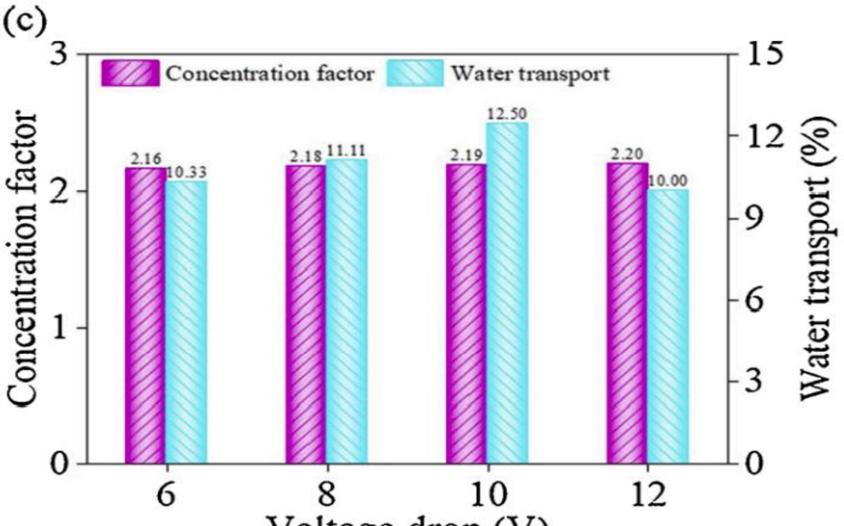
B.First-stage ED performances of voltage drop

The voltage drop is considered as an important parameter affecting the ED stack performance.Generally,thevoltage drop applied on one unit of ED stack is in the range of 0.5–2.5 V. In this section, the selected voltage drops were 6, 8, 10 and 12 V with CMX/AMX stack. Fig.5-5a shows the temporal evolution of current in the course of ED process at different voltage drops. As expected, the highest current value was achieved for 12V voltage drop at the beginning of the experiment. As the voltage drop increases from 6 V to 12V, the total operation time easily decreases from 60 min to 35 min. This is because a higher applied voltage drop resulting in higher driving force during ED operation, thereby a less experimental time will be. Furthermore, it can be seen that the concentrate conductivity curves significantly increase with the increment of voltage drop, as is shown in Fig. 5-5b. The current exhibits a downward trend with time,which is ascribed to the migration of ions from dilute solution to concentrate solution.

Fig. 5-5c illustrates the influence of voltage drop on the concentration factor and water ransport. The values of concentration factor were similar at different voltage drops, but it is interesting to note that the water transport was significantly affected. A highest water transport of 12.50% can be seen for 10 V, which is slightly higher than that of 6 V and 8 V. This phenomenon is due to the electro-osmosis and duration time of experiment. A severe electro-osmosis will be occurred at higher voltage drop, thus a higher amount of H2O will transport from dilute compartment to concentrate compartment at voltage drop of 10 V [31]. How- ever, the water transport exhibits a lower value of 10.00%when the voltage drop increases up to 12 V.The similar phenomenon has been reported by Yan et al. [25]. As is shown in Fig.5-5d, the energy consumption is intensified with the increment of voltage drop. This phenomenon demonstrates that a large amount of energy will be used to promote the ionic migration at the higher voltage drop.Meanwhile,Na_2SO_4 average flux is also intensified with the increment of voltage drop. A highest Na_2SO_4 average flux of 4.94 mol/㎡ h can be obtained at 12 V. Therefore, high voltage drop usually enhances the ionic migration rates for a given duration of experiment.


(a)
Current (A)
Time (min)
6V
8V
10V
12V


(b)
Conductivity (mS/cm)
Time (min)
6V-D
8V-D
10V-D
12V-D
6V-C
8V-C
10V-C
12V-C


(c)
Concentration factor
Water transport
Concentration factor
Water transport (%)
Voltage drop (V)
2.16
10.33
2.18
11.11
2.19
12.50
2.20
10.00

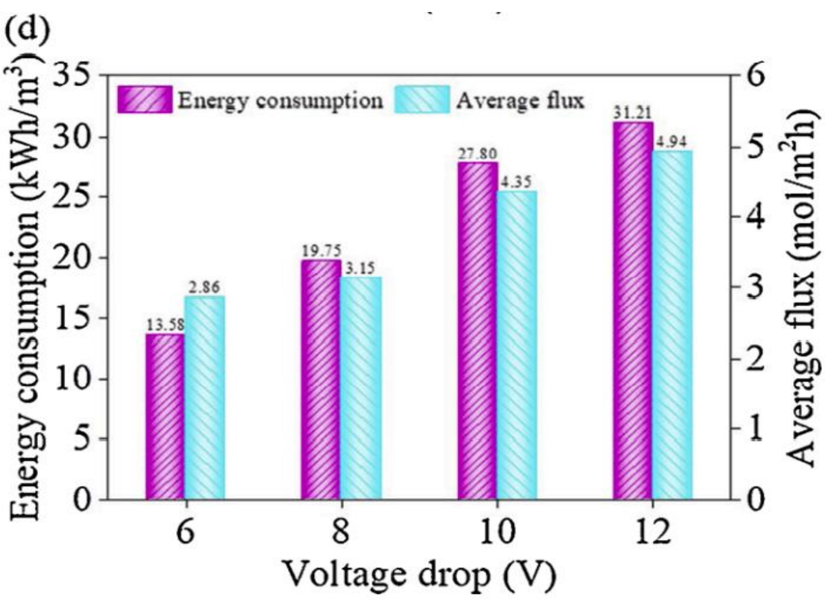
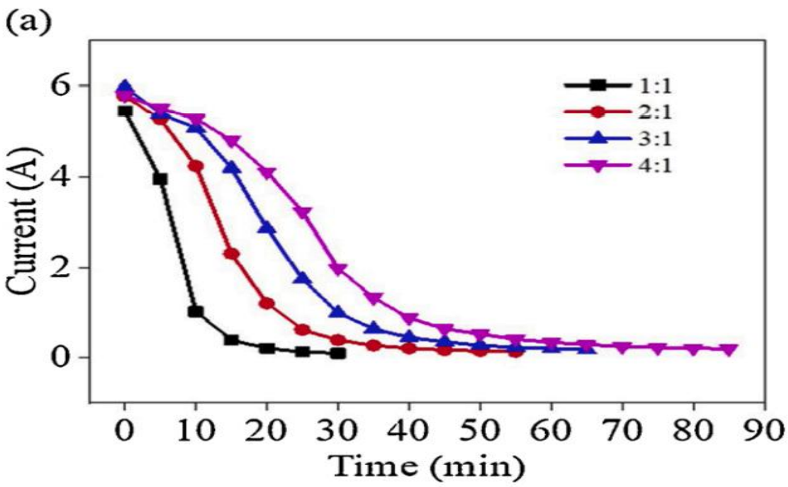


Fig. 5-5 Effect of voltage drop in first-stage ED process: (a) current, (b) conductivity of dilute and concentrate solution, (c) concentration factor and water transport, and (d) energy consumption and average flux.

C.Two-stage ED performances of volume ratio

The volume ratio between concentrate and dilute solution plays a significant role in Na_2SO_4 concentration. In this section, the initial volume of the concentrate solution was selected as 300 mL, while the volume of dilute solution varied from 300 mL to 1200 mL. The operation voltage drop was fixed at 8 V. As it can be seen in Fig. 5-6a, the recorded current decreases with the increment of the volume ratio between concentrate and dilute solution. This phenomenon is ascribed to the Na and SO_4^{2-} ions migration from dilute to concentrate compartment, thus the membrane resistance gradually declines as a function of time. Meanwhile, the current value is directly proportional to the volume ratio.



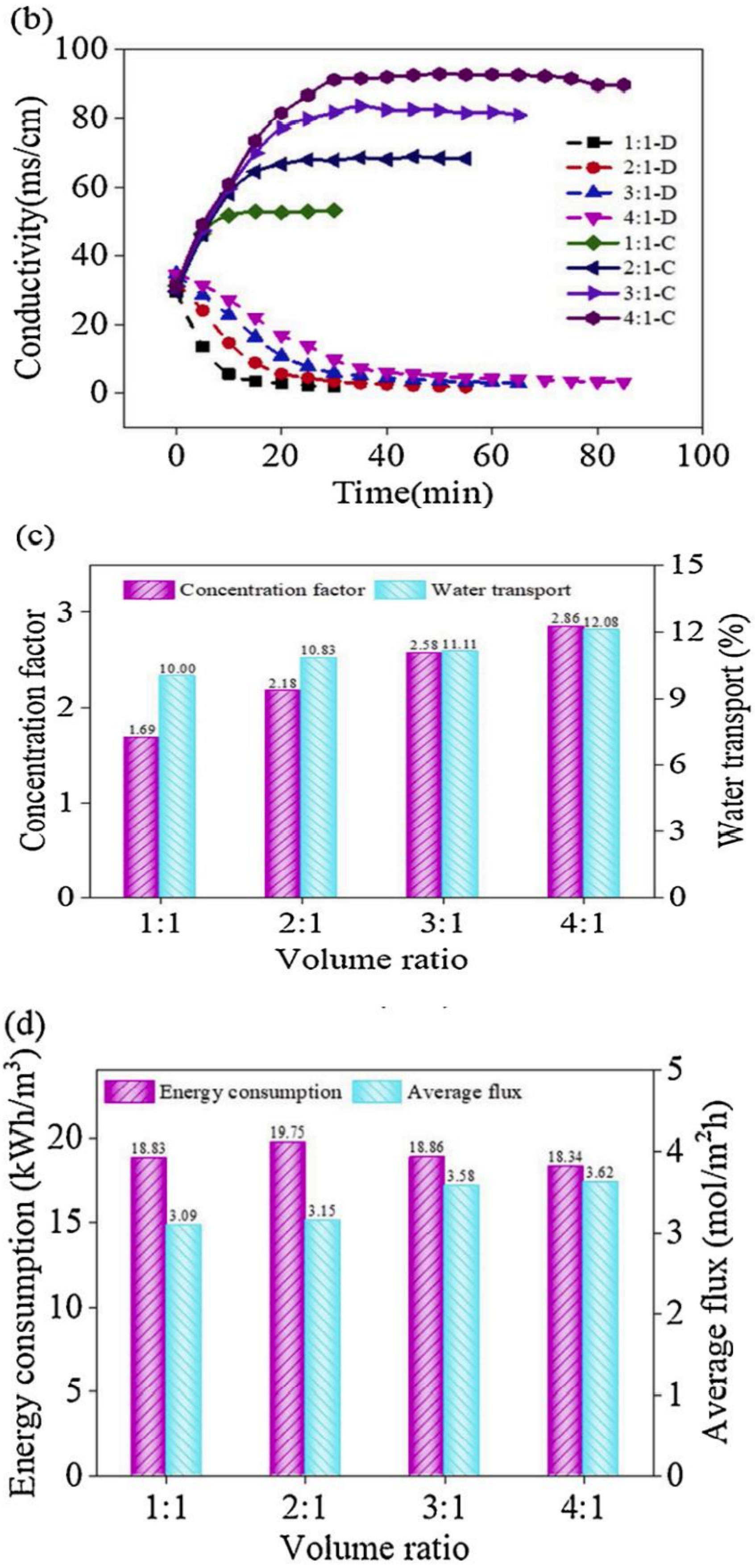

(b)
Conductivity(ms/cm)
Time(min)
1:1-D
2:1-D
3:1-D
4:1-D
1:1-C
2:1-C
3:1-C
4:1-C
(c)
Concentration factor
Water transport
Concentration factor
Water transport (%)
1.69
10.00
2.18
10.83
2.58
11.11
2.86
12.08
1:1
2:1
3:1
4:1
Volume ratio
(d)
Energy consumption
Average flux
Energy consumption (kWh/m3)
Average flux (mol/m2h)
18.83
3.09
19.75
3.15
18.86
3.58
18.34
3.62
1:1
2:1
3:1
4:1
Volume ratio

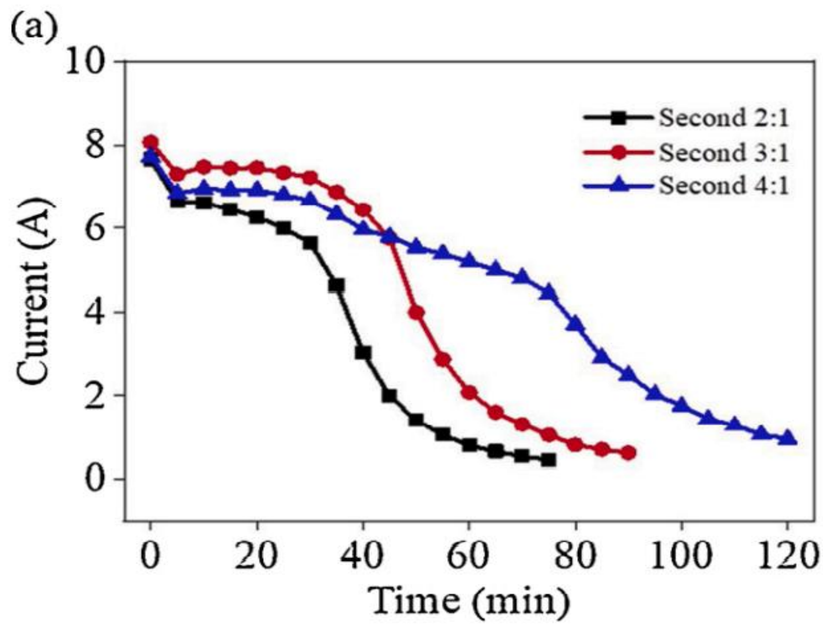
Fig. 5-6 Effect of volume ratio in first-stage ED process: (a) current, (b) dilute and concentrate solution conductivity, (c) concentration factor and water transport, and (d) energy consumption and average flux.

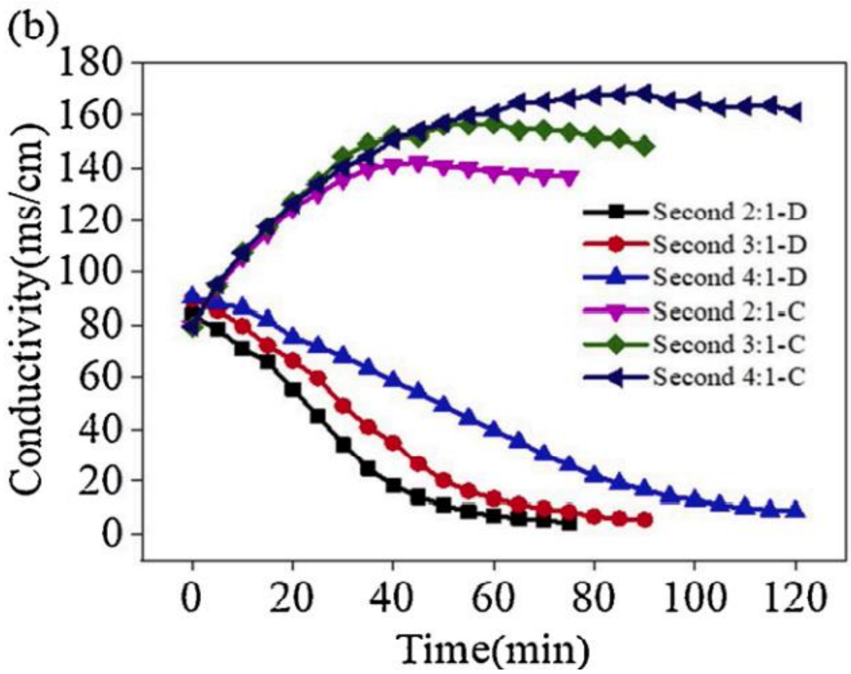
value during the experiment. Fig. 5-6b illustrates the concentrate solution conductivity rises consistently over the experiment when thevolume ratio fixed at 1:1, 2:1 and 3:1, respectively. It's indicated that final Na2SO4 concentration in the concentrate compartment is directly related to the volume ratio.The higher volume ratio always tends to achieve a higher salts concentration in the concentrate compartment. However, there is no increase in Na2SO4 concentration at the latter stage of experiment During this time period, there are small amount of Na2SO4 electrolytes in the dilute compartment, but the conductivity of concentrate solution is not further increased. This effect shows that salt transport is lower than solvent permeation, demonstrating that water transport caused by osmotic-pressure-difference has been emerged as a dominant factor at the end of experiment.

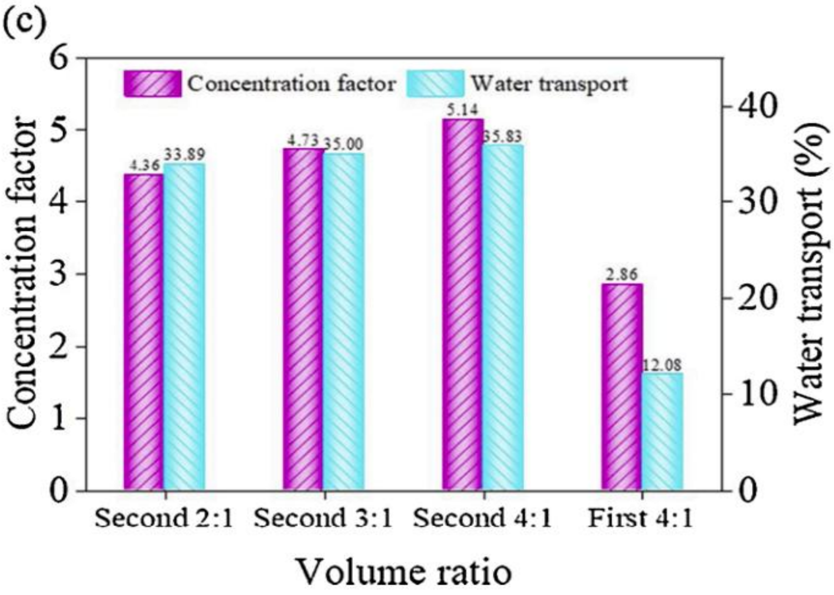
Fig. 5-6c presents the influence of volume ratio on the concentrate factor and water transport. It can be seen that the concentration factor is almost proportional to the volume ratio. The higher volume ratio applied between dilute an concentrate solution, the higher concentration of Na_2SO_4 can be achieved. This is because the high mole number of salt ions in high volume ratio, and thus a maximum water transport is obtained with Vd:Vc = 4:1. Fig. 5-6d illustrates the influence of volume ratio on the energy consumption and Na2SO4 average flux. As it can be observed, there is a slight increase in average flux as the increment of volume ratio.The average flux increase demonstrates that more salts migration can be achieved at high volume ratio. However, the influence of volume ratio on energy consumption is not pronounced.

Due to the limitation of the first-stage ED mode, a second-stage ED process is also introduced to further increase the concentration. In contrast to the first-stage ED process, the recorded current in the second- stage ED (Vd:Vc = 3:1) can be achieved a highest value, which is because the lowest membrane stack resistance during the experiment, as is presented in Fig. 5-7a. Fig. 5-7b shows the evolution of conductivity of dilute and concentrate compartment during the second-stage concentrating, and a higher Na_2SO_4 concentration can be achieved at the second-stage ED. Similarly, the conductivity of concentrate solution exhibits a downward trend at the later stage of experiment,which is because the concentration-gradient formed between dilute compartment and concentrate compartment.

Fig.5-7c illustrates the influence ofvolume ratio on the water transport and concentrate factor in second-stage ED. It should be noted that a highest concentration factor (5.14) is achieved during two-stage ED (Vd: Vc = 4:1).Furthermore, the water transport is also proportional to the volume ratio. As mentioned above, the water osmosis caused by osmotic-pressure-difference will be intensified with the quantity of Na2SO4 in dilute compartment. Meanwhile, the electro-osmosis will be intensified at a high-saline solution in the second-stage ED process. Fig. 5-7d illustrates the influence of volume ratio on the concentrate factor and water transport in second-stage ED. It shows that the energy con- sumption in second-stage ED is much higher than that in first-stage ED. One possible reason is the processing capacity increased at a higher salt concentration. Therefore, due to the leakage of coions, the current efficiency decreases and simultaneously the energy consumption in- creases. Meanwhile, the salt flux during the second-stage ED is much higher than the first-stage ED, which is because the lower membrane stack resistance in first-stage ED. In general, the ionic electrolyte is necessary to be concentrated to a high concentration through a two- stage ED process. In addition, it should be noted that in lab-scale experiment, the energy consumption of electrode reaction maybe consumes a large amount of the total energy consumption. The energy consumption in practical applications should be much lower than that in lab-scale experiment.







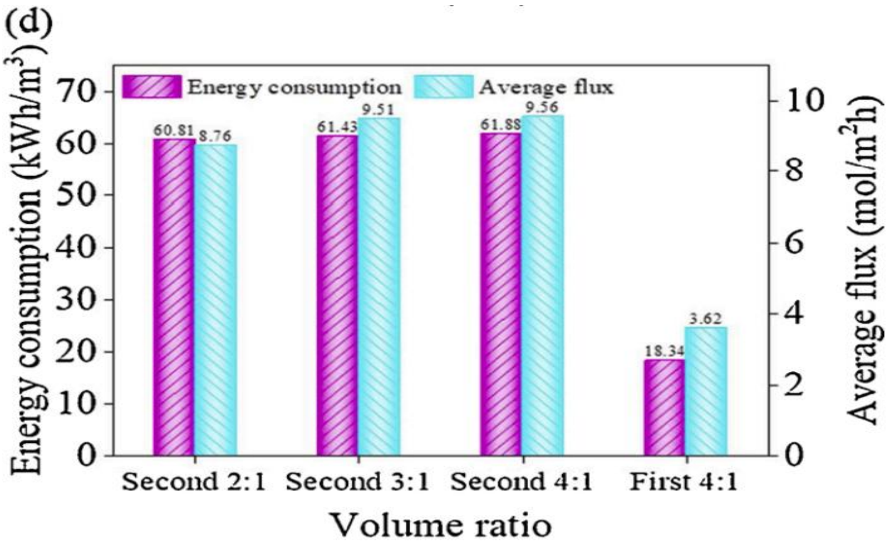


Fig.5-7 Effect of volume ratio in second-stage ED process: (a) current, (b) dilute and concentrate solution conductivity, (c) concentration factor and water transport, and (d) energy consumption and average flux.

3 ）Acid and base recovery via BMED process

.During the BMED process, water transport caused by osmosis also emerged as an important factor due to the migration of Na+ and SO_4^{2-}, limiting the concentration of acid and base. However, a high-saline so- lution is always required in the BMED process and simultaneously, the feed solution concentration is expected to be decreased as much as possible. Therefore, the BMED process was evaluated by decreasing the volume of the base/acid solution, Vb/Va from 500 to 300 mL. The feed solution was fixed at a constant initial volume of 500 mL. Furthermore, three types of commercial membranes (BP-1E/AMX/CMX, BP-1E/AHA/ CMB and BP-1E/FAB/FKB) were investigated in BMED process.

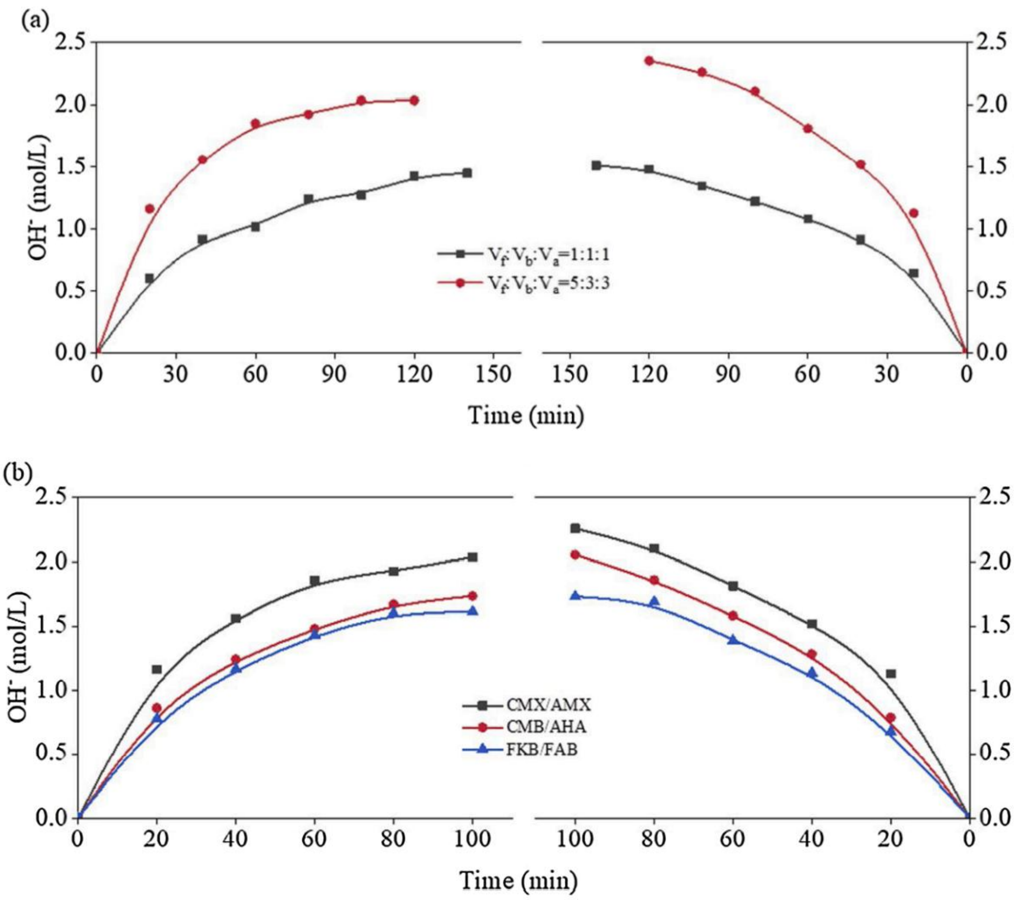


Fig.5-8 (a) Effect of volume ratio in BMED process; (b) effect of membrane type in BMED process.

As it can be seen in Fig. 5-8a, when the volume ratio changes from 500:500:500 to 500:300:300, the final OH^- concentration improves from 1.45 to 2.03 mol/L and simultaneously, the final H^+ concentration increases from 1.51 to 2.35 mol/L. Importantly, the demand global market concerning high acid/base concentrations is always increasing due to the high value of these chemicals. However, in ED applications the final H^+/OH^- concentration could diffuse from acid/base solution to feed solution under concentration-gradient.In this case, the final H^+/OH^- concentration presents a stable trend at the later period of the experiment. From this phenomenon, the investigation of different membrane stacks on the acid/base production with high concentration is necessary. Fig. 5-8b illustrates the effect of membrane type on the acid/ base production. The final OH^- concentration of the BP-1E/AMX/CMX stack is 2.03 mol/L, while the final H^+ concentration of the BP-1E/AHA/ CMB stack and BP-1E/FAB/FKB stack are 1.73 and 1.62 mol/L respectively, demonstrating that the water splitting capability of BP-1E/CMX/ AMX stack is the best. This can be ascribed to the following two reasons. On the one hand, a higher water splitting capability of the bipolar membrane usually results in more H+/OH ions,hereby maintaining the electric neutrality in the corresponding compartment.On the other hand, membrane resistance differently with three membrane stacks. Membranes with dense structure can maximum the stack resistance, thereby reducing the base/acid concentration in the base/acid compartment. Therefore, it can be inferred that the BP-1E/AMX/CMX stack is suitable for

acid/base production with high efficiency.

5.4.4 Conclusions

This work proposes an integration RO-ED-BMED process for sustainable recovery of resources from cold-rolling wastewater (i.e., Na2SO4concentrating, base/acid recovery, and fresh water regeneration). The RO membrane has achieved 3.17times preconcentration of salts in wastewater. In ED process, the effect of voltage drop, membrane type and volume ratio were investigated according to concentration factor, energy consumption and water transport. Results show that CMX/AMX stack exhibit better performance in terms of concentration factor and Na2SO4 average flux. The concentration factor was proportional to the increment of volume ratio, and a higher average flux can be obtained at volume ratio 4:1.Specifically, a highest average flux was accomplished at volume ratio 4:1 via second-stage ED. Through the operation of BMED, base and acid can be generated from the high-saline solution via an optimal BP-1E/AMX/CMX stack. Furthermore, the change of volume ratios (Vf:Vb:Va = 5:3:3) between feed, base and acid solution significantly increased the final H^+/OH^- concentration. Hence, the hybrid RO-ED-BMED process proves a strong technical applicability for sustainable resource recovery from cold-rolling wastewater, in consideration of closing the material circulation and minimizing the liquid discharge.

5.5 Pilot technology application of electrodialysis membrane technology to treat leachate from rural waste transfer stations

In recent years, some rural areas in China began to use evaporation systems to dispose of leachate, evaporation treatment method is often used as waste leachate wastewater for deep concentration, evaporation is an easy to operate, but expensive, high energy demand treatment. It uses heating and provides negative pressure in the system to evaporate water from leachate, and the water vapor is collected through a cooling system to a storage tank, while the thick liquid continues to concentrate to a thick slurry state, and then a dewatering system is used to make the water loss approximate the dry slag state. It is due to its high energy consumption that other engineering methods are being demanded for replacement.

The existing leachate treatment process of a landfill in Shangyu is "biochemical - membrane concentration - evaporation", in which the designed influent chloride ion mass concentration of the biochemical process is less than 6000 mg/L, and the treatment process has been operating stably for more than 4 a. In this landfill After the composition of the accepted waste changed, the salt content of the leachate increased rapidly, and the chloride ion mass concentration reached more than 10000 mg/L, which caused serious impact on the biochemical system and affected the operation effect of the process. In order to ensure the stability of the system effluent standard, the actual operation adopts the method of reverse osmosis water reflux to dilute the feed water salinity to maintain the process performance of the biochemical system, resulting in a significant increase in operating costs. In order to alleviate the impact of high salinity of leachate, reduce the salinity of feed water of biochemical system and maintain the operation effect of biochemical process, electrodialysis process was adopted in the pilot project to treat high salinity waste leachate, enrich the salts in electrodialysis concentrate, reduce the concentration of chloride ions in fresh water of electrodialysis to the level suitable for feed water of biochemical system, and increase the salinity of concentrate as much as possible, and trap organic pollutants in the fresh water side to remove impurities in the concentrate to improve the feed water quality of the subsequent evaporation process, simplify the evaporation pretreatment process, and reduce the operating cost of the evaporation system [32].

5.5.1 Materials and methods

1） Test raw water

The test raw water is the leachate of a landfill, the average mass of chloride ions in the leachate of this landfill after the change of the accepted waste components.

The water quality of the test raw water was analyzed before the pilot test and the results are shown in Table.5-6.

Table. 5-6 Raw water quality

pH	Conductivity/ ($mS\cdot cm^{-1}$)	Total hardness/ ($mg\cdot L^{-1}$)	ρ(Ammonia nitrogen)/ ($mg\cdot L^{-1}$)
7.8	36.5	1650	2000
ρ(Ca^{2+})/ ($mg\cdot L^{-1}$)	ρ(SO_4^{2-})/ ($mg\cdot L^{-1}$)	ρ(Cl^-)/ ($mg\cdot L^{-1}$)	ρ(CODcr)/ ($mg\cdot L^{-1}$)
1050	450	12500	10000

2） Test device

The maximum volume of water treated by the electrodialysis unit used in the test was about 80 L/h, and the actual volume of water treated in this test was 12.1 to 42.7 L/h. The process flow of the test is shown in Figure 5-9.

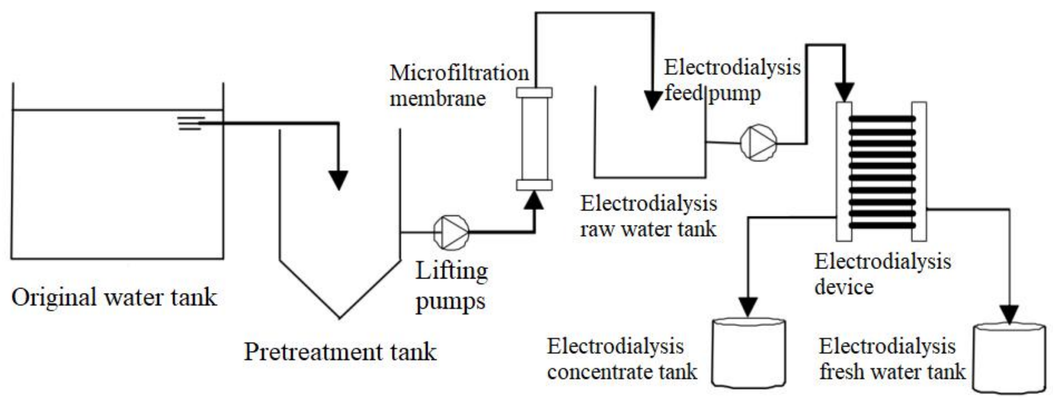


Fig. 5-9 Exprimental process flow

The test water flows from the original water tank to the pretreatment tank, and liquid alkali (NaOH) and quicklime (CaO) are added in the pretreatment tank to make the pH value reach about 12.0, so that the alkalinity of the original water can be used to form calcium carbonate precipitation. The precipitate is fully separated from the supernatant to obtain a clarified solution that meets the subsequent process requirements. The clarified solution is pressurized by the pressurized pump into the tubular microfiltration membrane to remove the suspended matter in the water. The membrane filtered water is collected in the electrodialysis tank, and HCl is added to adjust the pH value. The raw water is pressurized by a booster pump into the electrodialysis module. The electrodialysis concentrate and fresh water are collected in the concentrate tank and fresh water tank respectively. According to the characteristics of the raw water, 3% sodium chloride solution is selected for the electrodialysis cathode solution, 3% sulfuric acid for the anode solution, 3% sodium sulfate solution for the blocking solution, and 1% sodium chloride solution for the initial concentrate.

5.5.2 Results and Discussion

1）Performance of electrodialysis

The test uses standard diaphragms. The pilot test was conducted to reduce the salinity of raw water and obtain fresh water to meet the feed water requirements of biochemical system as the primary objective. While reducing the salinity of the raw water, the properties of the electrodialysis concentrate were investigated to improve the quality of the concentrate for the subsequent operation of the crystallization and salt separation process.

①Salt concentration performance

The salt concentration performance of electrodialysis is shown in Figure 5-10.

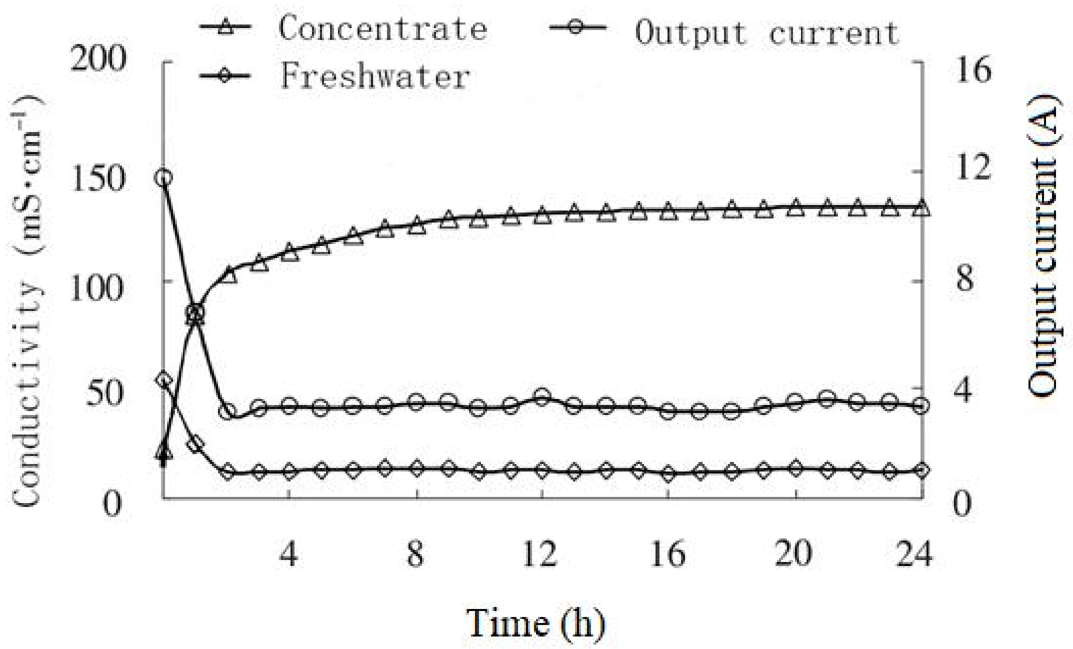


Fig. 5-10 Salt concentrating performance of electrodialysis

The conductivity of the freshwater side dropped from above 50 mS/cm to below 13 mS/cm and reached the equilibrium after 2 h of system start-up, and the average conductivity of freshwater was 12.7 mS/cm during the whole test. The conductivity of the concentrate increased rapidly from 23 mS/cm to more than 120 mS/cm during the first 6 h of operation, and then increased slowly to 130 mS/cm at 12 h, and remained stable. The conductivity of the concentrated solution reached a maximum of 139 mS/cm during the whole test, indicating that the concentration limit of salt by electrodialysis was about 140 mS/cm under this operating condition. A total of 192.5 L of fresh water and 96.6 L of concentrated solution were obtained in the test for 24 h. The recovery rate was 66.6%.

②Organic matter in concentrated brine

The evaporation of organic matter in concentrated brine is an important process in the zero-discharge waste leachate treatment process [33]. The purity and quality of the salt product seriously affect the overall effect and cost of the process, and only salt products that meet the criteria can be reused, otherwise they can only be treated as miscellaneous salt.

The high concentration and complex composition of organic contaminants in waste leachate are the main factors affecting the quality of salt products [34]. The semi-permeable membrane of electrodialysis is an ion-exchange membrane, and since most of the organic matter in water exists in the form of uncharged molecules, which cannot pass through the electrodialysis membrane, electrodialysis can trap the organic matter in the freshwater side and reduce the concentration of organic matter in the concentrate [35-37]. In this study, three groups of samples were randomly taken during the stabilization phase (16-24 h) of the experimental electrodialysis operation to determine the TOC concentration, and the effect of electrodialysis on the retention of organic pollutants is shown in Figure 5-11.

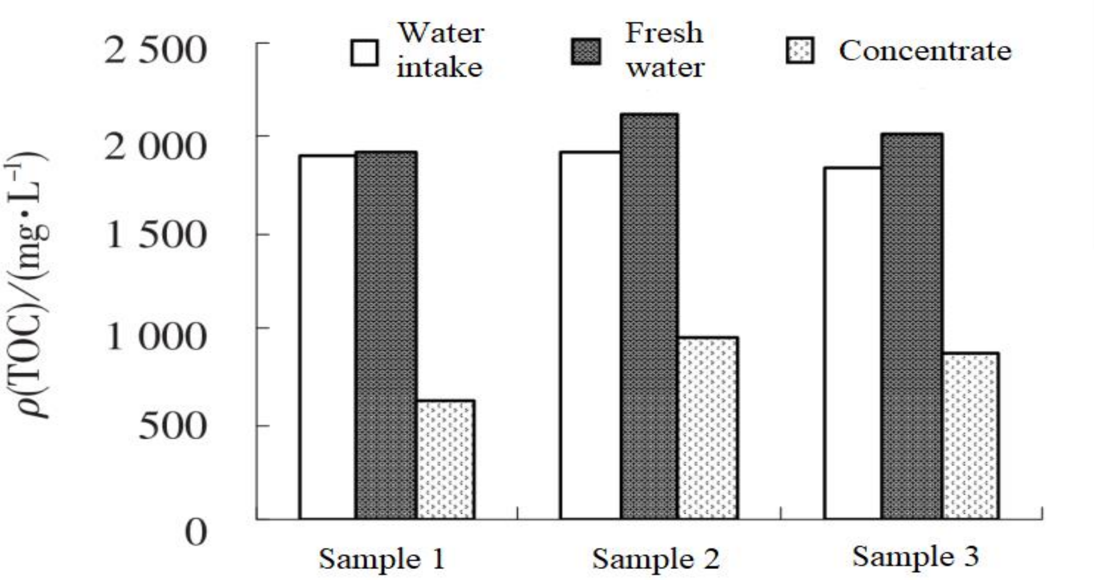


Fig. 5-11 Retention effect of organic pollutants

As shown in Figure 5-11, the mass concentration of TOC in the electrodialysis feed water reaches about 1900 mg/L. After the retention effect of the electrodialysis system, the concentration of TOC in the concentrate is significantly reduced, and its mass concentration is 600-1000 mg/L. The organic pollutants in the waste leachate are complex, and contain some organic acids and amino acids that can be dissociated into ions in water, and this ionic state of Organic substances in ionic form can pass through the electrodialysis membrane under the action of electric field and be migrated to the concentrate side [38-39].

③ Overall water quality

As shown in Table.5-7, the experimental freshwater desalination effect, with a chloride ion mass concentration below 3 000 mg/L, fully met the requirements of the biochemical system for feed water salinity. The experiment shows that electrodialysis can effectively reduce the concentration of ammonia nitrogen in freshwater, and the average mass concentration of ammonia nitrogen in freshwater is 250 mg/L, which is much lower than that of raw water. Thus, the electrodialysis process can reduce the feed water ammonia and nitrogen load of the biochemical process by enriching the ammonia and nitrogen in the concentrated solution while concentrating the salt.

Table.5-7 Water quality

Water samples	Water volume/%	Conductivity/ ($mS\cdot cm^{-1}$)	$\rho(Cl^-)$/ ($mg\cdot L^{-1}$)	$\rho(TOC)$/ ($mg\cdot L^{-1}$)	ρ(Ammonia nitrogen)/ ($mg\cdot L^{-1}$)	$\rho(Ca^{2+})$/ ($mg\cdot L^{-1}$)	$\rho(SO_4^{2-})$/ ($mg\cdot L^{-1}$)
Raw water	100	36.5	12500	1700	2000	1050	450
Fresh Water	66.6	13	2836	2100	250	22	< 5
Concentrate	33.4	140	59556	800	4500	400	< 5

5.5.3 Conclusion

Electrodialysis freshwater salinity can meet the biochemical system influent requirements and reduce the ammonia and nitrogen load of the biochemical system, but there is a certain concentration of organic pollutants in the concentrate, and the enrichment of ammonia and calcium ions, only after further in-depth treatment, can meet the water quality requirements of subsequent evaporation influent.

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Chapter6

STUDY OF WASTEWATER PLANNING ——CASE STUDY ON SHANGYU

CHAPTER SIX: STUDY OF WASTEWATER PLANNING —CASE STUDY ON SHANGYU

6.1 Overview of Shangyu

6.1.1 Overview of Shangyu

1) Geographical location

Shangyu District is located in the southern part of the Yangtze River Delta, in the middle of the Ningshao Plain and in the lower reaches of the Cao'e River. The city is located between 120 ° 36′23 ″ ~ 121 ° 06'9 ″ east longitude and 29 ° 43'38 " ~ 30°16 , 17" north latitude , with a total area of 1427.5 square kilometers. Among them: the sea area is 212.3 square kilometers, the water area is 153.7 square kilometers, and the land area is 1061.5 square kilometers. In 2013 , the total registered population of the city was 779,500 , the non-agricultural population was 299,700 , and the temporary resident population was 177,400 .

Shangyu District is adjacent to Yuyao City in the east, Xiazhou City in the south, Yuecheng District and Shaoxing County in Shaoxing City in the west, and Hangzhou Bay in the north. There are two expressways on the Yong and Shang lines, the Hangzhou-Ningbo railway, the 104 and 329 national highways and the Hangzhou-Ningbo Canal. It is 45 kilometers away from Hangzhou Xiaoshan International Airport and has the only sea port on the south bank of Hangzhou Bay. With the planning and construction of the Hangzhou Bay Bridge, Shangyu City will be included in the Shanghai 2 -hour traffic circle, and the location advantage will be more prominent.

2) Natural conditions

① Climate

Shangyu is located on the southern edge of the northern subtropical zone, and has an East Asian monsoon climate with prominent monsoons, mild climate, four distinct seasons, humid and rainy. Due to the complex terrain, the geographical differences in light, temperature and water are obvious, there are more severe weather, and there are more floods than droughts. The average annual temperature is 16.4 watts. The monthly average maximum temperature is 28.7°C (July), the highest year is 31.2°C (1971), the monthly average minimum temperature is 4.1°C (January), and the lowest year is 0.5°C (1977). The average annual wind speed is 3.0 m/s, and the maximum wind speed is 29.0 m/s. Southerly winds are the prevailing winds, but there are differences from season to season.

② Hydrology

The Cao'e River, the third largest river in Zhejiang Province, is an important tributary of the Qiantang River. It originates from the Tiantai Mountains, runs through the whole of Shangyu from south to north, and joins the Qiantang River in Jianshan River Bay at Jiusiqiu, the Shangyu sea flat. It is a perennial river with no ice period, and the riverbed is 100 to 600 meters wide. The average water depth in the middle reaches is 4 to 5 meters, and the water depth in the lower reaches is 1 to 2 meters. The main stream of the Cao'e River (Zhikoumen) is 197 kilometers long, the average slope of the main river is 3.0 ‰ , and the drainage area is 6080 square kilometers. Its upper reaches have a large gradient and turbulent water flow, and has the characteristics of mountain and creek rivers. The average slope of the river above Dongshabu Hydrological Station is 3/1,000. After entering Shangyu City, the river surface is open and the water flow is gentle. In the lower reaches of the plain and estuary, the downstream is obviously affected by the tide, and the tide can be traced back to the Three Realms. At the end of 2008 , the Cao'e River sluice was built to store water, with a normal water level of 3.9 meters and a normal storage capacity of 146 million cubic meters. The normal water level of the river network in the Dongguan Plain is 3.9 meters, and the water level when the gates are opened for drainage is 4.0 meters. The Cao'e River above the gate is not affected by tides.

The average annual inflow of water in Shangyu is about 2.795 billion cubic meters, which is 3.33 times the total water resources in the region . There are mountains, rivers, lakes and seas in Shangyu. The rivers, streams and lakes belong to the Cao'e River and the Yaojiang River system. In addition to the main stream of the Cao'e River, the Cao'e River water system includes the hills in the south of the city and the streams and lakes in the Dongguan Plain. The Yaojiang River System includes the Fenghui Basin and the streams and rivers in the Yubei Plain. The plain rivers include the Shishili River, the Shibaili River, the Yaojiang River, the Yuyong Canal, the Baisong

River, the Gaixie River, the Gaili River, and the Shangpu Gate. The main canals, the central rivers in the hills of the tidal flat, the Yantang River and the entire Yubei river network, the lakes mainly include Zaoli Lake, Baima Lake, Xixi Lake, Xiaoyue Lake, Dongbo, Xibo, Pogang Lake, Chanwan Lake, Dabo, Kong Jiachong Lake, etc. The Cao'e River section, where the area is located, is a tidal section, with the highest average water level of 8.65 meters (the elevation of the Yellow Sea, the same below), the lowest average water level of 2.61 meters, and the maximum average tidal range of 2.51 meters. The average water level of Cao'e River over the years is 3.55 meters, the lowest water level is 1.61 meters, the highest flood level once in a century is 9.87 meters, the highest flood level in 50 years is 9.36 meters, and the highest flood level in 20 years is 8.68 meters.

Natural disasters are mainly floods. The main causes of floods are the plum rain and typhoon storms, as well as the autumn tide, especially the typhoon storms, the threat is more prominent. Shangyu District is adjacent to the Qiantang River Estuary and Hangzhou Bay in the north. Typhoon and rain are often intertwined with the autumn tide. The upstream flood discharges and the downstream tide supports it, which is easy to cause external floods and internal waterlogging.

③ Topography

The terrain of Shangyu District is low in the north and high in the south, and the area of the water network in the north is half that of the low mountains and hills in the south. The northern part is the coastal plain, where the intertidal mudflats silt up and collapse frequently, and the land reserve resources are relatively abundant. The central part is the valley basin of the Cao'ejiang and Yaojiang river systems and the Ningshao water network plain. The terrain is flat, the rivers and lakes are densely covered, and the land is fertile. The southern low mountains and hills belong to two branches, the southeast is the remnant of Siming Mountain, which is relatively high and steep; the southwest belongs to the remnant of Kuaiji Mountain, which is slightly gentle.

The stratum of Shangyu District belongs to the stratigraphic area of southeastern Zhejiang. It is located at the intersection of the two major mountain ranges, the Siming Mountains and the Kuaiji Mountains, on both sides of the Jiangshan - Shaoxing fault zone, forming two structural units and stratigraphic divisions with different attributes. The east is the east of Zhejiang; the west of the fault zone is the northwest of Zhejiang. Shangyu territory is dominated by the former. In terms of geomorphology, it belongs to the volcanic rock low mountain and hilly area in southeastern Zhejiang. The bearing capacity of the foundation is generally 7 ~ 9T/ ㎡ ; the surface soil layer can be divided into mixed fill layer and loam layer from top to bottom, the bearing capacity is 7 ~ 9T/ ㎡ ; silt clay or silt clay layer, its The bearing capacity is between 5 ~ 6T/ ㎡ , and the underground diving water level is about 1 meter above the surface. [1-9]

3) Social and economic status quo

①Administrative division

Shangyu District has jurisdiction over 6 streets, 12 towns, and 3 townships: Baiguan Street, Cao'e Street, Dongguan Street; Daoxu Street, Xiaoyue Street, Lianghu Street, Shangpu Town, Tangpu Town . Zhang Town, Xiaguan Town, Fenghui Town, Yonghe Town, Yiting Town, Songxia Town, Xietang Town , Changtang Town, Gaibei Town; Lingnan Township, Chenxi Township, Dingzhai Township.

Fig.6-1 Administrative division [10]

② Economic development

Since the reform and opening up, the comprehensive economic strength of Shangyu District has been continuously enhanced, and the living standards of its residents have been improving. Technological Innovation Pilot Counties (Cities) In 2016 , under the strong leadership of the higher-level party committees, governments and district committees, and under the supervision and support of the district people's congress , we united and relied on the people of the whole district, and guided by the "five development concepts", Focusing on the construction of the "Four Shangyus", focusing on reform, focusing on innovation, focusing on transformation, increasing vitality, focusing on overall planning, optimizing the environment, focusing on people's livelihood, and promoting harmony, we have achieved a good start for the development of the "Thirteenth Five-Year Plan".

In 2016 , the regional GDP was 77.322 billion yuan, an increase of 7% ; the total fiscal revenue exceeded 10 billion yuan for the first time, reaching 10.372 billion yuan, of which the general public budget revenue was 5.965 billion yuan, an increase of 11.3%, ranking first in the city in growth rate; completed The investment in fixed assets was 54.812 billion yuan, an increase of 13%, of which the industrial production investment was 31.034 billion yuan, the second largest increase in the city; the total retail sales of consumer goods was 30.181 billion yuan, an increase of 11.3% ; the total foreign trade export was 22.657 billion yuan, an increase of 8.5% ; urban and rural The per capita disposable income of permanent residents reached 50,910 yuan and 27,089 yuan respectively, an increase of 7.7% and 8% ; the urban registered unemployment rate was 2.36% .

4) Shaoxing city master plan

In November 2012 , the State Council approved the "Shaoxing City Master Plan (2011-2020)". In October 2013 , the State Council issued the "Reply on Approving Zhejiang Province to Adjust Some Administrative Divisions of Shaoxing City", approving Keqiao District and Shangyu District to remove counties (cities) into districts. Shaoxing City has changed from "one district and five counties (cities) " to "three districts and three counties (cities)", namely Shaoxing City

(Yuecheng District, Keqiao District, Shangyu District), Zhuji City, Xiazhou City, Xinchang County, the urban area expanded from 362k ㎡ to 2,942k ㎡ , and the population increased from 653,000 to 2.16 million.

①Urban planning area

The scope includes all the administrative areas of Yuecheng District, Keqiao District and Shangyu District, with a total land area of 2942k ㎡ and a long-term urban construction land scale of 275k ㎡ .

②City positioning and development goals

According to the overall urban planning approved by the State Council, Shaoxing is positioned as a national historical and cultural city, an ecological and livable water city in the south of the Yangtze River, and a central city in the Yangtze River Delta region.

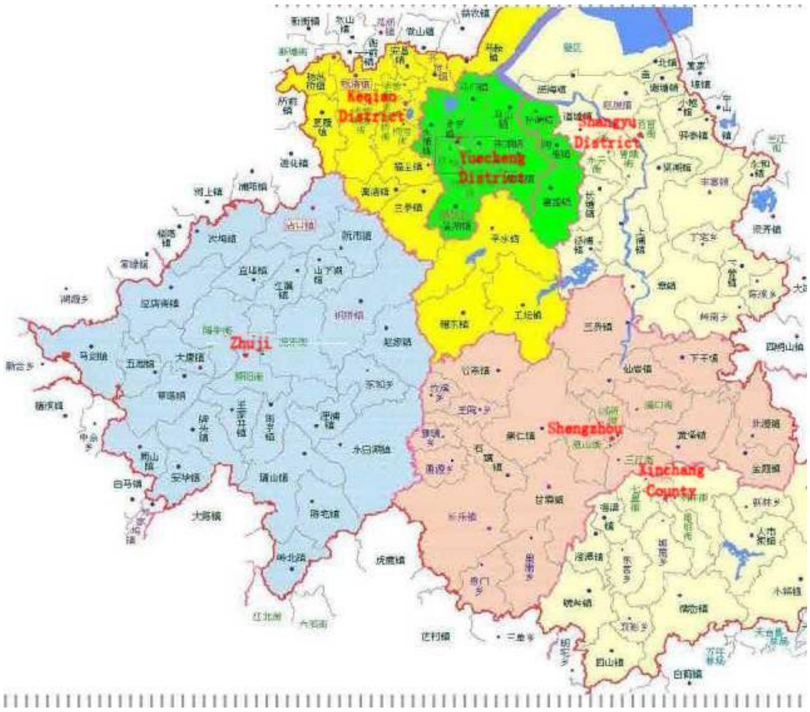

Fig.6-2 Urban planning area [10]

③ City size

In 2013 , the current population of Shaoxing urban area was 2.16 million, the scale of urban construction land was 200k ㎡ , and the per capita construction land was 109 k ㎡ .

2020 , the planned population of Shaoxing urban area is 3.05 million, the scale of urban construction land is 225k ㎡ , and the per capita construction land is 100 ㎡.

2030 , the planned population of Shaoxing urban area is 3.24 million, the scale of urban construction land is 275k ㎡ , and the per capita construction land is 98 ㎡. [10-14]

Table.6-1 Population and planned population summary table of Shaoxing District [12]

areat	year 2013	year 2023	year 2030
Yuecheng District	74	109	116
Keqiao District	64	109	116
Shangyu District	78	87	92
total	216	305	324

5) The overall planning of Shangyu

①The nature of the city

It is an important transportation hub city in northeastern Zhejiang, an advanced manufacturing production base, and an ecological city with riverside characteristics.

②City size

Planned urban population size: 562,000 in 2010 ; 775,000 in 2020.

Scale of planned urban construction land: 62.57 square kilometers in 2010 ; 81.38 square kilometers in 2020.

Urban population in the planned central city : 325,000 in 2010 ; 440,000 in 2020.

Scale of construction land in the planned central urban area: 34.13 square kilometers in 2010 ; 46.2 square kilometers in 2020.

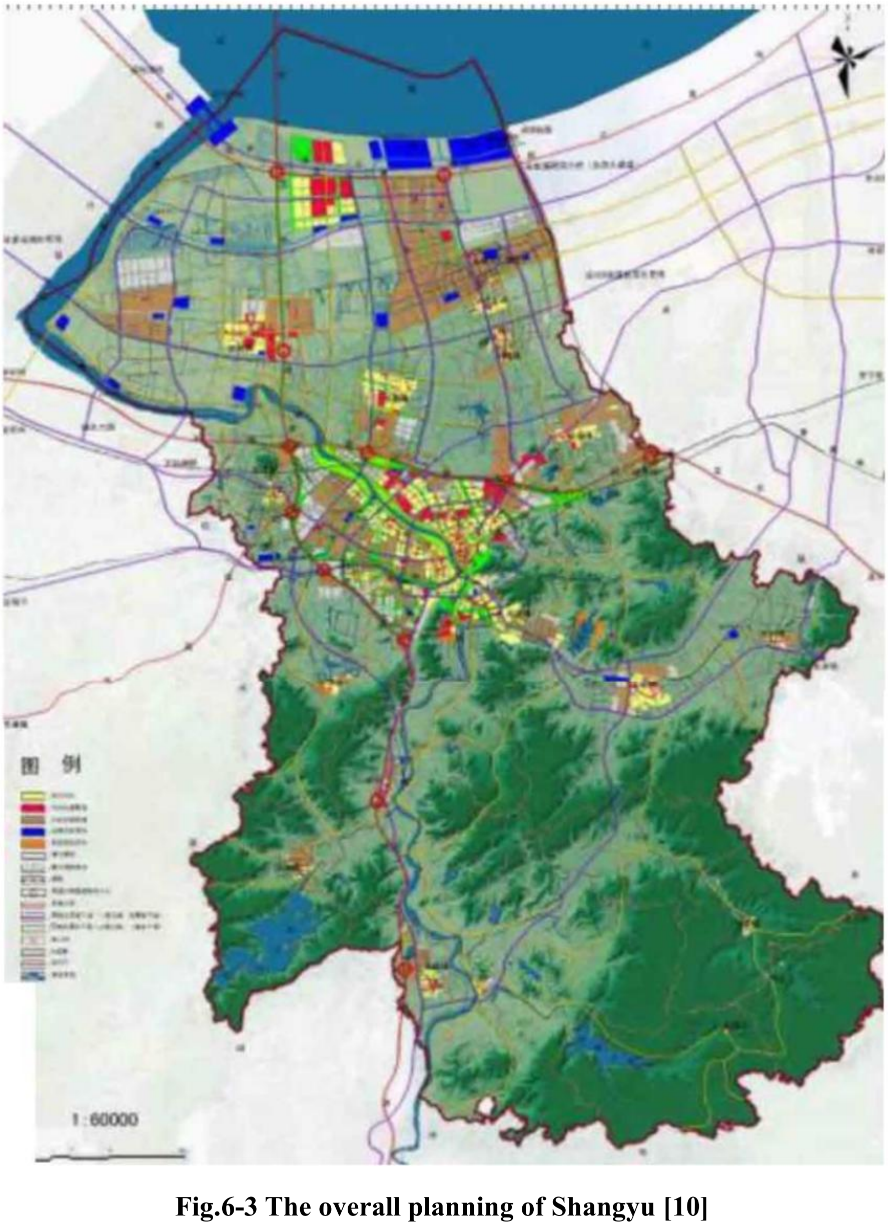

Fig.6-3 The overall planning of Shangyu [10]

③Development strategy

The urban development of Shangyu is based on the strategy of "Dragon Mountain", " Cao'e River" and " Hangzhou Bay "; in the planning and construction of the central city, the development idea of focusing on the North New District of the city is established . The urban development strategy of extending eastward connection, developing along the river, and upgrading the old city" accelerates urban construction.

④Overall structure

Overall structure of the central city: form a spatial structure of "one axis, two wings, three centers and three rings".

One axis: the landscape axis of Cao'e River. The Cao'e River passes through the middle of the urban area, and ecological landscape green spaces are planned on both sides to improve the urban environment and reflect the characteristics of a riverside city and a landscape city. Further strengthen the role of Cao'e River as the main axis of the city, improve the green belts, residential areas, cultural corridors and pedestrian blocks along the river; use the low hillsides of Longshan to build new high-end living communities, and create a landmark area that reflects the city's characteristics and enhances the city's taste.

Two wings: Jiangdong and Jiangxi are divided by Cao'ejiang as the axis. The Jiangdong film includes four groups: the north, east, south and old city. The Jiangxi film includes the Binjiang Group, the Economic Development Zone Group and the Southwest Group formed by Cao'e Dongguan .

Three hearts: the north of the city, the economic development zone, and the main city center of the old city. The north of the city forms a comprehensive main center for administration, commerce and residence of the whole city. The old city has been organically sorted out, transformed and upgraded to form a traditional commercial and residential center in the city, and the riverside area of the economic development zone has become a business center serving advanced manufacturing industries.

Three Rings: Inner Ring, Third Ring Road, Fourth Ring Road. The existing Shunjiang Road, Fengshan Road, Dujiang Road and Daqiao Road are connected to form the inner ring of the urban area, which relieves the traffic pressure in the downtown area and acts as a protection ring. The Third Ring Road connects various functional areas in the urban area and is the main traffic artery. The Fourth Ring Road is responsible for part of the transit traffic. [15-20]

Table. 6-2 Shangyu Planning Population Table [12]

area	2023 (Unit: 10,000 people)		
	Household population	Foreign population	Village population
central area	25.0	35.0	60.0
Changtang Town	1.3	0.1	0.9
Daoxuzhen	4.5	1.2	3.6
Fenghui Town	5.0	1.5	4.7
Gaibei Town	2.4	6.1	7.0
Lihai Town	5.4	17.6	20.0
Lianghu Town	2.7	0.5	2.6
Songxia Town	11.0	2.0	9.0

Tangpu Town	2.0	0.6	1.8
Xiaguan Town	1.1	0.2	0.8
Xiaoyue Town	3.1	1.5	3.7
Xietang Town	2.6	0.9	2.8
Zhangzhenzhen	4.3	1.5	4.0
Shangpu Town	2.3	0.3	1.6
Yonghe Town	1.6	0.3	1.3
Yiting Town	1.2	0.7	1.7
Lingnan Township	0.5	0	0.5
Chenxi Township	0.4	0	0.4
Ding Zhai Xiang	0.6	0	0.6
total	77.0	70.0	125.5

6.1.2 Shangyu water supply and drainage planning

1) Special plan for water supply in Shangyu area

①The scale of urban and rural water supply

According to the water demand forecast and balance analysis, in 2020 , the maximum daily urban and rural water supply scale of the restrained type in Shangyu is 290,000 m^3 /d, and the maximum daily water supply of the differential type is 310,000 m^3 /d ; The maximum daily water supply scale in 2030 is 290,000 m^3 /d .

② water supply system planning

Urban and rural water supply: The main water supply sources for Shangyu in the near and long term are Tangpu Reservoir and Siminghu Reservoir, and the main canal of Shangpu Gate is the urban backup water source. Shangyu Film currently has 150,000 m^3/d of Shangyu Great Triangle Water Plant , 150,000 m^3 /d of Shangyu Shangyuanzha Water Plant , 30,000 m^3 / d of Shangyu Yonghe Water Plant , and 20,000 m^3 /d of Shangyu Tangpu Water Plant . The water supply scale is 350,000 m^3 /d, which can meet the water demand, but there is no surplus. From the perspective of emergency backup and ensuring safe water supply, with the increase in water consumption, the second-phase expansion project of the Dajiang River Water Plant should be started in due course. It is planned to expand the Shangyu Great Triangle Water Plant by 150,000 m^3 /d in the near future, with a scale of 300,000 m^3/d .

Industrial water use: The planned near- and long-term industrial water source is the water diversion project in eastern Zhejiang. It is planned to build a new emergency standby water plant in Hangzhou Bay, Shangyu District, which will supply industrial water at ordinary times, with a scale of 200,000 m^3 / d, which will be implemented in stages, with a recent scale of 100,000 m^3/d .

③Planning of raw water transportation system

The current raw water conveying system of Shangyu Film can meet the requirements. However, the raw water is overly dependent on the Tangpu Reservoir. Once an accident occurs in the raw water system of the Tangpu Reservoir, the urban water supply will be greatly affected. According to the water delivery capacity of the raw water delivery system and the location of the water supply source, the short-term and long-term construction arrangements for the raw water delivery system are as follows:

A. Shangyu Tangpu Raw Water Lifting Pumping Station: The raw water of Tangpu Reservoir is lifted and sent to the water purification structure of the Dajiao Water Plant, with a water delivery capacity of 300,000 m^3 /d ;

B. DN1600 raw water pipeline: construct the raw water transmission pipeline from Tangpu Raw Water Lifting Pumping Station to Dajiang Delta Water Plant, with a planned diameter of DN1600 .

C. Raw water emergency pressurization pumping station: The Cao'e River water intake pumping station is planned to be constructed near Shangyuanzha Water Plant, with a planned scale of 300,000 m^3/d.

The water connection pipe is used for raw water transportation.

2) Special Drainage Planning for Shangyu Area

①Sewage treatment plant scale

According to the forecast of sewage volume, in 2020 the scale of restricted sewage treatment in Shangyu District will be 230,000 m^3 /d, and the scale of differential sewage treatment will be 250,000 m^3 / d ; Shangyu District Sewage in 2030.

The processing scale is 230,000 m^3 /d .

The scale of the sewage treatment plant in Shangyu District is determined to be 300,000 m^3 / d .

② Interconnection between sewage treatment plants

Current facility utilization: The current Jiangbin Sewage Treatment Plant and Shaoxing Sewage Treatment Plant have a one - way connecting pipe of DN1600 (Jiangbin Sewage Treatment Plant delivers to Shaoxing Sewage Treatment Plant). The sewage lifting pump station can realize two-way connection.

New facilities: In order to achieve emergency connectivity in the event of an accident at the three recent sewage treatment plants. In this plan, it is recommended to open the DN1600 connecting pipe of Jiangbin Sewage Treatment Plant and Shaoxing Sewage Treatment Plant , and connect the DN1200 sewage pressure pipe to realize interconnection with Shangyu Sewage Treatment Plant. Emergency connection, and a new 100,000 m^3 /d Zhan Zhan Road pumping station for the midway sewage lifting.

DN1200 connecting pipe connecting the Binhai New Town sewage treatment plant to the DN1200 sewage treatment plant (planned in the near future)， so as to form an emergency interconnection between the four sewage treatment plants.

③Tail water discharge project

The tail water project of Shangyu Sewage Treatment Plant includes a sea discharge pump station with a design scale of 300,000 m^3 / d and a current scale of 180,000 m^3/d and a sea discharge pipe of DN1600 . The equipment of the sea discharge pump station in the near future It should be installed to the design scale (300,000 m^3 /d) , and another 8.5km DN1600 sea drain pipe should be built . At the same time, a

300,000 m^3/d dischargeport is builted now.

3) Special plan for water supply in Shangyu District

①Water consumption forecast

The city is divided into two parts: urban water supply and Hangzhou Bay Shangyu Economic and Technological Development Zone, which belong to urban, Yonghe, Tangpu and decentralized water supply systems.

forecasted total urban water consumption is: 359,500 m^3 / d in 2020 ; 489,600 m^3 / d in 2030.

Considering the uncertainty of water supply in Shangyu Industrial Economic Development Zone of Hangzhou Bay, an industrial water plant of 100,000 m ^{3}/d is reserved .

Table. 6-3 water supply summary table [11]

water system name	Water supply range	Forecast water consumption (10,000 m³ /d)		Planning project scale (10,000 m³ /d)	
		2023	2030	2023	2030
city water supply	Central City, Zhongxia Town, Xiaoyue Street, Gaibei Town, Changtang Town, Daoxu Street, Lianghu Street, Xietang Town, Yiting Town	18.57	23.32	30.0	45.0
	Hangzhou Bay Shangyu Economic and Technological Development Zone	12.8	10.7		
	Subtotal	31.37	34.02		
urban industrial water	Hangzhou Bay Shangyu Economic and Technological Development Zone	0	10.8	0	20.0
Total water supply		31.37	44.82	30.0	65.0
Yonghe	Yonghe Town, Fenghui Town	1.74	1.58	3.0	3.0
Yupo	Tangpu Town> Shangpu Town Zhang Town, Dingzhai Town, Xiaguan Town	2.66	2.40	2.0	2.0
Lingnan	Lingnan Township and some villages	0.10	0.09		
Chen Xi	Chenxi Township and some villages	0.08	0.07		
total		35.95	48.96	35.0	70.0

6.2 Status of water supply and drainage system

6.2.1 Status of water supply system

Shangyu District integrates urban and rural water supply. According to the current situation of water supply, geographical location, topographic conditions, and water supply sources in the central urban area and each township, three centralized water supply systems have been formed: the central urban water supply system, the Yonghe water supply system, and the Tangpu water supply system. Chenxi and Lingnan decentralized water supply systems.

1) Current status of water supply system in central urban areas

①Water supply range

The scope of water supply in the central urban area: the central urban area, Shangyu Binhai New Town, Shangyu Economic and Technological Development Zone in Hangzhou Bay, Changtang Town, Lianghu Street, Daoxu Street in the north, Xiaoyue Street, Yiting Town, Songxia Town, Xietang Town, Eight towns including Gaibei Town are supplied with water. Shaoxing

Binhai New City's domestic water is also supplied by the water supply system in the central urban area of Shangyu District..

②Water purification plant

There are two water purification plants in the central urban area of Shangyu : Shangyuanzha Water Plant and Dajiao Water Plant.

The first-phase project of Shangyuanzha Water Plant was completed and put into operation in January 1993. The site is located at the northeast corner of the intersection of East Third Ring Road and the main trunk canal, covering an area of about 4.7 hectares. After several expansions, the total scale of the water plant has reached 150,000 m^3/ d .

The water supply source is Tangpu Reservoir, and there is a lifting pump station for raw water transportation . The water purification process is the conventional treatment of flocculation, sedimentation, filtration and disinfection. One of the 30,000 m^3 / d water purification structures has been transformed, and the water purification processes are flocculation, sedimentation, secondary flocculation, membrane treatment, and disinfection.

The total designed water supply scale of the Grand Delta Water Plant is 300,000 m^3/d, and the scale of the first phase of the completed project is 150,000 m^3/d . The factory site is located on the west side of Yan Village, Cao'e Street, covering a total area of 145.6 mu. The water supply source is Tangpu Reservoir, and the raw water pipeline is four tunnels plus five pipelines, with a total length of 16.14km, a pipeline diameter of DN1600, and an effective tunnel diameter of D2.2 meters. The first phase of the project utilizes the water level of the reservoir to transport water by gravity. The water purification process is: mechanical mixing, folded plate reaction, advective sedimentation , V -type filter tank, and conventional treatment process of disinfection. The plant has reserved land for algae removal process.

In order to improve the safety of water supply, a DN1200 raw water connection pipe is built between the two water plants. The pipe is about 5km long. The pipe is made of steel pipes.

In order to solve the problem of poor safety of the raw water conveying system in Shangyu District and improve the raw water conveying capacity, a double-line project for the raw water pipeline in Shangyu District was built, so that the maximum daily raw water conveying capacity of the urban water supply system in Shangyu District reached 450,000 m^3 /d, and the accident water conveying capacity reached 450,000 m^3 /d. The starting point of the 300,000 m^3 /d.double-track project is Tangpu Reservoir, and the end point is the Great Triangle Water Plant. The total length of the pipeline is about 18.60km , of which the length of the tunnel is 5.70km , and the diameter of the tunnel is 2200 ; Use steel pipes. Project is under construction.

③Water supply status and pipeline network

The factory pipes of Shangyuan Sluice Water Plant are divided into three routes. One route goes north along Jiangdong Road to the north of Chengbei New City, the old city, and the high-speed railway new city. The diameter of the pipes is DN1200-DN1000 ; All the way along the East Third Ring Road to the east of the city, the diameter of the pipe is DN1000 ; All the way to the west along the South Third Ring Road, it is connected with the factory pipe of the Dajiao Water Plant, the diameter of the pipe is DN800 o

The two ex-factory pipes (DN1400X2) of the Dajiang Delta Water Plant are laid to the north to the Cao'e River and the DN1000 outlet pipe of the Shangyuanzha Water Plant is arranged in a ring. The water supply loop of DN1400-DN1000-DN800 has been basically formed in the third ring of the central urban area of Shangyu District . A relatively complete water supply ring pipe network has been formed in the central urban area. There are two main pipes for water delivery to the north, one is laid along the access road from south to north, passing through Xiaoyue Street, Xietang Town, Gaibei Town to Hangzhou Bay Shangyu Economic and Technological Development Zone, with a pipe diameter of DN800 ; It is laid along the North-South Avenue, passing through Songxia Town to the Central Avenue, with a pipe diameter of DN1200X2 .

Each town (street) has two or more water supply main pipes entering the town. The pipe network in the town is arranged in a ring, and the water supply pressure basically meets the requirements. Hangzhou Bay Shangyu Economic and Technological Development Zone has a trunk pipe of DN1000 along the central river, which is connected with two trunk pipes (north-south direction) to form the main water transmission loop. Ring-based network. The total length of the water distribution pipes with a diameter of DN100 or more is 2000km, and the pipes of the newly built pipes are mainly PE pipes and ductile iron pipes. The central urban area is supplied by the Shangyu District Water Supply Company. Since a relatively complete annular water supply main pipe has been formed in the central urban area, the pressure distribution is relatively uniform, and the free water head is maintained above 28.0m . The pressure of the pipe network meets the water demand.

There are two sources of water supply for enterprises in Hangzhou Bay Shangyu Economic and Technological Development Zone. One is for self-provided water, and the other is for the urban water supply of Shangyu Water Supply Company. The current water consumption is: The average daily water consumption of the development zone in 2017 is 78,800 m^3 /d, and the self-provided water average daily water consumption is 17,000 m^3 / d .

2) Status of yonghe water supply system

①Water supply range

Water supply scope of Yonghe water supply system: Yonghe Town, Fenghui Town.

②Water purification plant

design scale of Yonghe Water Plant is 30,000 m^3/d, and it was completed and opened to water in October 2009 . The site of Yonghe Water Plant is located in a small mountain valley on the east side of the main canal of Siming Lake, the north side of Qiujia Bay and the south side of Mingyin Temple. The total area of the water plant is 22.4 mu. The water supply source is Siming Lake Reservoir, and the original water pipe has a diameter of DN600 and a length of about 1.12 kilometers. The water purification process is: raw water lifting-mixing-folding plate reaction-advective sedimentation - V -type filter-disinfection conventional treatment process.

③Water supply status and pipeline network

There are two main pipes of Yonghe water supply system, one is laid to the north to Yonghe Township, and turned to the northwest to connect with the main pipe of Yiting Town, with a diameter of DN600 ; the other is laid to the west to Fenghui Township, and turned to the north It is connected to the main pipe of Lianghu Street. Yonghe water supply system is connected with the central urban water supply system and can be used as backup for each other. The construction of the water distribution pipeline network in Yonghe Town is becoming more and more perfect, and every village in Yonghe Town is now connected to water. The pressure of the pipe network to the township is basically 0.30 to 0.25Mpa . Meet the water needs of the town. The town of Fenghui Town is now connected to every village with water. The pressure of the pipe network to the township is basically 0.20 to 0.25Mpa , which basically meets the water demand of the township.

3) Status quo of tangpu water supply system

①Water supply range

Water supply scope of Tangpu water supply system: Tangpu Town, Shangpu Town, Zhang Town Town, Dingzhai Township, Xiaguan Town.

②Water purification plant

Tangpu Water Plant has a design scale of 20,000 m^3 /d and was completed in October 2010 . The site of Tangpu Water Plant is located in the raw water lifting pump station of Shangyuanzha Water Plant in Tangpu Town. The total area of the water plant is 13.8 mu. The water supply source is Tangpu Reservoir, which is connected to the plant area from the reserved interface DN500 of the original water pipe of the Dajiao Water Plant. The water purification process is: raw water, mixing , folding plate reaction , advective sedimentation, V -type filter tank , conventional treatment process of disinfection.

③Water supply status and pipeline network

The DN400 outlet pipe of Tangpu Water Works is laid northwest to Tangpu Township. Tangpu Township is now connected to every village with water, and the pipe network pressure in the township is basically 0.30 to 0.25Mpa to meet the water demand of the township. The DN600 outlet pipe of Tangpu Water Works will be laid to the northeast to National Highway 104 , and the DN400 pipe will be laid to the north to Shangpu Town; the DN600 pipe will be laid to the south to Zhangzhen Town . Down the town. Shangpu Township is now connected to every village with water. The pressure of the pipe network to the township is basically 0.25Mpa o to meet the water demand of the township. The pipelines in the township of Zhangzhen Township are arranged in the urban ring, and the township is now connected to every village with water. A pressurized pump station is set up before entering the town, and the pressure of the pipe network to the town is basically 0.30 to 0.25Mpa, which can meet the water demand of the town. Dingzhai Township and Xiaguan Town are now supplied by Tangpu Waterworks. The main water supply pipes are arranged in branches, and the internal water supply pipes are not perfect.

4) Status Quo of Decentralized Water Supply System

① Chenxi Township

Chenxi Township is supplied with water by a self-built water plant with a design scale of 50 m^3 /d , and the water source is Taxi. The water purification process of the water plant is as follows: a first-level lifting pump room-integrated equipment - feeding pump room - high -level pool (400 cubic meters). The water distribution pipe network is newly built, and the leakage rate of the pipe network is not high. Chenxi Township Market Town, Stalagmite Mountain, Hongxi, Xiaochen Valley, etc. are supplied by the township water plant. Other areas in the township depend on the small reservoirs on the mountains for water supply.

②Lingnan Township

Lingnan Township has not built a systematic water supply project at present. The residents of each village use the mountain pond reservoir and mountain stream water as the water source, which is directly supplied to the residents after treatment by integrated equipment or even without treatment.

5) Water supply

Table. 6-4 Shangyu District Water Company over the years [12]

Years	Annual water supply (10,000 tons)	growth rate (%)	Leakage rate (%)	Water consumption (10,000 tons)		Industry: Integrated Living	Maximum daily water supply (10,000 tons)	Diurnal coefficient of variation	Comprehensive water consumption index (10,000 tons / 10,000 people per day)	Comprehensive domestic water consumption index (liter/person-day)
				industry	Comprehensive domestic water					
2004	4563.87	13.24	12.61	2385.91	1602.66	0.60: 0.40	14	1.12	0.279	97.96
2005	5452.25	19.47	12.1	2892.31	1900.07	0.60: 0.40	17.64	1.18	0.321	111.69
2006	6289.84	15.36	10.89	3570.31	2034.64	0.64: 0.36	20.39	1.18	0.359	115.85
2007	678	7.8	10.4	4071	2000.62	0.67:	24.88	1.34	0.427	126.03

	2.82	4	8	.29		0.33				
2008	6887.27	1.54	10.45	4055.04	2112.64	0.66:0.34	21.69	1.15	0.344	105.49
2009	7208.36	4.66	10.36	4237.49	2224.31	0.66:0.34	23.31	1.18	0.358	110.29
2010	7941.7	10.17	7.96	4040.14	3142.05	0.56:0.44	25	1.15	0.373	147.76
2011	8311.91	4.66	7.24	4069.75	3427.41	0.54:0.46	26.98	1.18	0.401	164.82
2012	8324.08	0.15	8.07	4103.19	3449.77	0.54:0.46	26.58	1.17	0.394	163.82
2013	8593.84	3.24	7.03	4269.49	3546.12	0.55:0.45	28.6	1.22	0.421	174.31
2014	8477.67	-1.35	7.02	4286.54	3507.17	0.55:0.45	26.9	1.16	0.39	161.54
2015	8498.70	0.25	6.95	4936.80	2856.50	0.63:0.37	28.1	1.16	0.401	129.69
2016	8750.71	2.97	8.45	4910.13	2546.88	0.66:0.34	30.2	1.24	0.431	115.63
2017	8613.92	1.56	5.98	5106.17	2667.36	0.66:0.34	29.0	1.21	0.414	126.32
14 year average	7478.35		8.97	4066.75	2644.16	0.61:0.39	24.52	1.19	0.38	132.23
Average over the past 5 years	8586.97		7.09	4701.83	3024.81	0.61:0.39	28.56	1.20	0.41	141.50

6.2.2 Status of sewage system

1) Status of sewage treatment plants

Shangyu District Water Treatment Development Co.Ltd. (hereinafter referred to as "Shangyu Sewage Treatment Plant"), located on Weisan East Road, Shangyu Economic and Technological Development Zone, Hangzhou Bay, mainly treats all centralized sewage in Shangyu City.

Shangyu Sewage Treatment Plant covers an area of 491.85 mu, with a planned total scale of 300,000 m³ /d . The first phase of the project with 75,000 m³ /d, was completed and put into operation in 2002. It was stopped in 2009 because the technological process could not meet the new requirements for upgrading and emission reduction . The second - phase project of 225,000 m^3 /d was implemented step by step. The first-line project of 112,500 m^3 /d was put into operation in October 2008 , and the second-line project of 112,500 m^3 /d was put into operation in May 2012 .

The second-stage (225,000 m^3/d) sewage treatment process is: steady flow tank - folded plate flocculation advective sedimentation tank anaerobic tank - A/O biological treatment tank - secondary sedimentation tank - high density clarification tank - ultraviolet disinfection tank one row Subsea pump room and high-level wells in the field - subsea discharge pipes.

See the table below for the amount of sewage inflow and water quality in recent years:

Table. 6-5 sewage inflow and water quality in recent years

years	Annual total sewage	water quality index									
		Influent C0D	Outlet COD	Influent BOD	Outlet BOD	Influent TP	Outlet TP	Influent SS	Outlet SS	Ammonia nitrogen in influent	Ammonia nitrogen in effluent
2015	51.95 million tons	386	79	113	12	4.89	0.54	239	22	30.10	0.72
2016	56.79 million tons	336	75	82	17	7.85	0.63	186	25	26; 80	1. 32
2017	61.09 million tons	326	63	150	17	7.69	0.30	150	22	32. 80	1.93
average value	56.61 million tons	349	72	115	15	6.81	0.49	192	23	29. 90	1. 32

After the sewage treatment plant reaches the standard, the tail water will be discharged into the Qiantang River, and the tail water will be discharged into the high-level well after being lifted by the sea discharge pump house.

The sludge in the sewage treatment plant is deeply dewatered by high-pressure plates and frames, and the moisture content of the sludge is reduced to 70%. Due to the limited capacity of the thermal power plant in the park to accept sludge, Shangyu Sewage Treatment Plant has entrusted Shaoxing Shangyu Huanxing Sludge Treatment Co., Ltd. to carry out sludge treatment, and the 150 m^3/d sludge incineration project has started operation.

2) Status of sewage pipe network system

Municipal sewage system: At present, the urban sewage collection scope is Hangzhou Bay

Shangyu Economic and Technological Development Zone, Central City, Daoxu, Xietang, Xiaoyue, Yiting, Lihai, Songxia, Fenghui, Lianghu, and Yonghe. The sewage collection system in the area adopts the combination of gravity flow and pressure flow, and the collection system has been basically completed. The collection pipelines in urban areas and townships are mainly gravity flow, and the transportation pipelines between urban areas, towns and sewage treatment plants are mainly pressure flow. In the existing sewage collection system, there are 84 main sewage pumping stations built or under construction, and the main sewage pipelines built and under construction are 402km, with a conveying capacity of more than 280,000 m^3/d .

The sewage system in the central city is composed of two major systems: Jiangdong and Jiangxi.

Jiangdong Sewage System: Located on the east side of the Cao'e River, it mainly collects sewage from the land east of the Cao'e River. The sewage collection scope includes the high-speed rail new city, the new city in the north of the city, the old city, the east area of the city, and the south area of the city, with an area of about 56.9k ㎡, and it will also be transferred to the upstream. Sewage from Lianghu Street and Fenghui Town. About 14 large and small sewage lifting pumping stations have been built, including Chengnan Pumping Station, Ludong Pumping Station, Chengdong Pumping Station, Hengli Pumping Station, Chengshan Pumping Station, Chengbei Pumping Station and Jiangdong Central Pumping Station. The main sewage pipes that have been built are mainly arranged along Jiangdong Road, Third Ring Road and Fourth Ring Road. Jiangdong Central Pumping Station is the terminal pumping station of Jiangdong Sewage System. After being collected and lifted by this pumping station, sewage is discharged northward along the Fourth Ring Road in the form of pressure flow into Shangyu Sewage Treatment Plant for centralized treatment.

Jiangxi Sewage System: Located on the west side of the Cao'e River, it mainly collects sewage from the plots west of the Cao'e River. The sewage collection area includes Shangyu Economic Development Zone, Dongguan Street, and Cao'e Street, with an area of about 51.04 k ㎡ . In addition, it will be transferred to Daoxu Street in the upper reaches. Sewage coming in. About 9 large and small sewage lifting pumping stations have been built, among which large sewage pumping stations include Southwest Pumping Station, Juying Road Pumping Station, Yongxiang Road Pumping Station and Jiangxi Central Pumping Station. The existing sewage mains are mainly arranged along Bowen Road, Binjiang Road, Fourth Ring Road and Wuxing West Road. Jiangxi Central Pumping Station is located in Jiangxi area.

The terminal pumping station of the sewage system. After the sewage is collected and lifted by the pumping station, it is discharged into the Shangyu Sewage Treatment Plant in the form of pressure flow to the north along the Fourth Ring Road. The statistics of the main sewage pumping stations and main sewage pipes in Shangyu City are shown in the following table 6-6- table 6-7 ：

Table.6-6 Statistical table of current main sewage main pipes (unit: m)

Drainage block	Serial number	Pipe start and end points	Pipe diameter (mm)	Tube length (m)	Operating status
Jiangdong	1	Jiangdong Road Central Pumping Station - Zongxia Transfer Pumping Station - Sewage Treatment Plant	D1200 X 2	15.6X 2	pressure tube
	2	Sanhuan North Road	D800/D1800	4.4/ 4.9	pressure/gravity
	3	Chengnan Pumping Station - Jiangdong Central Pumping	D800	5.8	pressure tube

		Station			
	4	Ludong Pumping Station-Sanhuan North Road	D800	1.9	pressure tube
	5	Fenghui Pumping Station - Longshan Tunnel	D600	9.1	pressure tube
	6	Jiangdong Central Pumping Station - Jiangyang North Road	D1200-D1300	2.7	pressure tube
	7	Chengbei Pumping Station - Jiangdong Central Pumping Station	D1200-D1300	1.7	pressure tube
	8	Chengnan Pumping Station-Sanhuan North Road	D800	5.4	pressure tube
	9	Hengli Pumping Station-Sanhuan North Road	D800	3.2	pressure tube
	10	Chengdong Pumping Station-Shengshan Road Pumping Station	D800-D1000	3.0	Gravity Tube
	11	Yingbin Avenue - Chengbei Pumping Station	D1000-D1800	4.7	Gravity Tube
	12	Ludong Pumping Station - Jiangdong Road	D800	4.7	pressure tube
Jiangxi block	13	Yongxiang Road Pumping Station-Jiangdong Central Pumping Station	D1000/D1200	0.6/ 1.0	pressure tube
	14	Jiangxi Central Pumping Station-Jiangdong Central Pumping Station	D1200	1,1	pressure tube
	15	Yuexiu Road Pumping Station-Juying Road Pumping Station	D600-D1200	2.0	pressure tube
	16	Southwest Pumping Station - Yongxiang Road Pumping Station	D700/D800	3.0/ 3.6	pressure tube
	17	Juying Road Pumping Station - Yongxiang Road Pumping Station	D600	3.1	pressure tube
	18	Daoxu Pumping Station-Jiangxi Central Pumping Station	D800	7.0	pressure tube

	19	Yongxiang Road Pumping Station-Jiangxi Central Pumping Station	D1200	1.0	pressure tube
	20	Dongguan Dongtang Pumping Station - Caoxin Road	D400	2.9	pressure tube
	21	Outer Ring South Road Pumping Station - Caoxin Road	D400	2.5	pressure tube
	22	Cao'e Jincun Pumping Station - Caoxin Road	D400	1.0	pressure tube
	23	Caoxin Road - Southwest Pumping Station	D700	0.9	pressure tube
	24	Shaoxing Daughter Winery Special Line	D400	2.8	pressure tube
	25	Development Zone Enterprise Line	D700	4.0	pressure tube
Eastern Line block	26	Xietang City Regional Pumping Station - Songxia Transfer Pumping Station	D600	3.5	pressure tube
	27	Yiting Wufu Pumping Station-Xietang Pumping Station	D300-D600	9.5	pressure tube
	28	Xiaoyue Xinzhai Pumping Station-Xietang Pumping Station	D300	3.3	pressure tube
	29	Xietang Xiejiatang Pumping Station-Xietang Pumping Station	D400	1.6	pressure tube
	30	Songxia Yanxiangtou Central Pumping Station - Yuexia Transfer Pumping Station	D500	3.0	pressure tube
Southern Line block	31	Jiangcun Central Pumping Station - Huihuang Pumping Station - Southwest Pumping Station	D600	19.0	pressure tube
	32	Zhangzhen Pumping Station - Shangpu Pumping Station - Jiangcun Central Pumping Station	D400/D500	8.0/ 3.1	pressure tube
	33	Tangpu Pumping Station-Jiangcun Central	D400	2.2	pressure tube

		Pumping Station			
Northwest Line block	34	Park Jingsan Road Pumping Station - Sewage Treatment Tea Factory	D800	2.3	pressure tube
	35	Park expansion area pump station - sewage treatment plant	D500	0.5	pressure tube
	36	Park Jingsan Road Pumping Station - Sewage Treatment Plant	D600	4.8	pressure tube
	37	Lihai No. 1 Pumping Station - Park Jingsan Road Pumping Station	D300-D400	8.9	pressure tube
	38	East Second District Pumping Station - Park Development Area Pumping Station	D1000	3.3	pressure tube
	39	Binhai Pumping Station - East Second District Pumping Station	D900	6.1	Gravity Tube

Table. 6-7 Status quo of main sewage pumping stations

The area located	Pumping station name	Design scale (m^3 /d)	Pumping station address	Remark
Yu Nan block	Fenghui Yuanzhen Bridge Pumping Station	15000	Near Fenghui Town Police Station, next to Yuanzhen Bridge	The effluent is connected to Fenghui Pumping Station
	Fenghui Middle School Pumping Station	5000	Next to Fenghui Town Middle School	
	Fenghui Pumping Station	30000	Dongguang Village, Fenghui Town	The effluent is connected to Chengnan Pumping Station and Ludong Pumping Station
	Xieqiao Pumping Station	10000	Northeast side of Xiejia New Bridge	

	Yonghe Industrial Functional Zone Pumping Station	5000	Next to Yonghe Industrial Functional Area	
	Chengnan Pumping Station	50000	Sancun, Baiguan Street (next to Chengnan Bridge)	The effluent is connected to Jiangdong Central Pumping Station
	Zhangzhen Wangchong Road Pumping Station	80000	Zhangzhen Wangchong Road	
	Zhangzhen Industrial Zone Pumping Station	2000	Zhangzhen Shangsan Expressway	
	Zhang Town Xinye Village Pumping Station	2000	Inside Xinye Village	
	Zhangzhen Datong Nanyuan Pumping Station	2000	East of Datong Nanyuan	
	Zhangzhen Pumping Station	10000	Jingqiao Village, Zhangzhen Town	The effluent is connected to the Shangpu pumping station
	Zhang Town Jiangshan Old Street Pumping Station	350	Zhangzhen Town Old Market Town	
	Zhangzhen Town Xieyu Road Pumping Station	2000	Intersection of Zhudong Road and Xieyu Road	
	Shangpu Pumping Station	2000	Sifeng Village, Shangpu Town	The effluent is connected to Jiangcun Central Pumping Station

The area located	Pumping station name	Design scale (10,000 m^3/d)	Pumping station address	Remark
	Shangpu No. 1 Pumping Station	1000	North Head of Heping Road	
	Shangpu No. 2 Pumping Station	1000	South Head of Heping Road (Shangpu Middle School)	
	Shangpu No. 3 Pumping Station	5000	Shangpu Farmers Market North Head	
	Tangpu Pumping Station	10000	Tangpu Town	The effluent is connected to Jiangcun Central Pumping Station
	Jiangcun Central Pumping Station	30000	Jiang Village, Tangpu Town	The outlet water is connected to Huihuang Pumping Station
	Huihuang Pumping Station	30000	Huihuang Village, Changtang Town	The effluent is connected to the Southwest Pumping Station
	Cao'e Industrial Functional Zone Pumping Station	10000	The turning point of the waterworks in Cao'e street	The effluent is connected to the Southwest Pumping Station
	Southwest Pumping Station	50000	104 , Cao'e Street (under Chunhui Overpass)	The effluent is connected to Jiangxi Central Pumping Station
	Outer Ring South Road Pumping Station	15000	East side of Minfeng Community, South Outer Ring Road	The effluent is connected to the Southwest Pumping Station
	Dongguan Yongxingqiao Pumping Station	5000	Dongguan Yongxing Bridge	
	Dongguan Juxing Pumping Station	5000	Former Superstar Company Bridgehead	

	Dongguan Hotel Pumping Station	5000	East of Ying Song Hotel	
	Dongguan Dongtang Pumping Station	12000	Next to the Agricultural Bank of Dongguan New Oriental Home	The effluent is connected to the Southwest Pumping Station
Yuxi block	Daoxu Zhonglian Pumping Station	5000	Near Tishan Heavy Industry, Daoxu Town	Water outlet to Tao Hui Pumping Station
	Daoxu Renmin West Road Pumping Station	5000	Next to the traffic light on Renmin West Road, Daoxu	
	Dao Hui Pumping Station	25000	Chenghai Village, Daoxu Town (next to Longsheng Group)	The effluent is connected to Jiangxi Central Pumping Station
	Tao Hui Market Pumping Station	0.0	Dao market market entrance	
	Daoxu Town Middle Road Pumping Station	1000	The entrance of Daoxu Town Government	
	Daoxu Town East Road Pumping Station	1000	Daoxu old police station entrance	
	Daoxu Runtu Primary School Pumping Station	1000	Inside Daoxu Runtu Primary School	
	Daohui Pearl Court Pumping Station	1000	Daoxu Zhonglian Mingzhu Court South	
	Jiangxi Central Pumping Station	100000	Baiguan under the Fourth Ring Bridge west of Cao'e River	The effluent is connected to the Songxia Transfer Pumping Station
	Yongxiang Road Pumping	50000	Guangming Village, Cao'e Street	The effluent is connected to Jiangdong

	Station			Central Pumping Station
	Juying Road Pumping Station	20000	To the end of Juying Road, Cao'e Street (by the landscape belt)	The effluent is connected to Jiangdong Central Pumping Station
	Yuexiu Road Pumping Station	10000	Juying Road, Cao'e Street	The effluent is connected to Juying Road Pumping Station
Suburban block	Jiangdong Central Pumping Station	100000	Under the Fourth Ring Bridge east of Cao'e River, Baiguan	The effluent is connected to the Songxia Transfer Pumping Station
	Chengshan Road Pumping Station	35000	Baiguan Street, the intersection of Shanlu Road and the Third Ring Road	The effluent is connected to the Jiangdong North Road Pumping Station
	High-speed rail new city center pump station	20000	Under the Fourth Ring Bridge east of Cao'e River, Baiguan	
City block	Hengli Pumping Station	80000	No. 18 , Hengli West Fourth District, Baiguan Street	The effluent is connected to Jiangdong Central Pumping Station
	Chengbei Pumping Station	50000	Under the Third Ring Bridge, Jiangdong Road, Baiguan Street	The effluent is connected to Jiangdong Central Pumping Station
	Chengdong Pumping Station	40000	Next to Citizen Avenue International Hotel, Baiguan Street	The outlet water is connected to the Shanlu Pumping Station
	Sijia Pumping Station	50000	Baiguan Street is called the extension of Mountain Road	
	Dingjiesi Pumping Station	2000	Dingjie Temple, Baiguan Street (beside Xinhe River)	
	Experimental Primary School Pumping Station	2000	Inside Baiguan Street Experimental Primary School	
	Huawei Middle School	5000	Inside Huawei Middle	

	Pumping Station		School	
	Renmin East Road Pumping Station	5000	Fork between Renmin Road and Civic Avenue at the east end (next to Chengdong Primary School)	
Yuzhong block	Songxia Yanxiangtou Central Pumping Station	25000	Diagonally opposite the Second People's Hospital of Songxia Town (across the river)	The effluent is connected to the Songxia Transfer Pumping Station
	Songxia Peijia Pumping Station	2000	Next to the intersection of Huazhen Station	
	Songxia Sa m^3engqiao Pumping Station	5000	Opposite Tianwai Tianma Road, Shihua Village	The effluent is connected to the Songxia Transfer Pumping Station
	Songxia No. 5 Pumping Station	15000	Songxia Development Zone, next to the town government	
	Zuixia No. 6 Pumping Station	8000	Zuixia Development Zone, next to the town government	
	Zhongxia West Street Pumping Station	5000	Songxia West Street	
	Songxia Transfer Pumping Station	300000	Dongshanghu Village, Zhongxia Town	The effluent is connected to the sewage treatment plant
Yudong block	Yiting Wufu Pumping Station	3000	After Yiting Town Government	The outlet water is connected to Yiting Pumping Station
	Yiting Pumping Station	10000	Zhaoxiangqiao Village, Xiaoyue Town	The effluent is connected to Xiaoyue Pumping Station
	Xiaoyue Shiluo Pumping Station	10000	Diagonally opposite Yongsheng Automobile in Xiluo Village, Xiaoyue Town (across the river)	The effluent is connected to Xiaoyue Pumping Station
	Xiaoyue Pumping	40000	Hengshan Xu Village,	The effluent is connected to the

	Station		Xiaoyue Town	Xietang pumping station
	Xiaoyue Shuangyan Industrial Zone Pumping Station	5000	Xinxing Village, Xiaoyue Town	
	Xiaoyue Xinzhai Pumping Station	5000	Xinzhai Village, Xiaoyue Town (beside Gabian Highway)	The effluent is connected to the Xietang pumping station
	Xietang Pumping Station	60000	Xindaijia Village, Xietang Town (beside Gabian Highway)	The effluent is connected to the Songxia Transfer Pumping Station
	Xietang Chenhui Industrial Zone Pumping Station	2000	Chenhui Hangzhou Bay Shangyu Economic and Technological Development Zone	
	Xietang Xiejiatang Pumping Station	7000	Traffic Police Brigade New District Squadron	The effluent is connected to the Xietang pumping station
	Xietang Jinshengjiayuan Pumping Station	2000	Next to Xietang Jinsheng's home	
Yubei	Park Jingsan Road Pumping Station	25000	The north end of Jingsan Road, Shangyu Economic and Technological Development Zone, Hangzhou Bay	The effluent is connected to the sewage treatment plant
	Park Jingsan Road Pumping Station	50000	Hangzhou Bay Shangyu Economic and Technological Development Zone, north of Jingshisan Road end	The effluent is connected to the sewage treatment plant
	Park expansion area pump station	50000	Hangzhou Bay Shangyu Economic and Technological Development Zone (Tianwei Electroplating Factory beside)	D100 outlet pipe of the East Second District
	Binhai Driving	2000	Next to Binhai Driving	

	School Pump Station		School	
	Gaibei Square Pumping Station	3000	Opposite to Gaibei Town People's Government	
	Gaibei Pumping Station	5000	Opposite to Gaibei Town People's Government	under construction
	Binhai Central Pumping Station	20000	The intersection of Binhai Avenue and Changhai Highway	
	Park East Second Road Pumping Station	70000	Hangzhou Bay Shangyu Economic and Technological Development Zone (Kangyang Avenue Bridge head)	The effluent is connected to the sewage treatment plant
	Built-up area pump station	5000	Weiqi East Road, Shangyu Economic and Technological Development Zone, Hangzhou Bay (Baiyun after the hotel)	
	1 Pumping Station, Center Avenue	15000	Located at the top of Kangyang Avenue, near the sea flower field	
	Center Avenue 2 Pumping Station	15000	Opposite to Science and Technology Innovation Center on Kangyang Avenue	

3）Current Sewage System Evaluation and Problem Analysis

After years of construction, the current sewage collection system in Shangyu District has been gradually improved, and the sludge has basically been completely disposed of. Currently, it is also actively carrying out the work of improving the quality of the water environment, effectively improving the quality of the water environment in Shangyu, and providing a solid foundation for social and economic sustainability. basic guarantee. However, due to the relatively lag in the reconstruction of the capillary network and the pipeline network in the old city, the sewage collection rate is low. Compared with the people's demands for the ecological environment, the quality of the water environment is still not small, and individual rivers are still polluted to a certain extent.

① The sewage collection system needs to be further improved.

Current Situation The drainage pipelines in the old urban area were constructed earlier, and some of the ditches formed by landfill rivers are used to transport sewage. The pipelines and channels are in disrepair, blocked and seriously damaged; In addition, some sewage discharge pipe networks are not included in the municipal pipe network, and there is not enough space for rain and sewage diversion transformation, and the diversion of rain and sewage is not complete; the sewage in some areas is discharged nearby without centralized collection and treatment, resulting in the pollution of surface water; the status quo of some areas The aging of the pipeline is serious. Due to the early construction, the pipeline was invaded by plant roots; in the roads built earlier in the south and north of the city, due to the development of the surrounding plots, the pipelines such as mud leakage and silt intrusion were blocked and the drainage was not smooth. In some areas, due to supporting facilities The roads were not included in the construction plan in a timely manner, resulting in the failure of the pipelines and the inability to discharge sewage.

②The drainage system is chaotic, and the diversion of rain and sewage is not complete.

In many areas in the central urban area, the sewerage of rain and sewage in the sewage collection system is not complete. The problem of unclear segregation of rain and sewage in the old urban area is particularly serious. The rain and sewage diversion is not perfect, resulting in the current gravity confluence pipeline running at full capacity in the rainy season. The peripheral pumping stations have increased their discharge efforts. The municipal sewage gravity main and pressure mains are almost saturated, and the surrounding connecting pipelines cannot be discharged again, which eventually leads to the shutdown of the pumping station. Or open emergency discharge outlets, a large amount of water on the road, rain and sewage in the community are poured back, urban rivers are polluted, and even enterprises are forced to stop production.

③ The channels of the municipal sewage system are too single, lacking both functions and functions, and there is a problem of drainage safety.

At present, the sewage in Shangyu District flows from south to north, from east to west through the existing D1200HOBAS pipe and D1200 steel pipe into the terminal transfer pumping station, and finally discharges into the sewage treatment plant . Pipe, about 12,000 m^3/d, domestic sewage is discharged into D1200 steel pipe, and the peak period has exceeded 90,000m^3/d .

Therefore, in a strict sense, about 130,000 tons of sewage in Shangyu District is discharged to the north in a single-channel mode. In case of a pipe burst accident or the supervisor needs to be maintained, how to schedule each pumping station, downstream enterprises How to discharge sewage will become a serious problem highlighted.

④ Interconnection and interoperability need to be further strengthened.

7 main sewage pumping stations built and under construction , including 23 main pumping stations in the central urban area . Although there are many pumping stations, each pumping station is self-contained, and there is a lack of space between them. Necessary connecting pipelines, especially in the east and south line projects, due to the long distance between the road and the road and the complicated situation along the way, the current system lacks the necessary emergency guarantee mechanism, and the emergency situation is still mainly handled manually.

⑤The charging mechanism for sewage treatment needs to be improved.

The current sewage charging standards are relatively low, resulting in serious losses for sewage treatment enterprises. With the continuous improvement of the state's requirements for sewage sludge treatment and disposal, the optimization of various technological processes of sewage treatment plants and the upgrading of treatment facilities will lead to further increase in the construction and operation costs of sewage treatment plants. After accounting, Shangyu Sewage Treatment Plant has suffered serious losses in recent years, and the huge losses have had a great impact on the stable operation and sustainable development of the enterprise.

⑥ Supervision needs to be strengthened.

At present, the industrial sewage collection and treatment system has been basically perfected, but the penalties for stealing and leaking sewage and discharging sewage beyond the standard are not severe. Concatenation and other behaviors lack effective restraint mechanisms and administrative supervision means. At the same time, Shangyu District has basically achieved full sludge disposal, but some enterprises still pile up industrial sludge at will and incinerate sludge by themselves, which is very likely to cause serious secondary pollution.

6.2.3 Determination of drainage system

1） An overview of the drainage system

Usually, the choice of drainage system is the primary issue in urban drainage system planning. It affects the design, construction, maintenance and management of the drainage system, has a profound impact on urban planning and environmental protection, and also affects the total investment, initial investment and operation and management costs of the drainage system project. Generally, it should be comprehensively considered from the overall situation according to the overall urban planning, environmental protection requirements, original drainage facilities, water environment capacity, topography, and climatic conditions.

The drainage system is divided into two forms: the combined system and the divided system. A drainage system that mixes domestic sewage, industrial wastewater and rainwater in one conduit is called a combined system. The confluence system is divided into two types: straight-line confluence system and closed-flow confluence system. The former is that the mixed sewage is directly discharged into the water body without any treatment and utilization, and no sewage treatment facilities are set up. On the basis of the former, the latter builds interception trunks (usually along rivers or other receiving water bodies), sets up overflow wells at the interception, and sets up sewage treatment plants, and all sewage in the early rainy and dry seasons will flow into the sewage treatment plants, when the rainfall increases, the mixed sewage overflows to the water body for removal. The confluence system causes serious water pollution, does not conform to the current national environmental protection policies, and is generally not used.

The diversion system is a system that discharges domestic sewage, industrial wastewater and rainwater in two or more separate pipe areas. The splitting system is divided into incomplete splitting, semi splitting and complete splitting. The semi-diversion system has good sanitary conditions, but the investment is too large. The incomplete diversion system is to establish a complete sewage system, and the rainwater enters the open ditches or small rivers that are not in the system by means of surface flooding. It is generally suitable for developing areas and can be constructed in stages to save recent investment. The complete separation system sends industrial wastewater and domestic sewage to the treatment plant for treatment and discharge or utilization, and rainwater and some industrial cleaner wastewater are discharged nearby. This system has good sanitary conditions, and is generally adopted in newly built cities, industrial zones and development zones.

Generally, in the early stage of urban construction, the surrounding water bodies are good, the water environment capacity is large, and due to the limitation of construction funds, the confluence system is mostly adopted. With the development of the city and the deterioration of the water environment, it is difficult to carry out complete diversion reconstruction at this time due to social and natural factors such as building density and renovation funds. New urban areas are often planned and designed according to the diversion of rainwater and sewage, and a diversion system is adopted.

Table. 6-8 Comparison table of advantages and disadvantages of drainage system

Drainage system	In-line confluence system	Interception and confluence	Full diversion	Incomplete distribution system	Half split system
Scope of application	In the initial stage of urban development, the water environment	In the beginning stage of urban development, urban areas	Newly-built urban areas, urban areas that can be	Urban development areas, with suitable topographical	Areas with high environmental protection requirements

	has a large capacity	without conditions for renovation	renovated	conditions, are transitional measures	and good economic conditions
Environmental protection	worst	poor	good	good	best
Invest	small	big	big	small then big	maximum
Implementation difficulty	easiest	easier	difficult	easy before difficult	hardest
Running cost	lowest	high	high	low first then high	highest
Construction management	simple	simpler	complex	simple then complex	most complicated

2）Choosing of drainage system

The type of drainage system to be used should be based on natural conditions and construction conditions, and adjust measures to local conditions.

①Hangzhou Bay Shangyu Economic and Technological Development Zone

In the Hangzhou Bay Shangyu Economic and Technological Development Zone, all the built-up areas have adopted a complete segregated drainage system, and the subsequent construction areas should also adopt the same drainage system.

② The central city and surrounding towns (streets)

According to the current economic development of Baiguan Street and Daoxu, Lianghu, Xiaoyue, Xietang, Gaibei, Yiting, Jiexia, Fenghui, Yonghe, Zhangzhen, Tangpu, Shangpu, Changtang, Dongguan and Cao'e District, Cao'e Sub-district and other townships (streets) have built the status quo of the comprehensive sewage management system, as well as their own water environment capacity, the use of the confluence system is very polluting, and it is also inconsistent with the state's laws and policies on environmental governance, and the confluence system is simply used. is not feasible. The diversion system complies with relevant national policies and regulations, has less pollution, and can play a greater role in promoting environmental protection. Therefore, this planning adopts the drainage system of rainwater and sewage diversion for the drainage system of the central urban area and surrounding townships (streets).

In the reconstruction project of the old city (market town) area, the incomplete diversion system can be used as a temporary transitional measure. With the deepening of the reconstruction of the old city, the diversion of rain and sewage in the drainage system will also be accelerated. The drainage system in the newly built area adopts a complete diversion system.

③ Four townships in southeastern Yu

The four towns of Dingzhai, Xiaguan, Chenxi and Lingnan have built rural domestic sewage collection systems. However, due to their location in the remote area of Shangyu, the sewage collection pipelines between towns and between towns and existing cities are far away; The distribution of villages in the area is relatively scattered; the scale of the villages is small, and there are certain technical difficulties in integrating the sewage from each village into the municipal sewage collection pipeline. In addition, the overall sewage volume of the above-mentioned managed projects is relatively small, the investment cost is high, and the i m³ut and output are relatively low. After comprehensive consideration, this plan proposes that the terminals of the rural domestic sewage collection system in the above four towns will not be included in the municipal sewage pipe network for the time being. Sewage treatment is carried out in the mode of decentralized treatment and discharge.

From a long-term perspective, the above four towns have abundant eco-tourism resources, and they are all included in the district's beautiful rural demonstration towns, focusing on the development of eco-tourism industry, and are also key towns and towns for water resources protection in Shangyu District. With the continuous advancement of economic construction and the continuous expansion of the scale of tourism development, the amount of domestic sewage is bound to continue to increase, and the requirements for environmental protection will also become higher and higher, making it more and more difficult to disperse the technology in the on-site decentralized treatment mode, the disadvantages of easy to cause point source pollution have become increasingly prominent. In order to cooperate with the smooth progress of projects such as the construction of beautiful villages in the district and create an ecologically harmonious natural environment, a comprehensive assessment of sewage discharge, environmental requirements and construction costs should be re-evaluated in due course. When the time is right, the domestic sewage in the four townships of Dingzhai, Xiaguan, Chenxi and Lingnan will be collected and treated in a unified and centralized manner, and the sewage management project in the whole area of Shangyu City will be completed. This planning proposes several ideas for later reference or comparison of individual or all townships when they need to be managed:

Lay DN300 pipes from high to low in Chenxi Township, pass through Xiaguan Town and Dingzhai Township, and connect to the sewage supervisor of Fenghui Town; Lay DN300 pipes from high to low in Lingnan Township to access sewage in Zhangzhen Township director.

Lay DN300 pipes from high to low in Chenxi Township, pass through Xiaguan Town and Dingzhai Township, and connect to the sewage supervisor of Zhangzhen Town; Lay DN300 pipes from high to low in Lingnan Township to connect to Zhangzhen Town sewage director.

Lay DN300 pipes from high to low from Chenxi Township, pass through Xiaguan Town and Dingzhai Township, and set up a small domestic sewage treatment plant at a suitable location in Dingzhai Township. DN300 is laid from high to low terrain, and a small domestic sewage treatment plant is set up at a suitable location in Lingnan Township. After the treatment reaches the standard, it will be discharged into the nearby water body.

6.3 Wastewater system planning

6.3.1 Wastewater collection system planning

1) Planning specific principles

①General layout principle

A. The alignment of the main sewage pipe is implemented simultaneously with the construction of the planned road network, which facilitates the access of the branch pipes on both sides: the main sewage pipe is arranged in the middle of the planned sewage collection area to reduce the burial depth of the pipes on both sides. Therefore, the buried depth of the starting point pipeline is considered as 2.0m, which is conducive to the access of the branch pipes in the neighborhood.

B.When setting the line, take major municipal facilities, railways, highways, rivers, etc. as the system boundaries, and try to avoid or reduce pipelines crossing rivers or railways.

C. Make use of the terrain as much as possible to reduce the buried depth of the pipeline and reduce the sewage to lift the pump station midway.

D. There are many river networks in the central urban area, the groundwater level is high, the soil quality is weak foundation, and the bearing capacity is low. At the same time, considering the strength of domestic sewage pipes and local construction conditions, it is considered to install sewage according to the pipeline burial depth of about 4.0~5.0 When the pump station is lifted midway, the bridge pipe should be used for the pressure pipe to cross the river.

E. Make rational use of existing sewage engineering facilities, do a good job in the connection of old and new pipelines, and give full play to their economic and environmental benefits.

F. This planning and design only considers the main sewage main pipe and the secondary main pipe, and does not consider the planning and design of the sewage branch pipe.

G. The main sewage pipe is planned and designed according to the long-term plan in 2030, the pipe diameter is determined according to the long-term design flow, and the main pipe is laid in sections according to the near and long-term development.

② Comprehensive principle of pipeline

Although only drainage pipeline planning is carried out in this plan, there are many other pipelines under the road, such as water supply pipes, gas pipes, power cable trenches, telecommunication pipes, etc. When arranging drainage pipes, they should be properly handled both horizontally and vertically. The relationship with these pipelines, that is, the pipeline synthesis problem should be considered. The piping layout shall comply with the requirements of the "Code for Comprehensive Planning of Urban Engineering Pipelines".

A. Pipeline comprehensive plane position

Water supply pipes and gas pipes are all pressure pipes, which are easy to cause damage during operation, and require frequent ground-breaking maintenance and repairs, and should be arranged under the sidewalk. Due to the large cross-sectional area and large amount of earthwork, the rainwater pipes should be arranged in the center of the road or on both sides of the road, so that the neighborhood rainwater and the road rainwater outlet can be connected. Cable trenches and telecommunication pipelines are generally arranged under sidewalks or non-motorized vehicle lanes. Sewage pipes are arranged under the roadway or non-motorized vehicle lanes, which is conducive to the operation and maintenance of pipeline dredging machinery or dredging vehicles.

B. Comprehensive vertical arrangement of pipelines

All kinds of pipelines have requirements such as installation clearance in the vertical direction, which shall be implemented in accordance with the specifications. The vertical layout of pipes from top to bottom should generally be: power cable trenches, telecommunications, water supply, gas pipes, rainwater pipes, and sewage pipes. When there is a vertical conflict in the pipeline synthesis, coordination should be carried out according to the following principles: gravity pipelines should be used for pressure pipelines, trunk pipelines should be used for branch pipelines, large diameter pipelines should be used for small diameter pipelines, and flexible pipelines should be used instead of hard-to-bend pipelines.

2) Comparison and selection of pressure sewage pipes

①Pipe selection

In sewage engineering, pipeline engineering investment accounts for a large proportion of the total project investment, and pipe material costs account for about 50% of the total pipeline engineering investment . Sewage pipelines belong to urban underground permanent concealed engineering facilities and require high safety and reliability. Therefore, it is very important to choose the pipe material reasonably. For pipe requirements, the material of the drainage pipe must meet certain requirements to ensure the normal drainage function: the drainage pipe must have sufficient strength to withstand the external load and internal water pressure; the drainage pipe must have resistance to waste water. Erosion and wear of impurities. It should also have anti-corrosion properties, especially for some corrosive industrial wastewater; drainage pipes must be impermeable to prevent wastewater from seeping out or groundwater infiltrating, polluting groundwater or corroding other pipelines and building foundations; drainage pipes and canals The inner wall of the pipe should be neat and smooth to minimize the water flow resistance; the drainage pipes should be made of materials on the spot, and the prefabricated pipe fittings and the possibility of rapid construction should be considered to reduce transportation and construction costs.

②Type of pipe

Commonly used pressure flow sewage pipelines are basically the same as water supply pipelines, including steel cylinder pipes, steel pipes, ductile iron pipes, glass steel pipes and polyethylene pipes. The application of these pipes in the sewage collection system, in addition to considering the price, service life, construction and maintenance convenience, but also the anti-corrosion problem.

A. Prestressed Concrete Cylinder Pipe (PCCP)

Steel tube and concrete composite pipe (PCCP pipe) is a new type of pipe introduced from abroad, which is suitable for large-diameter pipes. The structure of the PCCP pipe has five layers: from the inside to the outside, the first layer is the tax core, which is cast in the steel mold, and the inner surface is smoother than the general killing pipe; the second layer is the welded steel cylinder, which plays the role of impermeability and longitudinal tensile strength. The third layer is the building layer outside the welded steel cylinder, which is the main structural layer; the fourth layer is the prestressed steel wire layer, which is wound outside the third layer of tax layer to ensure the safe operation of the pipeline under working pressure; the fifth layer is The outermost layer of cement mortar protects against mechanical damage and corrosion of prestressed steel wires. The interface of the PCCP pipe is composed of a socket ring with precise size control, which is automatically centered on the interface, easy to install, and has good sealing performance and no water leakage. PCCP pipe not only has the strong anti-seismic and corrosion resistance of steel pipe, but also has the characteristics of high strength and strong impermeability of steel pipe. It is an excellent non-metallic pipe. However , the self-weight of the PCCP pipe is relatively large, and the construction requires better construction machinery and a relatively open site.

B. Steel pipe (SP)

The steel pipe has the best mechanical strength, can withstand high internal and external pressure, has strong impermeability, and has a certain degree of curvature. The weldability of the steel pipe body is convenient for the manufacture of various pipe fittings, especially suitable for pipelines with complex terrain and high requirements. However, the anticorrosion of the hand-welded pipe interface is the weakest link of the steel pipe. With the increase of the use time, it is easy to become a hidden danger of accidents. At the same time, the pipe price of steel pipe is high, and the anti-corrosion cost is large.

C. Ductile Iron Pipe (DIP)

Ductile iron pipe is an upgraded product of grey cast iron pipe. The graphite in centrifugal ductile iron is spherical, and has little effect on weakening the matrix and causing stress concentration. Therefore, the strength and toughness are better than those of gray cast iron pipes. The body of the ductile iron pipe is lighter than the PCCP, and it is connected by a rubber ring, which is easy to operate and not easy to leak. The internal and external anti-corrosion is completed by the manufacturer at the same time when the pipe is made, and the anti-corrosion performance is good. The price of ductile iron pipes increases greatly with the increase of the pipe diameter. When used in pipes with a pipe diameter below DN1000, the price is relatively cheap.

The advantage is obvious. The external anti-corrosion of ductile iron pipes for sewage can be constructed according to the requirements of the construction unit, and the internal anti-corrosion is aluminate cement mortar, which has better anti-corrosion performance; it can also be used for internal anti-corrosion with higher requirements according to the quality of sewage. The wall thickness of ductile iron pipes for sewage is smaller than that of ductile iron pipes for water supply, and the price is about 10% lower than that of ductile iron pipes for water supply .

D. Fiberglass Pipe (GRP) and Polyethylene Pipe (PE)

Both FRP pipes and polyethylene pipes have the advantages of high strength, light weight and good corrosion resistance, and are suitable for conveying sewage. However, the quality of the pipe varies greatly with the quality of the manufacturer, and the construction requirements are high and the price is not low.

Through the analysis of commonly used sewage pipe materials, FRP and PE pipes have good hydraulic conditions, high strength, high corrosion resistance, and light weight; ductile iron pipes for sewage have the essence of iron, the performance of steel, and the light weight. Strong corrosion resistance, long service life and reasonable price.

Considering that Shangyu District is a relatively developed area, the construction of sewage projects should adhere to a high starting point and high standards, and the safety and reliability of pipes should be given sufficient attention. Therefore, high-quality pipes should be given priority, and the safety of water delivery should be considered comprehensively. In order to improve the performance and economy of the pipeline, PE pipe is recommended for diameter DN600 , steel pipe is recommended for pipe diameter 3DN600 , and steel pipe or other pipe materials are used according to the actual situation when crossing special terrain.

The final pipe material to be used needs to be determined by technical and economic comparison in the subsequent design stage.

6.3.2 Sewage treatment system planning

1) Overview of the sewage treatment system in the whole region

① During the " Twelfth Five-Year Plan" period, the sewage treatment system in Shangyu District completed the following projects

A.The second production line of the second phase of the water treatment plant was completed. Since the process of the first phase (75,000 m^3 /d) could not meet the current effluent quality requirements, it was discarded. The actual production scale of the water treatment plant was 225,000 m^3 / d ;

B.60% after dewatering ;

C.Completion of the water treatment quality upgrading and upgrading project.of sewage entering the water treatment plant is about 170,000 m^3 /d, and the water treatment capacity meets the needs of urban sewage treatment and is appropriately rich; the discharge standard of tail water after water treatment has been raised from CODcr 200 mg/L to 80mg/L, which meets the requirements of raising the standard and reducing emissions; the pumping station for township sewage collection and the pressure conveying sewage main pipe have been basically completed, and the increase in the rate of sewage into the network is just around the corner; the water treatment system facilities in Shangyu District have a certain amount of advance.

② Development goals of the " 13th Five-Year Plan" for the sewage treatment system

A. Sewage treatment system scale

Continue to pay close attention to the expansion of the treatment scale of the water treatment plant, meet the water environment management requirements for the establishment of a green ecological city, and adapt to and moderately advance the requirements of Shangyu's economic and social development for water treatment systems.

B. Water Quality Control of Incoming Sewage from Sewage Treatment Plant

Continue to strengthen the control of water quality standards for water quality improvement and emission reduction of sewage entering the plant, and strictly implement the sewage permit system. The water quality entering the plant meets the requirements of the third-level standard of " Integrated Wastewater Discharge Standard" (GB8978-1996) .

C. Water quality target of effluent from sewage treatment plant

Industrial sewage strictly implements the new standard "Comprehensive Wastewater Discharge Standard" (GB8978-1996) first -level standard, wherein COD implements 80mg/L ; after the upgrading and transformation, the tail water of domestic sewage reaches the "Guiding Standard for Clean Discharge of Urban Sewage Treatment Plants in Zhejiang Province", Among them , CODW30mg/L, NH3.NW1.5 (3) mg/L ; TNW10 (12) mg/L, TP^0.3 mg/ LL o Strive to achieve 100% water standard rate.

D. Comprehensive utilization of water resources

Promote the promotion and trial of " reclaimed water reuse" technology, and create conditions for the application of reclaimed water in the Economic Development Zone of Shangyu District, Hangzhou Bay.

E. Management modernization.

Continue to improve the construction of the secondary distributed automatic control system of the water treatment plant and the sewage collection pipe network in the sewage treatment system to realize the centralized control of sewage collection, transportation and treatment; continue to provide management informatization and digitalization to improve the operation of the sewage treatment system For the purpose of safety and reliability, reduce hidden dangers of accidents and the possibility of sewage overflow, and protect the ecological environment of rivers.

2）Construction plan of sewage treatment plant

① Scale of sewage treatment plant

The planned total scale of Shangyu Sewage Treatment Plant is 300,000 m^3 /d . Phase I and Phase II projects have been completed (two lines) O Phase I project of 75,000 m^3/d was completed and put into operation in 2002 ; The first-line project of 112,500 m^3 /d was put into operation in October 2008 , and the second-line project was put into operation in May 2012 . In 2013 , Shangyu Wastewater Treatment Plant underwent quality upgrading and upgrading, and it was put into operation in October 2015 .

The first phase of the project: The total investment is 243 million yuan, including 113 million yuan for the pipe network system and 130 million yuan for the sewage treatment plant . Constructing a pipeline network with a transmission capacity of 100,000 m^3 / d and a sewage treatment capacity of 75,000 m^3 /do. Three production lines with a capacity of 25,000 m^3 / d were built and put into operation in July 2002 , December 2002 and September 2003 , respectively . On January 20 , 2005 , the first phase of the project passed the environmental protection acceptance of the Provincial Environmental Protection Bureau. In February 2009 , the first phase of the project stopped operation after being reported to the municipal government for approval because it could not meet the increasing bid-raising and emission reduction requirements.

The second phase of the project: The construction content is 225,000 m^3/d of sewage treatment plant facilities and 300,000 m^3 /d of pre -treatment and tail water discharge pipes. Among them, the pretreatment is implemented at a time of 300,000 m^3 / d , the sewage treatment plant and the tail water discharge pipe are implemented in steps, the first step of the sewage treatment plant is implemented on a scale of 112,500 m^3 /d, and the second step is implemented on a scale of 112,500 m^3 / d ; The first implementation scale of tail water discharge pipe is 150,000 m^3 / d, and the second stage implementation scale is 150,000 m^3 / d.

The upgrading project of Shangyu Wastewater Treatment Plant includes two parts: the upgrading of domestic sewage and the upgrading of industrial wastewater. The total designed scale is 300,000 m^3 /d o The scale of upgrading and upgrading of domestic sewage is 100,000 m^3 / d e The total scale of upgrading and upgrading of industrial wastewater is 200,000 m^3 / d, which will be carried out in two phases based on the actual water inflow. The recent renovation scale is 100,000 m^3 /d, and the second phase will be expanded by 100,000 m^3 / d .

According to the forecast of sewage volume: the domestic sewage system is planned to have a total of 112,400 m^3 /d in the near term in 2022 , and a total of 175,600 m^3 / d in the long- term in 2030 ; The annual total amount of centrally managed sewage is 98,600 m^3 /d, and in the long- term in 2030 , the total amount of centrally managed sewage will be 136,600 m^3 / d .

Considering the trend of increasingly strict environmental protection standards, the existing plant vacant land is reserved for the upgrading of industrial sewage treatment lines (Shangyu Sewage Treatment Plant No. 1), with a treatment scale of 10+ 100,000 m^3 /d (100,000 m^3 / d for domestic treatment lines) (industrial processing line 100,000 m^3/d) . Combined with the spirit of the higher-level planning such as the "Overall Plan of Hangzhou Bay Shangyu Economic and Technological Development Zone (2017-2030) " and the "Controlled Detailed Planning of the East Third District of Hangzhou Bay Shangyu Industrial Park", it is planned to expand the sewage treatment plant and build it in the Hangzhou Bay Economic Development Zone The plot on the northeast side of the intersection of Binhai 4th Road and Binhai 7th Road is planned as U21 drainage land. After the plan comparison and selection, it is suggested that the off-site expansion project of Shangyu Sewage Treatment Plant (Shangyu Sewage Treatment Plant No. 2) should be located in Hangzhou Bay. The land plot on the northeast side of the intersection of Binhai 4th Road and Binhai 7th Road in the Economic Development Zone is adjusted to the land north of the existing sewage treatment plant (the northeast corner of the intersection of Zhanxian 3rd Road and

Zhenxing 2nd Road), with a total land area of about 250 mu. During this planning period , a domestic sewage treatment line of 50,000 m³ / d and an industrial sewage treatment line of 50,000 m³ /d will be implemented first . The prospective scale is 150,000 m³ /d, to meet the sewage treatment requirements, it is recommended to start the revision of land use regulations in relevant areas as soon as possible. The near and long-term scale of the sewage treatment plant is shown in the following table:

Table. 6-9 List of near and long-term scale of sewage treatment plants

Planning staging	Scale of sewage treatment plant (m³ /d)	
	Shangyu Sewage Treatment Plant No.1	Shangyu Sewage Treatment Plant No.2
status quo	100000+100000	
recent	100000+100000	50000
long term	100000+100000	50000+50000
Vision	100000+100000	50000+50000+50000

Four townships, Dingzhai, Xiaguan, Chenxi and Lingnan, have built rural domestic sewage collection systems. The above four townships are located in remote areas of Shangyu, and the sewage collection pipelines between towns and between towns and existing cities are all far away. ; The distribution of villages in the township is relatively scattered; the scale of the villages is small, and there are certain technical difficulties in integrating the sewage from each village into the municipal sewage collection pipeline. In addition, the overall sewage volume of the above-mentioned managed projects is relatively small, the investment cost is high, and the i m³ut and output are relatively low. After comprehensive consideration, this plan proposes that the terminals of the rural domestic sewage collection system in the above four towns will not be included in the municipal sewage pipe network for the time being. Sewage treatment shall be carried out in the mode of on-site decentralized treatment and discharge, and long-term overall consideration shall be considered.

②Inlet and effluent quality of sewage plant

See the table below for the designed influent and effluent water quality of the first phase of the sewage treatment plant. At that time, it was determined that the tail water of the factory should implement the second-level standard of the national "Integrated Wastewater Discharge Standard" (GB8978.1996) .

Table. 6-10 Phase design of inlet and outlet water quality (mg/L)

Project	COD cr	bod $_5$	SS	nh $_3$ -n	Chroma	TP	PH
Water intake	1000-1200	350-500	300-400	80-120	1000	3-6	6-9
Out of water	200	60	150	50	80	1.0	6-9

During the design of the second phase of the project, according to the actual operation conditions, appropriate adjustments were made to the influent water quality as shown in the table below. According to the EIA requirements of the second phase of the project, the water quality of the first and second phases of Shangyu Sewage Treatment Plant is implemented in accordance with the second-level standard in the "Comprehensive Wastewater Discharge Standard" (GB8978J996) . In order to complete the pollution reduction targets during the " Twelfth Five-Year Plan" period in Shangyu District, Shaoxing City and improve the regional environmental quality, according to the document of the Shangyu Municipal People's Government Office in July 2013 (Yu Zheng Ban Fa [2013] 195 #), it is required to start from 2013 From July 1st , Shaoxing Shangyu District Water Treatment Development Co., Ltd. will control the COD concentration below 100mg/L , and the nitrogen and nitrogen concentration below 15mg / L . .1996) first- level standard implementation.

At present, the main pollutant indicators of tail water discharge from sewage treatment plants are shown in the table below.

Table. 6-11 Phase II Design Influent Water Quality and Current Drainage Standard (mg/L)

Project	CODcr	BOD_5	SS	NH_3-N	Chroma	TP	PH
Water intake	1000	300-400	400	80-120	1024	3-6	6-9
Project	CODcr	bod 5	SS	NH_3-N	Chroma	TP	pH
Out of water	100	60	150	15	80	1.0	6-9

See the table below for the design of the influent and effluent water quality of the upgrading project by quality:

Table. 6-12 Domestic sewage upgrading and transformation of influent and effluent water quality (mg/L)

Project	CODcr	BOD_5	SS	NH_3-N	Chroma	TP	PH
Water intake	350	150	300	45	35	4-8	6-9
Out of water	50	10	10	15	5(8)	0.5	6-9
Processing efficiency	85.7%	93.3%	96.7%	66.7 %	85.7%	91.6%	---

Table.6-13 Influent and effluent quality of industrial wastewater upgrading and transformation (mg/L)

project	COD cr	BOD_5	SS	NH_3-N	Phosphate (as P)
water intake	500	85	400	44	10

out of water	80	20	70	15	0.5
Processing efficiency	84%	76.5%	82.5%	66.9 %	94.5%

(Note: Other indicators are subject to the first-class standard in the Comprehensive Wastewater Discharge Standard (GB8978-1996))

In general, due to the fact that Shangyu District has strengthened policy guidance, optimized industrial structure, and promoted pollution control in recent years, the emission reduction has achieved remarkable results. " Special emission limit" standard, this plan clarifies:

The water quality of each sewage enterprise entering the sewage collection system meets the requirements of the third-level standard of the "Integrated Wastewater Discharge Standard" (GB8978-1996) . At the same time, all managed enterprises CODcr Index The highest index of network access is 500mg/L.

Industrial wastewater strictly implements the new standard "Comprehensive Sewage Discharge Standard" (GB 8978-1996) -level standard; domestic sewage strictly implements the "Urban Sewage Treatment Plant Pollutant Discharge Standard" (GB 18918-2002) A standard of the first-level discharge standard.

③ Construction land for sewage treatment plant

Shangyu Sewage Treatment Plant is located in the north of Weisan East Road, Shangyu Economic and Technological Development Zone, Hangzhou Bay, with a total land area of 492 mu. In view of the lack of suitable construction land outside the plant area, it is planned that the newly added upgrading structures will be located on the land used for the demolition of the original first-phase project treatment structures, that is, the reserved construction land for domestic sewage treatment. The land is located in the southwest of the plant area, adjacent to Current status of sludge drying treatment plant.

After the comparison and selection of plans in this planning, it is suggested that the off-site expansion project of Shangyu Sewage Treatment Plant (Shangyu Sewage Treatment Plant No. 2) should be located at Binhai 4th Road and Hangzhou Bay Economic Development Zone.

The plot on the northeast side of the intersection of Binhai 7th Road is adjusted to the plot to the north of the existing sewage treatment plant (the northeast corner of the intersection of Zhanzhan 3rd Road and Zhenxing 2nd Road), with a total land area of about 250 mu .

6.3.3 Planning and layout of sewage system

1) Sewage collection system partition.

According to the current situation of the main sewage pipe network in Shangyu and the planning of the municipal sewage collection system, the sewage collection system at the district level of Shangyu is divided into 7 areas, namely East A , East B , South A , South B , West, North District and Central District.

East Area A : the original east line project, the sewage collection scope includes Yiting Town, Xiaoyue Street and Xietang Town, with an area of about 104.41 km 2 . After the third channel is opened, some sewage will be transferred to East B District and Central District.

East B area: the scope of pollutants includes Yonghe Town, Fenghui Town, and Lianghu Street, with an area of about 212.14 km 2

South A area: the original south line project, the sewage collection scope includes Zhangzhen Town, Shangpu Town, Tangpu Town and Changtang Town, with an area of about 322.63 k ㎡

South B area: four towns and towns in Gaoshan in the south of Shangyu , which are the research areas of the planned sewage collection system. The sewage collection range includes Lingnan Township, Chenxi Township, Xiaoguan Township, and Dingzhai Township, with an area of about 186.32 k ㎡ 2 .

Western District Sewage System: The scope of sewage collection includes Cao'e Street, Dongguan Street and Daoxu Street, with an area of about 118.18 km 2 . In addition, it is necessary to transfer the sewage from the South A District.

Sewage system in the north area: the scope of receiving sewage includes Songxia Town, Gaibei Town, and Hangzhou Bay Economic Development Zone, with an area of about 203.09km 2 . This area is the current first channel for sewage discharge and the planned second channel area, which transmits sewage from East A , East B , South A , West and Central .

Central District Sewage System: It is the core area of Shangyu urban area, and the scope of pollutants includes Baiguan Street, with an area of about 44.06 km 2 . In addition, it will also transfer part of the sewage from East B District, South District A and West District.

2） Interconnection between sewage treatment plants.

① Interconnection of sewage treatment plants between regions.

Planning Zhanzhan Road DN1200 sewage pressure pipe: According to the "Shaoxing Urban Drainage (Sewage) Special Plan", " in order to achieve emergency connection in the event of an accident in the recent three sewage treatment plants. It is recommended to use DN1600 in Jiangbin Sewage Treatment Plant and Shaoxing Sewage Treatment Plant. The upper opening of the connecting pipe is connected to the DN1200 sewage pressure pipe, which is interconnected with Shangyu Sewage Treatment Plant. Through valve switching, emergency connection of the three sewage treatment plants can be realized in the event of an accident, and a new 100,000 m^3 /d Zhanjiang Road Pumping Station will be built. It is used for the improvement of sewage in the middle." Zhanzhan Road Pumping Station and DN1200 sewage pressure pipes are jointly built in three districts, with a total length of 20.2km of interconnecting pipes , of which the length of DN1200 pipes in Shangyu is 12.3km .

② Interconnection of sewage treatment plants in the district.

From Shangyu Sewage Treatment Plant to Shangyu Domestic Sewage Treatment Plant DN1400 pipeline: build a 150,000 m^3/d sewage lifting pump station (Weisan East Road Pumping Station) near the existing sewage treatment plant, and build a DN1400 pipe from the lifting pump station The main sewage water delivery pipe to the domestic sewage treatment plant, with a planned length of 1.4km, is used to transport recent domestic sewage. At the same time, the pipeline can also be used as a connecting pipe between the domestic sewage treatment plant and the industrial sewage treatment plant to improve the safety of sewage transportation.

Table. 6-14 List of new pumping stations

Serial number	Pumping station name	Planning scale (m^3 / d)	Volume (m^3)
1	Zhanwang Road Pumping Station	100000	5000
2	Weisan East Road Pumping Station	150000	5000
3	Domestic sewage treatment plant	150000-200000	140000

Table. 6-15 Quantity of sewage main pipe construction works

Serial number	Name	Pipe diameter (mm)	Length (km)	Remark

1	Prospect road trunk	D1200	12.3	
2	Domestic sewage raw water main pipe	D1400	1.4	
3	Main pipe of reclaimed water distribution	D800	2.87	The reclaimed water is discharged from the domestic sewage plant, and the tail water is discharged by the original sea pipe

3) Expand the second channel (Western Sewage Transport Channel)

At present, the sewage in Shangyu District has been transported and treated by different quality and separate pipelines. One of the two DN1200 sewage mains is responsible for the transportation of domestic sewage and the other is responsible for the transportation of industrial sewage. The original concept of emergency backup has changed. If an emergency occurs, the water will be treated after switching The company's sewage treatment will have a certain impact; at the same time, the original first-phase DN1200 sewage main pipe was constructed in 2000 and officially put into use in 2002. The pipe is made of HOBAS material. By the end of the current phase of planning, the service life will be about 30 years, and it will continue to be used. The security risk is extremely high. Therefore, considering the above factors, a DN1000 sewage pressure pipe is planned from Jiangdong Central Pumping Station along Changhai Highway and Binhai Avenue to the domestic sewage treatment plant. The planned length is 14.9km, and it is connected to the DN1200 of Zhanzhan Road, which can realize the connection with Shangyu sewage. The treatment plant and the Shaoxing Sewage Treatment Plant are interconnected to divert the sewage from Jiangxi and improve the safety of sewage transportation. Due to the long pipeline, a 100,000 m^3/d Changhai pumping station was built in the middle.

Table. 6-16 List of new pumping stations

Serial number	Pumping station name	Planning scale (m^3 /d)	Volume (m^3)
1	Changhai Pumping Station	100000	5000

Table. 6-17 Quantity of sewage main pipe construction works

Serial number	Name	Pipe diameter (mm)	Length (km)	Remark
1	Trunk of Changhai Line	D1000	12.8	
2	Jiangdong Road main pipe	D1000	2.1	

4) Open the third channel (sewage transportation east channel)

①Renovation of the outlet pipe of Fenghui Center Pumping Station.

DN300. 400 pressure pipe of the Fengyong Line , it marks that the sewage in Yonghe Town and the blocks along the Yonghe to Fenghui line has been incorporated into the sewage collection system of Shangyu District , The transportation pressure of the DN600 pipe from the original Fenghui central pumping station will further increase. At the same time, with the continuous access of rural domestic sewage along the line, the planning proposes to carry out safety transformation on the part of the section from the Fenghui pumping station to Shungeng Avenue.

③ New Lianghu Central Pumping Station.

Current situation In the Lianghu section of the Fenghui center pumping station, with the sewage from the Cao'e River tourist resort entering the network, the development and construction area of Lianghu Street has expanded, and the requirements for the collection rate of rural domestic sewage along the line have continued to increase, resulting in the section of the outlet pipe The transportation capacity tends to be saturated , the instantaneous maximum flow has reached 2100 cubic meters per hour (1000 cubic meters per hour in Fenghui Central Pumping Station , 300 cubic meters per hour in Cao'ejiang Resort , 500 cubic meters per hour in the three Lianghu Pumping Stations , and 100 cubic meters per hour in Tianxiang Huating Pumping Station. The original DN600 pipe (economic transport capacity of 1300 cubic meters per hour) can no longer meet the transportation requirements, so it is necessary to consider expanding the pipe to DN800 in the Lianghu Street area .

DN600 water outlet pipe of Fenghui Central Pumping Station has too many pressure inlets along the line, the pressure in the pipe is extremely unstable, and the water head loss is large, which greatly reduces the transportation efficiency ; When the tunnel is transported to the Ludong Pumping Station, the lift of the Fenghui Pumping Station needs to be increased, the power consumption will be greatly increased, and the lift of the pressure access port along the way needs to be increased simultaneously.

To plan to build a sewage lifting pump station (50,000 m^3 /d) in Lianghu Street (Fenghui design scale is 30,000 m^3 /d , Cao'e River Resort 50,000 irrVd , Lianghu 9,000 m^3 / d) d . Rural domestic sewage along the line : 10,000 m^3 /d) ° The water outlet pipe will use the current DN600 pipe in the near future , and expand it to DN800 pipe in the long-term, about 2.5 kilometers to Shungeng Avenue, and the DN600 inlet pipe of Ludong Pumping Station and Chengnan Pumping Station DN600 inlet pipes are interconnected, and valves are set for flexible switching.

④ The expansion and reconstruction of Ludong Pumping Station.

After the completion of the Lianghu Central Pumping Station, in order to relieve the pressure of the DN800 pipe on Jiangdong Road and free up more space to reserve capacity for the development of the south of the city, in principle, the incoming water from the Lianghu DN800 pipe will enter the DN600 pipe of the East Third Ring Road crossing tunnel (the intersection valve is emergency It will be transported to Ludong Pumping Station. In the long term, the capacity of Ludong Pumping Station will be expanded to 51,000 m^3 / d , which will be used as the third channel (East Line Channel) to transmit the pumping station.

⑤ Construction of the third channel.

In order to relieve the conveying pressure of the third ring sewage gravity pipe and DN800 pressure pipe, divert the sewage in the core area of Shangyu, improve the safety of sewage discharge, and completely solve various problems in sewage discharge along the third ring road, it is planned to be located at the north end of the third ring road tunnel along the east of the third ring road. A D800 sewage pressure pipeline is arranged on the road , extending to the northeast, passing through undeveloped areas such as Baima Lake and Xiaoyue Lake to the access road, and connecting the single road along the planned 329 national highway north to the sewage treatment plant to the north, as the city's sewage discharge east. The main road of the line channel is about 18 kilometers long, and a new 50,000 m^3 /d Yuexie pump station is built in the middle.

Construction of the channel:

A. Completely divert the sewage from Yonghe-Yifeng-Huiyi-Hu line, avoid the main urban sewage channel, and free up more sewage space for the renovation of rain and sewage diversion in the old city;

B. Part of Shunliu Road East Industrial Zone, Chengdong Industrial Zone, Renmin East Road, and Chengbei Commercial and Trade Zone have solved the problem of the high liquid level in the three-ring gravity pipe, which is conducive to the sewage discharge of surrounding plots;

C. DN600 pipe from Xietang Pumping Station to Qixia Transfer Pumping Station was built in 2009 and has a long service life. At the same time, the traction pipe accounts for more than 50% . The sewage transportation in the three towns of Xiaoyue, Xiaoyue and Yiting will be completely stagnant. The construction of the third channel, the main channel for the discharge of sewage from the Yiting-Xiaoyue-Xietang Line is formed, and the pipeline from the Xietang pumping station to the Songxia transfer pumping station can be used as a backup pipeline to improve the safety of sewage discharge."

In view of the complexity of the route selection of Bianli Line, in order to improve the operability and implementability, it is recommended to implement the pipeline section of the third channel Xietang pumping station in the near future (according to the long-term DN800 pipeline, about 8.9 kilometers in one step). The continued pipeline section can be advanced synchronously with the implementation of the main roads in the region.

Table. 6-18 List of new and expanded pumping stations

Serial number	Pumping station name	Planning scale (m^3 / d)	Volume (m^3)
1	Lianghu Central Pumping Station	50000	3500
2	Expansion of Ludong Pumping Station	50000-100000	22000 (current status)
3	Yue Xie Pumping Station	50000	3500

Table. 6-19 Quantity of sewage main pipe construction works

Serial number	Name	Pipe diameter (mm)	Length (km)	Remark
1	Fenghui pumping station outlet	D600	3.0	Security Retrofit
2	Lianghu Central Pumping Station	D800	2.5	Long-term timely expansion and transformation
3	third channel	D800	18.0	forward scale
4	Phase I Project of the Third Channel	D800	8.9	Xietang Pumping Station to Sewage Treatment Plant

5) Improve the southern route project

In order to solve the short-term exit of sewage from Huihuang Pumping Station, while taking into account the diversion of part of the flow of the Southwest Pumping Station to ensure the safety of sewage discharge on the southern line, this plan proposes the following two schemes in combination with the route of the second sewage channel in the city: A D600 sewage pressure pipe is arranged at the intersection of Shungeng Avenue , extending westward along the concession belt of Shangsan Expressway to Dongguan Interconnection, and then northward along the concession belt of the east side of Zhejiang Juxing Aluminum Co., Ltd. and straight up to the concession belt north of Xiaoyong Railway. Then go westward to the planned Changhai Line, which is connected with the Changhai Line Channel to form the western sewage line channel in the city area. It has both functions and is convenient for flexible scheduling. Second, from the Southwest Pumping Station to the west along the non-motorized vehicle lane of National Highway 104 (not yet renovated) to Majiaqiao Village, Dongguan, along the river in the village to the north to the concession zone north of the Xiaoyong Railway, and then westward to the planned Changhai Line. The Changhai Line channel is connected to form the urban sewage discharge west line channel, which has both functions and is convenient for flexible scheduling (the concept of the second channel is proposed in this plan, and the specific line position is recommended for the next step of specific demonstration and comparison).

Table. 6-20 List of new pumping stations

Serial number	Pumping station name	Planning scale (m^3 / d)	Volume (m^3)
1	Dongguan Pumping Station	30000	2000
2	Fourth Ring Pumping Station	30000	2000
3	Wujiadu Pumping Station	25000-100000	2000

Table. 6-21 Quantity of sewage main pipe construction works

Serial number	Name	Pipe diameter (mm)	Length (km)	Remark
1	South Line Classification Trunk (Plan)	D600	8.4	D600 pipeline in Daoxu Street section of Changhai Line
2	South Line Classification Trunk (Option 2)	D600	5.0	D600 pipeline in Daoxu Street section of Changhai Line

6) Sewage system in East A District

Table. 6-22 List of Renovated Pumping Stations

Serial number	Pumping station name	Planning scale (m^3 /d)	Volume (m^3)
1	Xietang Pumping Station	25000	4450 (current status)

Table. 6-23 sewage main pipe construction works

Serial number	Name	Pipe diameter (mm)	Length (km)	Remark
1	Pipeline inspection from Yiting Wufu Pumping Station to Xietang Pumping Station	D300-D600	12.2	Involving Yiting Wufu Pumping Station, Yiting Pumping Station, Xiaoyue Shiluo Pumping Station, Xiaoyue Shuangyan Pumping Station, Xiaoyue Pumping Station, Xietang Pumping Station
2	Pipeline inspection from Xietang pumping station to final Xiamen transfer pumping station	D600	3.4	Involving Xietang Pumping Station and Songxia Transfer Pumping Station

7) East B area sewage system

①Sewage outlet

The current situation of the sewage outlet in this area is that it is transported to the Chengnan Pumping Station through the Fenghui Pumping Station, and the D800 pipe along the Jiangdong Road is connected to the Jiangdong Central Pumping Station, merged into the D1200 main channel, and discharged to the north into the Shangyu Sewage Treatment Plant; recently, the Fengyong Line D300- 400 pipes were completed, Fenghui Xieqiao Pumping Station was put into operation, Yonghe and the sewage along the line was put into pipes; in the long term, the newly built Lianghu Central Pumping Station will be directly discharged into the East Line Channel through the D600 pipe of the tunnel. In the vision, the planned sewage volume in this area is 11,400 m^3 / d .

②Sewage pipeline planning

Recently, about 3 kilometers of D600 pipes on the west side of Fenghui Central Pumping Station have been reconstructed, laying the foundation for the construction of Lianghu Central Pumping Station; about 5.6 kilometers of D800 pipes in Lianghu Central Pumping Station will be added in the future , to Shungeng Avenue and Ludong Pumping Station The DN600 inlet pipe and the DN600 inlet pipe of Chengnan Pumping Station are interconnected, and valves are set for flexible switching.

③ Planning of sewage pumping station

50,000 m^3 /d Lianghu central pumping station was newly built to divert downstream sewage and lay the foundation for the third channel.

Table. 6-24 List of new pumping stations

Serial number	Pumping station name	Planning scale (m^3 / d)	Volume (m^3)
1	Lianghu Central Pumping Station	50000	3500

Table. 6-25 sewage main pipe construction works

Serial number	Name	Pipe diameter (mm)	Length (km)	Remark
1	Fenghui pumping station outlet	D600	3.0	Local pipeline safety modification

8) South A District Sewage System

①Sewage outlet

The current situation of the sewage outlet in this area is through Jiangcun Pumping Station and Huihuang Pumping Station, through the D600 pipe of the southern line, into the D400 pressure pipe of Shungeng Avenue , into the Southwest Pumping Station to the Jiangdong Central Pumping Station, and then discharge to the north into Shangyu Sewage Treatment Plant . In the vision, the planned sewage volume in this area is 11,100 m^3 / d .

②Sewage pipeline planning

Improve the internal collection branch.

③ Planning of sewage pumping station

Add node pump stations as needed.

9) South B area sewage system

①Sewage outlet

Because this area is located in a remote area of Shangyu, the distance between towns is relatively long, the distribution of villages in the township is relatively scattered, the scale of villages is small, and it is difficult to collect sewage in a centralized manner. deal with. According to the relevant discussion in the above-mentioned chapter on the determination of the drainage system, this plan proposes two proposals for the sewage road in the area, including centralized treatment and new integrated treatment plants for on-site treatment and discharge. The planned sewage volume of this area is 2,800 m^3 / d .

② Wastewater planning

Option 1: Build a new D300 sewage pipe of about 18.5km between Lingnan Township and Laoji Town, Zhang Town, connect the sewage from Lingnan Township to the sewage pumping station in Laoji Town, Zhang Town, and properly renovate the pumping station in Laoji Town, Zhang Town; Dingzhai Township, After the sewage is collected in Xiaguan Town and Chenxi Township, the sewage is discharged into the Fenghui Pumping Station through the newly built D300 sewage pressure pipe. During this period, a new sewage pumping station (temporarily named Ding Zhai) will be built near the intersection of Fengzhang Highway and Baixuan Line. Pumping station), the collection scale is 4000T/d . D300 sewage pipeline is laid about 13km in the section of Xiaguan Town-Dingzhai Pumping Station in Chenxi Township , about 1.8km in the section of Dingzhai Township-Dingzhai Pumping Station, and D300 sewage pipeline is newly built in the section of Dingzhai Pumping Station and Fenghui Pumping Station The tube is about 12.1km .

Option 2: After proper renovation of the pumping station in Laoji Town, Zhang Town, the sewage from Lingnan Township and the collected sewage from Dingzhai Township, Xiaguan Town and Chenxi Township will be accepted at the same time. About 18.5km of new D300 sewage pipes will be built between Lingnan Township and Laoji Town of Zhang Town, and about 25.6 kilometers of new D300 sewage pipes will be built between Chenxi Township, Xiaguan

Town, Dingzhai Township and Zhang Town. A new sewage pumping station (temporarily named Dingzhai Pumping Station) will be built near the intersection of the suspension line, with a collection scale of 4000T/d .

Option 3: The sewage from Lingnan Township will be collected and transported to an integrated treatment plant through a new sewage pipe, and discharged after reaching the standard. A new sewage treatment plant will be built in an appropriate position in Lingnan Township, with a treatment scale of 1000T/d. The section between Lingnan Township and the newly built treatment plant will lay about 11.6km of D300 sewage pipes ; After the sewage in Dingzhai Township, Xiaguan Town and Chenxi Township is collected in a unified manner, the sewage is discharged into the newly built integrated treatment plant through the newly built D300 sewage pressure pipe, and discharged after the treatment reaches the standard. A new integrated treatment plant will be built near the intersection of Fengzhang Highway and Baixuan Line, with a treatment capacity of 3000T/d. The section between Chenxi Township and Xiaguan Town will lay about 5.2km of DN300 sewage pipeline , and the section between Xiaguan Town and the new treatment plant will be laid. DN300 sewage pipe is about 8.6km .

10) West Sewage System

①Sewage outlet

There are two current status of sewage outlet in this area: one is through the central pumping station in Jiangxi, and then it is connected to the D1200 sewage pressure pipe of the Fourth Ring Road through the Cao'e River, and then discharged to the east and then north into the Shangyu Sewage Treatment Plant; the other is through Yongxiang Road Pumping station D1000 crosses the river pipe, connects to the D1200 sewage pressure pipe on Jiangdong Road, enters the Jiangdong Central Pumping Station or enters the Jiangxi Pumping Station through the DN1300 pipe on Jiangxi Road, and then connects to the Fourth Ring Road D1200 sewage pressure pipe after being lifted again, and then goes eastward to the Jiangxi Pumping Station. The north is discharged into Shangyu Sewage Treatment Plant. The planned sewage volume of this area is 47,400 m³ / d e

② Wastewater planning

For details, please refer to the chapter on improving the southern route project.

11) North District Sewage System

①Sewage outlet

current status of the sewage outlet in this area Songxia Town and Gaibei Town are connected to the main channel of D1200 , and discharge northward into Shangyu Sewage Treatment Plant; Binhai New City discharges eastward along Kangyang Avenue through Binhai Central Pumping Station into Shangyu Sewage Treatment Plant; Industrial Park It is discharged into Shangyu Sewage Treatment Plant along the main channel through the pump station of Jingsan Road in the park, the pump station of the expansion area of the park, and the pump station of Jingsan Road in the park. The planned sewage volume of this area is 181,800 m³ / d e

②Sewage pipeline planning

A. For details about the western route and the domestic sewage plant, please refer to the chapter on expanding the interconnection between the western route (the second channel of sewage transportation) and the sewage treatment plant.

B. The backbone of the Hangzhou Bay Economic Development Zone has basically been formed, and the main thing that needs to be planned is the high-tech industrial park in the east area. It is planned to build a new D800 sewage pressure pipe to transport sewage to Shangyu Sewage Treatment Plant, with a planned length of 4.5km .

C. In-pipe transportation for quality improvement and standardization

According to the analysis and research of the current drainage system, the general principle of in-pipe transportation is as follows: the overall implementation of quality and in-line transportation, a small amount of which cannot be divided into quality and in-line transportation. The specific plan is as follows:

●domestic sewage transportation.

In the near future, the sewage in the central city will be lifted into the Jiangdong Central Pumping Station and then transported to the newly built Weisan East Road Pumping Station through the root main pipe D1200 , and then sent to the domestic sewage treatment plant through the planned new D1400 main pipe; The pumping station is lifted into the Songxia transfer pumping station or directly transported to the newly built Weisan East Road Pumping Station.

Jiangdong Central Pumping Station - Songxia Transfer Pumping Station - Weisan East Road Pumping Station - Domestic Sewage Treatment Plant as the first main channel for domestic sewage transportation.

Two new domestic sewage channels will be added in the long-term: Jiangdong Central Pumping Station, Changhai Pumping

Station, and Domestic Sewage Treatment Plant as the second main channel for domestic sewage transportation; Lianghu Central Pumping Station Yiyi East Pumping Station, Yuexie Pumping Station, Wei Sandong Road pumping station a domestic sewage treatment plant as the third main channel for domestic sewage transportation.

●Industrial sewage transportation.

The channel for conveying industrial sewage is the main sewage pipe of Hangzhou Bay Industrial Park. The specific planning is as follows:

Industrial sewage main channel 1: Park Jingsan Road Pumping Station-Shangyu Sewage Treatment Plant;

Industrial sewage main channel 2: East Second District Pumping Station 1 Shangyu Sewage Treatment Plant;

Industrial sewage main channel 3: Pumping station in the expansion area of the park - Shangyu Sewage Treatment Plant;

Industrial sewage main channel 4: Jiangxi Central Pumping Station - Songxia Pool A - Shangyu Sewage Treatment Plant;

Industrial sewage main channel 5: High-tech Zone Pumping Station 1 Shangyu Sewage Treatment Plant.

Since sewage transportation by quality is a systematic project, it is recommended that the next step be combined with the status quo of sewage treatment plants and sewage transportation systems to conduct a special study on quality improvement and transformation, so as to serve the goals of classified collection and quality treatment.

③ Planning of sewage pumping station

50,000 m^3 / d in the high-tech industrial park is planned to be used to improve the sewage in the high-tech industrial park.

Table. 6-26 List of new pumping stations

Serial number	Pumping station name	Planning scale (m^3 / d)	Volume (m^3)
1	High-tech Zone Pumping Station	50000	3500
2	Sewage clean discharge standard upgrading	100000	The land used for the demolition of structures in the original phase of the project

Table. 6-27 sewage main pipe construction works

Serial number	Name	Pipe diameter (mm)	Length (km)	Remark
1	High-tech Zone sewage transportation main	D800	4.5	

Table. 6-28 Quantity of sewage main pipe construction works

Serial number	Name	Pipe diameter (mm)	Length (km)	Remark
1	Reconstruction of Outlet Pipe of Chengshan Road Pumping Station	D600	0.9	For the time being, consider the sewage mains plan of Jinjiang East Road, and evaluate the Jinsanhuan sewage pressure mains plan before the project is implemented.
2	Emergency discharge port project			6 new emergency overflows have been added in the areas of Chengshan Pumping Station, Chengdong Pumping Station, Third Ring Road, etc.

12) Central District Sewage System

①Sewage outlet

The current situation of the sewage outlet in this area is to connect the D1200 main channel after being lifted by the central pumping station in Jiangdong, and discharge it northward into the Shangyu Sewage Treatment Plant; in the long term, the sewage will be diverted to three channels in this area to ensure the safety of sewage in the core area of Shangyu. In the vision, the planned sewage volume in this area is 49,700 m^3 / d .

②Sewage pipeline planning

Combined with road planning and the development of new plots, the sewage pipe network in the area (high-speed rail new city area, east of Jiangyang Road in Chengbei, south of the Fourth Ring Road, west of Shishi, north of the Third Ring Road, Chengdong Industrial Zone, and Chengnan area) will be improved, The rainwater and sewage diversion transformation will be carried out in the old urban area, the existing merging pipes will be retained as rainwater pipes, and sewage pipes will be added (Shunjiang East Road, Renmin Road, Xinjian Road, Jiefang Road).

In view of the fact that the Chengshan pumping station is inserted into the third-ring gravity pipeline, which has a great impact on the operation of the gravity pipe, and has produced various drawbacks, this planning considers a D600 pressure pipe drawn from the Chengshan pumping station and discharged along the south ramp of the third ring into the Chengbei pumping station , divert the traffic of the third ring line. Combined with the daily operation and maintenance of road pipelines, timely connect pipelines with fractures (Guanshan Road, Chengshan Road, Xuansha Road, Duoshi Road, etc.), and carry out health inspections of current main canals and old pipeline networks such as Renmin Road and Xinjian Road .

③ Planning of sewage pumping station

In this area, the old city will set up a drainage pump station to divert the rainwater, and the new city north area will set up an emergency overflow to divert the rainwater (rainwater overflow) to ensure that the area will not suffer from waterlogging in the disaster weather in the near future or if the renovation project cannot be carried out. , inversion and the occurrence of poor drainage of sewage .

6.3.4 Setting of auxiliary facilities

In addition to the conduit itself, certain structures need to be placed on the conduit system to remove sewage. Whether the design of these structures is reasonable or not has a great influence on the operation of the whole system. How to select and design these structures is an important part of the design of the drainage system.

1) Inspection well

The functions of the inspection well are: to facilitate the maintenance personnel to regularly check and clear the pipeline; to connect the upstream and downstream drainage pipelines, which are generally set at the intersection of the pipe set, where the size direction, slope and elevation of the pipe channel change. It also needs to be set every certain distance on the branch pipe segment. Referring to the actual situation of Shangyu pipeline project, especially the leakage of pipe wells, silt invasion, joint dislocation, obvious settlement in gravity flow system, this plan proposes to actively promote HDPE pipes and inspection wells of the same material (integrated PE inspection wells) Applications.

2) Water drop well

The function of the water drop well is to eliminate the energy of the water flow when the height difference between the upstream and downstream pipelines is large (greater than lm) and overcome the huge impact force generated when the water falls.

The common forms of drop wells are: standpipe type, overflow weir type and stepped type. The structure of the standpipe drop well is relatively simple, similar to the common inspection well, except that the cast iron standpipe and a few accessories are added. Overflow weir type and stepped water drop wells can be used on pipelines with large diameters. The water drop part adopts overflow weirs or multi-step steps to gradually dissipate energy. The base of the ladder should be firm.

3) Inverted siphon

When the drainage pipeline encounters rivers, mountain streams, depressions or underground structures, it cannot be buried according to the original slope, but passes through a concave broken line. This kind of pipeline is called an inverted siphon. The inverted siphon is troublesome to construct, difficult to maintain, and expensive to use, so it should be avoided as much as possible.

The inverted siphon is composed of inlet wells, pipes, and outlet wells.

There are two types of pipes: multi-fold and concave. The multi-fold type is suitable for the situation where the river surface and the beach are wide and the river bed depth is large. Large excavation is required for construction, and the required construction surface is large. The concave type is suitable for the narrow river surface and beach, or the obstacle area and depth In small cases, large excavation can be used for construction, and traction construction can also be used when conditions permit.

6.3.5 Parameters of sewage pumping station

At present, the domestic sewage pumping station basically operates in an unattended mode. For the pumping station with a power consumption of less than 30KW , the power consumption of the pump and equipment can be directly supplied from the nearby public distribution room or the outdoor box-type substation, so the pumping station can not be used. It will be used for auxiliary facilities such as management and power distribution.

Typical process flow of pumping station: sewage 11 > sediment well 11 > grid room 11 > pump pool 11 > outlet valve well 11 > conveying pipeline 11 > next level pumping station

In order to meet the needs of urban development and adapt to the urban planning style, as an environmental project, the sewage pumping station must contribute to the society in its own environment. Therefore, it is necessary to reduce the surrounding air pollution as much as possible. Smelly device, screen slag should be shipped out in time.

6.3.6 Safety measures for sewage pressure pipes

1) Waterproof hammer

In the process of long-distance transportation, the two phases of gas and liquid coexist with each other. The pressure of the pipeline is proportional to the height difference of the terrain. Once the valve of the pipeline is abnormally closed, the water flow will change suddenly, and the water will push the gas and form a water hammer, which will cause huge damage to the pipeline. Therefore, according to the distribution of the pipeline, a certain number of exhaust valves must be installed at appropriate locations (usually on the hump) to discharge the gas in the pipeline and reduce the working pressure. In addition, adding a pressure reducing and constant pressure valve and an overpressure relief valve device in the pipeline can play the role of detecting and controlling the pressure of the pipeline, which has a significant effect on ensuring the safe transportation of sewage and avoiding the formation of water hammer.

2) Emergency emptying

When the pipeline fails, the faulty pipe section must be quickly isolated in the pipeline network first, and then the water in the faulty pipe section must be emptied for repair. Since the laying of the pressure pipeline is basically along the slope, it is considered to set the venting valve at a certain distance. The venting valve is generally set in the downstream of the pipeline. Before the main line valve, the water in the pipeline should be vented by pumping.

3) Overhaul

Considering various factors such as emergency repair of sewage pressure pipe accident, terrain and construction, an inspection valve well is installed every 3 kilometers or so in the pipeline crossing river ditch, pipe channel, highway bridge and straight section to facilitate maintenance.

4) Flow control and pressure regulation

Due to the large number of access users and the main mode of pressure access, in the later operation of the pipeline network, the pressure of user access conditions should be adjusted according to the actual working pressure of the main network to achieve safe and reliable operation.

5) Regular inspections

Arrange professionals to regularly inspect the working environment of the pipeline and maintain it regularly to ensure that the sewage pipe does not leak and protect the water resources environment.

6.4 Construction and operation management of sewage main network

6.4.1 Guarantee of project quality

The domestic sewage system, especially the main sewage network system, is one of the important infrastructures in cities and towns, and it is very important to ensure its construction quality. Based on the experience over the years, a comprehensive analysis of the common problems in the construction quality of municipal sewage pipeline engineering is carried out. The most common quality problems are now divided into four aspects, the causes are analyzed, and preventive measures are proposed for the owners' reference.

1） Pipeline position deviation or water accumulation

① Causes: measurement errors, construction aliasing and accidental avoidance of original structures , resulting in positional deviation on the plane, water accumulation on the facade and even downhill.

② Preventive measures: prevent errors caused by measurement and construction . The preventive measures are as follows: A. Before construction, the handover piles should be re-measured and protected in accordance with the construction measurement specifications and regulations.

B. The construction stakeout should be combined with the hydrogeological conditions, in accordance with the embedding depth, design requirements and relevant regulations, and must be re-tested to verify that the error meets the requirements before delivery for construction.

③ The construction should be carried out in strict accordance with the sample piles, and the axis and longitudinal slope should be measured and accepted for trenches and flat foundations; if there is an accidental structure that must be avoided during the construction process, a connecting well should be added at an appropriate position, and the connection should be connected in a straight line. The well turning angle should be greater than 135 ° .

2) The pipeline leaks water, and the closed water test fails

●Causes: uneven subsidence of the foundation , poor construction quality of pipes and their joints, poor sealing at the end of the closed water section, and poor construction quality of the well body can cause water leakage.

●Prevention measures :

① Poor foundation conditions of pipelines will lead to uneven subsidence of pipelines and foundations, generally causing local water accumulation, and in severe cases, pipeline fractures or joint cracking. The preventive measures are:

A. Conscientiously construct according to the design requirements to ensure the strength and stability of the pipeline foundation. When the local foundation geology and hydrological conditions are poor, soil replacement should be carried out to improve the treatment to improve the bearing capacity of the bottom of the foundation trench. If the soil at the bottom of the tank is disturbed or soaked in water, the soft soil layer should be excavated first, and the over-excavated part should be backfilled with stable materials such as sand or gravel.

B. When excavating earthwork below the groundwater level, effective measures should be taken to prevent drainage and dewatering at the bottom of the trench to ensure dry trench excavation. If necessary, a 20cm -thick soil layer can be reserved at the bottom of the trench. closed.

② The quality of the pipe is poor, there are cracks or local taxes are loose, and the impermeability is poor, which is prone to water leakage. Therefore, it is required:

A. The pipes used must be provided with certificates and mechanical test reports by the quality department.

B. The appearance quality of the pipe requires that the surface be smooth and free of loose, exposed and honeycomb surface, and the sound of hard objects hitting the pipe wall is crisp and pleasant.

C. Check again section by section before installation, and those that have been found or have quality doubts should be discarded or used after effective treatment.

③ The filling and construction quality of the pipe joints are poor, and the pipes are damaged or the joints are cracked under the action of external force. Prevention and control measures:

A. Select the interface filler of good quality and organize the construction according to the test mix ratio and reasonable construction technology.

B. The joints should be clean, and the cement filler joints should be pre-wetted, and the oily ones should be pre-dried and then brushed with cold base oil, and then carefully constructed according to the construction operating procedures.

④ The construction quality of the inspection well is poor, and the joint of the well wall and its connecting pipe is leaking. Preventive measures:

A. The inspection well masonry mortar should be full, and the joints should not be omitted;

clean and wet the surface before plastering, and calender the slurry and maintain it in time when plastering the surface; in case of groundwater, the plastering and jointing should be completed in time with the masonry , it is not allowed to carry out internal plastering or internal jointing after backfilling.

B. The outer surface of the pipe connected to the inspection well should be wet and evenly brushed with a layer of cement slurry, and then the inner and outer surfaces should be plastered after the slurry is in place to prevent leakage.

⑤ The sealing of the closed water section is not tight, and it is often overlooked because it is in the well. If a brick wall is used for sealing, the following points should be paid attention to:

A. Before plugging, the nozzle should be placed within a range of about 0.5m Clean the inner wall of the inner tube, paint the cement slurry, and wet the bricks used for later use.

B. The grade of the plugging mortar should not be lower than M7.5, and it should have a good consistency.

C. The grade of cement mortar used for jointing and plastering shall not be lower than M10 . When the diameter of the pipe is large or when the inner and outer sides are small, only the outer single-sided jointing or plastering shall be used. The plastering surface should be constructed according to the waterproof 5 -layer construction method.

D. When conditions permit, sealing and masonry can be carried out before the inspection well is built to ensure the quality.

E. The preset drainage hole should be at the inner bottom of the pipe for inspection during draining and testing.

⑥ The closed water test is a comprehensive inspection of the pipeline construction and material quality, during which it is inevitable that three or two failures will occur. At this time, the leaks should be marked one by one, and the water in the pipe should be drained for careful treatment. For the leakage of small gaps or pockmarked surfaces, it can be painted with cement slurry or waterproof paint, and the more serious ones should be reworked. The ointment interface can be surface treated with a blowtorch, which is generally effective, otherwise it will be dug up and refilled. Serious leakage can be handled by professional technicians in addition to replacing pipes and refilling the interface. Do the test after treatment, and repeat until the closed water is qualified.

3） Deformation and subsidence of inspection wells, poor quality of components and parts

●Causes: deformation and subsidence of inspection wells , poor quality of manhole cover and installation quality, too random installation of iron ladders, affecting the appearance and quality of use.

●Prevention measures

① Do a good job of inspecting the base layer and cushion of the well, and use the method of breaking the pipe to make a flow trough to prevent the well body from sinking.

② The center position and height of the well room and wellhead should be well controlled to check the quality of the well masonry to prevent deformation of the well body.

③ Check the manhole cover and the seat to match; the seat slurry should be full during installation; the light and heavy models and the surface bottom are good for use, the iron climbing installation should control the position of the first step up and down, the deviation should not be too large, and the plane position is accurate .

6.4.2 Maintenance and management of pipeline network

With the continuous improvement and continuous use of the sewage pipe network system, the maintenance of the pipe network has become a real problem. Only timely maintenance can ensure the normal operation of the pipe network system, otherwise it will lead to the loss of its system function, and even It will cause paralysis of the local pipe network system, affecting people's life and normal production. Therefore, we must maintain and manage the pipe network to ensure the normal operation of the pipe network system.

1) Analysis and countermeasures of pipeline deformation, subsidence, fracture and disconnection

①Reasons for deformation, subsidence, fracture, and disjointness

The interface of the pipe currently used is a flexible interface, which is prone to fluctuations; in addition, the underground pipe is subjected to static and dynamic loads for a long time, so the pipeline and the pipe itself will be deformed, subsided, or even disconnected and broken.

②Processing method

A. Deformation and subsidence of the pipeline will destroy the slope. Therefore, once found, measures must be taken actively. For the foundation of the deformed pipeline, comprehensive water injection and sand filling can be used to strengthen the pipe foundation to prevent subsidence or excavate the severely deformed parts, and then reinforced with tax.

B. If the pipeline is disconnected or broken, it will lead to a large amount of sewage leakage and pollute the environment; if it is serious, it will cut off the discharge path of the sewage and cause the upstream sewage to overflow. Therefore, the treatment of the disconnected pipeline must be timely. Sewage pumps pump upstream sewage into downstream wells or temporarily into stormwater systems, excavation is performed and the severity of damage is checked:

C. The plastic pipe can be repaired by the lining method, that is, the disjointed or broken pipe is lined with HDPE , and the lining is heated. This method will reduce the diameter of the pipe, so the flow rate must be calculated before using it, and it should be used under the premise that the maximum flow rate can be discharged.

D. The method of adding inspection wells is adopted, that is, an inspection well is added at the fracture or disconnection.

E. When the displacement is large and the water cannot be cut off, the method of constructing a spanning well section can be adopted. After the spanning well section is completed, water is released, and then the original well section is blocked and abandoned. This method often involves the change of the pipe position, so a detailed investigation of the nearby pipelines should be carried out in advance, and a plan should be proposed.

2） Analysis and countermeasures for siltation caused by factors such as small slope and low flow rate and cross wells that damage hydraulic conditions

① Reasons for small slope, low flow rate and additional cross wells

When the existing sewage pipes often conflict with the original underground pipelines (electricity, gas, water supply, communication, rainwater, etc.), and the difference is not large, we often use the method of reducing the slope to make the new sewage pipes pass through the original construction. The pipeline, which leads to a small slope, produces a phenomenon of low flow rate.

When it is still impossible to pass by reducing the slope, we often use the additional cross-well method. Although the above method ensures the normal construction of the pipeline, it destroys the hydraulic conditions of the gravity flow of sewage in the pipeline, so that the flow velocity is less than the design flow velocity (ie $V<0.6m/s$), so that the impurities in the sewage sink and produce silt, blockage.

② Processing method

For the situation that the local slope is small and the flow velocity is low, the method of increasing the slope in the upstream part and speeding up the flow velocity can be adopted, so as to increase the flow velocity of the small slope part (ie $v>0.6m/s$) , and solve the problem of The low flow rate produces the phenomenon of siltation. In addition, an automatic valve can also be installed in the upstream well of the pipeline with a small slope. When the water level of the upstream well reaches a certain position, the valve will automatically open, so that the downstream pipeline can be flushed once, so that the sludge in the pipe can be washed away. It can achieve the effect of self-cleaning, but this method is not applicable when the sewage contains a lot of impurities, that is, when the sludge is more than 20% .

③ Maintenance of cross wells

A. Timely grasp the situation of silt in the cross well, and clear it regularly;

B. When the cross well is too small and it is inconvenient to clear it, a sediment well can be set up upstream of the cross well, and the sediment can be cleared in time.

3） Analysis of the importance of pipeline technology management to pipeline maintenance

L sewage pipeline technical management work includes many aspects:

① Archiving of technical files.

② Periodic inspection of pipes. Including the usual patrol inspection and technical inspection.

③ Technical inspection and appraisal of the units and equipment of the drainage pumping station.

④ Do a post-rain inspection after it rains.

4） More attention should be paid to the inspection of sewage pipelines, the contents of which are:

Check whether there is subsidence on the ground, whether there is excessive external load, whether there is abnormal change in the well, whether the water flow is normal, whether there is illegal access to the pipeline, and whether there is any blockage. Professional training should be carried out for the inspection personnel, so that they can master the basic skills of pipeline inspection and be familiar with the necessary business knowledge. The management and professional knowledge training of inspectors should be strengthened in peacetime. include:

① Supervisors should frequently check, patrol, fill in the inspection record form, and point out the key inspection areas.

② Regular meetings of inspection personnel are held to report on work and exchange experience with each other.

③ It is stipulated that the inspection personnel will check the walking route every day, and specify the time and place to meet the inspector of another lot.

④ Inspectors will develop a habit of inspecting a project for a long time. I am used to the topography and drainage pipes, and it is not easy to find problems. This is not good for work, and it can be exchanged for a quarter or half a year on a regular basis.

The contents of the technical inspection include: sedimentation in the pipe, changes in water depth, and groundwater infiltration.

6.4.3 Sludge Treatment and Disposal

According to the sludge survey data in 2015 , the current total scale of sludge treatment and disposal facilities in Shangyu District is 250 tons/day, and the current sewage treatment plant sludge (with a moisture content of 70%) is 230 tons/day. Safe handling and disposal. However, with the increase in the amount of water treated by the sewage treatment plant, the amount of sludge will also increase accordingly, and the current sludge treatment and disposal capacity will be difficult to meet. Therefore, the problem of sludge treatment and disposal in Shangyu District still needs to be paid attention to.

1） General principles of sludge treatment and disposal

As an inevitable product in the sewage treatment process, sludge has a high organic content and contains a large number of bacteria and parasites. If it is not properly treated and disposed of, it will cause secondary pollution. The general principles of sludge treatment and disposal are stabilization, reduction, innocence and recycling, taking innocence as the focus of sludge disposal and taking recycling as the ultimate goal of sludge disposal.

①Stabilization

Sludge stabilization is a process of degrading the organic substances in the sludge, further reducing the water content of the sludge, killing bacteria, pathogens, and eliminating odors in the sludge, so that various components in the sludge are in a relatively stable state. . It is necessary to adopt biological aerobic or anaerobic nitrification process, or add chemical agents, etc., to convert the organic components in the sludge into stable final products, further digest the organic components in the sludge, and avoid the final disposal of the sludge. secondary pollution in the process.

②Reduction

Sludge reduction in urban sewage treatment plants refers to reducing the volume of sludge by adopting process reduction methods to reduce the cost of sludge treatment and final disposal. Sludge reduction is usually divided into mass reduction and process reduction. The method of mass reduction is mainly through stabilization and incineration, and the method of sludge volume reduction is mainly achieved through two steps of sludge concentration and sludge dewatering. The amount can be achieved by ultrasonic technology, ozone method, membrane bioreactor, biological predation, microbial enhancement and chlorination method.

③Harmless

The purpose of the harmless treatment of sludge is to use appropriate engineering techniques to remove, decompose or "fix" the toxic and harmful substances in the sludge and sterilize it, so that the treated sludge will not have an impact on the environment in the final disposal. Preventing the transfer of unexpected contaminants between different media is safer and more sustainable, and will not cause harm to the environment.

④Resource

Recycling refers to recovering useful substances such as nitrogen, phosphorus and potassium or recycling energy while processing sludge, so as to achieve the purpose of turning harm into profit, comprehensive utilization and environmental protection.

The characteristics of sludge recycling are: high environmental efficiency, low production cost, high production efficiency, and low energy consumption.

6.4.4 Overview of sludge treatment and disposal technologies

Judging from the sludge treatment and disposal projects that have been completed and operated at home and abroad, the common sludge treatment methods are: aerobic fermentation (composting), anaerobic digestion, sludge concentration, sludge mechanical dewatering, etc.; sludge disposal methods include: Land use, landfill incineration, marine disposal and comprehensive utilization, etc.

1） Sludge treatment method

①Sludge aerobic fermentation

Sludge aerobic fermentation technology is a new biological treatment technology that utilizes microorganisms in sludge for fermentation. In practical applications, it can achieve the effect of harmless reduction and resource utilization. Additional energy, no secondary pollution and other characteristics.

②Sludge Anaerobic Digestion

Anaerobic digestion of sludge refers to the decomposition of biodegradable organic matter in sludge into stable substances such as carbon dioxide, methane and water by facultative bacteria and anaerobic bacteria under anaerobic conditions, while reducing the volume of sludge and removing odor. The process of odor, killing parasite eggs, and recycling the biogas produced during digestion. Anaerobic sludge digestion is currently the most widely used treatment method for sludge stabilization and recycling in the world due to its efficient energy recovery and low environmental impact.

③Sludge thickening

Sludge thickening is an effective method to reduce the moisture content of the sludge and reduce the volume of the sludge. Sludge thickening mainly reduces the interstitial water of sludge. The thickened sludge is almost mushy and still maintains fluidity. The methods of sludge concentration include sedimentation, air flotation and centrifugation. When choosing a concentration method, in addition to the characteristics of each method, the nature, source, entire sludge treatment process and final disposal method of sludge should also be considered. For example, the sedimentation method has a better effect when it is used to concentrate the mixed sludge of the primary sedimentation sludge and the remaining activated sludge. The pure residual activated sludge is generally concentrated by air flotation, and this year, some of them are concentrated by centrifugation.

④Mechanical dewatering of sludge

During sewage treatment, the separated sludge is generally dewatered mechanically for transport and further disposal. Mechanical dehydration is mainly divided into belt dehydration and centrifugal dehydration.

2） Sludge disposal methods

①Sludge land use

Mainly refers to sludge as a soil conditioner for farmland, forest land, municipal greening, or after being processed and processed into organic fertilizer, or used for restoration and reconstruction of damaged land.

For crops, the stabilized and harmless sludge can promote the growth and development of roots and their permeability, reduce the attack of parasites, reduce the dependence of plants on pesticides, herbicides and other drugs, and the self-purification of soil The ability can also make the sludge further harmless.

Sludge can be used for the restoration of damaged land (mines remaining after various mining, construction borrowing, deep pits for waste discharge, forest logging, landfill, heavily damaged areas, etc.). This type of land has generally lost the good characteristics of the soil and cannot be planted directly. The application of sludge can increase soil nutrients, improve soil characteristics, and promote plant growth. This method not only disposes of sludge, but also restores the ecological environment. The land use of sludge is also one of the cheapest sludge disposal methods, so it has been widely used.

② Sludge Sanitary Landfill

Sanitary landfilling of sludge started in the 1960s . From the perspective of environmental protection, scientific site selection and necessary site protection treatment are carried out on the basis of traditional landfilling, and it is a scientific engineering operation method with strict management system. Sludge landfill is a relatively mature sludge disposal technology, which has the advantages of large processing capacity and quick effect. But it also has some problems, such as difficult to find suitable sites, high cost of sludge transportation and landfill construction, limited capacity of landfills, leakage of harmful components may cause pollution to groundwater, sanitation and odor of landfills Air problems cause secondary pollution, etc. in developed countries. This method has been used a lot in the past, but with the reduction of available venues, the proportion of adoption is getting smaller and smaller at present.

③ Sludge Incineration

Sludge incineration is to dispose of sludge by utilizing the characteristics of high organic content and certain calorific value of sludge. The technical advantage of incineration lies in the thoroughness of its treatment, the reduction rate can reach about 95% , the organic matter is completely oxidized, and almost all heavy metals (except mercury) are trapped in the ash. However, the following problems have always existed in incineration: ①High investment and operating costs; ②Fly ash, slag and flue gas are generated during the incineration process. Studies have found that incineration ash, especially fly ash, contains a lot of Cd , Pb and other heavy metals, which are hazardous wastes. healthy. The exhausted flue gas contains highly toxic substances such as dioxin and bark, which may cause secondary pollution if not properly controlled; ③ The useful components in the sludge are not fully utilized.

6.4.5 Sludge Treatment and Disposal Planning Suggestions

. 1） Analysis of the status quo of sludge treatment and disposal

Sewage Treatment Plant is deeply dewatered by high-pressure plates and frames, and the moisture content of the sludge reaches 70 % . According to the plan of Shangyu District, Shaoxing City, the near - term sewage treatment volume is 191,100 m³ /d, and the long - term sewage treatment volume is 301,300 m³ /d. Then the sludge volume will increase simultaneously . tons/day.

Due to the limited capacity of the electric heating plant in the park to accept sludge, the Shangyu Sewage Treatment Plant has entrusted Shaoxing Shangyu Huanxing Sludge Treatment Plant Co., Ltd. for treatment, and the newly built sludge incineration project (150 tons/day) has already started operation. Therefore, the current sludge treatment capacity of Shangyu District (2.5 million tons/day) can meet the short-term requirements, but cannot meet the long-term requirements.

2） Sludge Treatment and Disposal Planning Suggestions

From the above analysis, it can be seen that the total sludge disposal capacity of Shangyu can meet the short-term requirements, but cannot meet the long-term requirements. Therefore, the sludge disposal capacity of Shangyu District should be considered as a whole. The specific suggestions are as follows:

① After the sewage treatment plant and sewage pipe network have been upgraded and upgraded by quality, it is recommended that the sludge from domestic sewage treatment and the sludge from industrial sewage treatment be used for resource utilization in different ways. Domestic sludge is recommended for agricultural and greening fertilizers for land use, and industrial sludge is recommended for incineration. At the same time, the management of ash disposal and flue gas control after incineration should be strengthened to prevent secondary pollution.

② After the sludge from domestic sewage treatment and the sludge from industrial sewage treatment are recycled in different ways, if the sludge volume of Shangyu Sewage Treatment Plant and Hangzhou Bay Sewage Treatment Plant still exceeds the current sludge disposal capacity, It is recommended to transport the excess sludge to the main urban areas (Keqiao and Yuecheng District) for unified treatment or to expand the scale of sludge disposal.

③ The disposal of wastewater, waste gas and solid waste generated in the sludge treatment process shall comply with relevant laws and regulations.

④ The planned sludge does not include the sludge treatment and disposal of industrial enterprises' pretreatment production. Therefore, it is recommended to carry out special research on sludge treatment and disposal in combination with industrial enterprise sludge in the next step, so as to serve the goal of harmless sludge disposal in urban areas.

6.5 Modernization of sewage treatment system management

6.5.1 Requirements for modernization of sewage treatment

The modernization of the sewage treatment industry includes the following five aspects: the moderately advanced sewage treatment capacity, the quality of the tail water from the factory meets the emission reduction requirements, the sewage and sludge treatment is safe, reliable, advanced and efficient, the sewage collection pipe network is fully equipped, the management is scientific, and the water Handling company management to achieve informatization and service to achieve all-round satisfaction.

1） Sewage treatment capacity

The sewage treatment capacity includes not only the treatment capacity of the sewage treatment plant, but also the collection capacity of the sewage collection system.

① "Energy -demand ratio" should be moderately advanced

The ratio between the urban sewage treatment capacity and the amount of sewage to be treated in the city becomes the "energy -demand ratio", and the energy-demand ratio is an important indicator to measure whether the urban sewage treatment capacity meets the needs of the economy and society. Due to the uncertainty of urban economic development and the amount of sewage to be treated, and the long construction period of sewage treatment plants, the urban sewage treatment capacity needs to be appropriately advanced. Referring to the "supply- demand ratio " requirements of modern urban water supply, it is recommended The "energy -to-demand ratio" of sewage treatment capacity is also maintained at 1.1 ~ 1.2.

② Sewage collection capacity

The sewage collection capacity is expressed by the sewage acceptance rate. The sewage acceptance rate represents the city's level of sanitation and civilization, and is also a reflection of the quality of life of the residents. The sewage management rate in urban areas should reach more than 90% ; the sewage management rate in townships should reach more than 80% .

The sewage collection system should be able to accept all the sewage that enters the collection system, and the overflow of sewage is not allowed in modern cities.

2） Water quality of factory tail water

The quality of the tail water of the sewage treatment plant is determined according to the environmental capacity of the receiving water body, the division of water function areas and the requirements of relevant standards. The quality of the tail water of the modern sewage treatment system should be better than the relevant norms and standards, so as to achieve the goal of energy saving and emission reduction.

3） Sewage treatment plant facilities

The main tasks of the urban sewage treatment plant are: to treat the incoming sewage to ensure that the quality of the tail water reaches the standard; The modern sewage treatment plant needs to complete the above two tasks, and the specific requirements are:

① According to the quality of sewage entering the plant, there must be targeted, advanced and reliable water treatment processes, which can adapt to the actual situation of changes in the quantity and quality of sewage entering the plant, and have a greater ability to resist shock loads . .

② There should be facilities suitable for the harmless disposal and comprehensive utilization of sludge, and the outlet of the sludge after disposal should be reasonably arranged to prevent secondary pollution.

③ The production process of sewage treatment and sludge disposal is automatically controlled.

④ Electric, mechanical, automatic control equipment and online instruments adopt new energy-saving equipment.

⑤ The water treatment plant should implement a distributed control system, and the main production processes should realize automatic three-level control: local control, field unit control, and dispatch room control.

⑥ The sewage treatment plant is equipped with deodorizing equipment to ensure the excellent air environment around the water treatment plant.

4） Sewage collection system

The sewage collection system consists of sewage pipes and sewage lifting pump stations.

①The diameter and slope of the sewage pipeline should be able to send all the received sewage to the designated place, and the filling degree should meet the requirements of the specification;

the depth of the sewage pipeline should ensure that all users discharge sewage at any time.

②The sewage lifting pump station should have a certain sewage storage capacity, slag removal function, and the sewage lifting and conveying capacity should exceed the amount of sewage inflow; the configuration of the lifting pump should be able to adapt to the changes in the amount of sewage inflow.

③The inlet pipe of the sewage pumping station shall be equipped with an online water quality monitoring instrument to supervise the water quality of the inlet station at all times.

④ Electrical, mechanical, automatic control equipment and online instruments adopt new energy-saving equipment; remote automatic control of pump station operation is realized.

⑤The pumping station should be equipped with deodorizing equipment to ensure the good air environment around the pumping station.

⑥ Speed up the renewal of corroded, long-term and old pipes, promote the application of new high-quality pipes, and reduce the leakage of the collection system. ⑺ Carry out a census on the sewage collection system, find out the current situation, establish a computer management system, and realize the scientific management of the sewage collection system

6.5.2 Status Quo and Modernization Gap of Sewage Treatment System

1）Sewage treatment capacity

According to the expected amount of sewage in Shangyu City, the current treatment capacity of the sewage treatment plant can meet the planned short-term (2022) water treatment capacity, but cannot meet the planned long-term (2030) water treatment capacity.

2） Water quality of factory tail water

According to the upgrading and transformation materials provided by the sewage treatment plant, after the upgrading and transformation project is completed, the tail water from the factory can meet the requirements of the Ministry of Environmental Protection.

3）Sewage treatment plant facilities

After the upgrading of the water treatment plant of Shangyu District Water Treatment Development Co., Ltd., the sewage treatment process can ensure that the water quality of the factory tail water reaches the standard rate of more than 99% . The sewage treatment process of the sewage treatment plant basically realizes automatic control, and the operation power consumption and chemical consumption meet the energy saving and emission reduction standards.

current sludge disposal capacity of Shangyu District can meet the planned short-term (2022) sludge production, but cannot meet the planned long-term (2030) sludge production.

4）Sewage collection system

The sewage collection system of Shangyu District Water Treatment Development Co., Ltd. adopts the combination of gravity flow and pressure flow. The collection pipelines in urban areas and towns are mainly gravity flow; the transmission pipelines between urban areas, towns and water treatment plants are mainly pressure flow. 76 sewage pumping stations have been built or under construction , the main sewage pipeline is 350km, and the sewage collection system network has been formed .

At present, the sewage collection pipelines in the townships are not perfect, the rain and sewage diversion in the old urban areas is not thorough enough, and there are many old pipelines that need to be renovated .

There is still a certain gap in the construction of sewage system at the end of the Five-Year Plan.

5）Operation and Management of Sewage Treatment System

At present, Shangyu District Water Treatment Development Co., Ltd. is responsible for the operation and management of the water treatment plant, the daily management of the sewage collection area, the emergency repair of pumping stations and pipeline failures, and the online monitoring of the water quality of the incoming sewage. The sewage treatment charges are collected by the Shangyu District Water Supply Company, so there is no economic management.

With the strict implementation of the pollutant discharge permit system and the development of paid use and trading of pollutant discharge rights, Shangyu District Water Treatment Development Co., Ltd. has increased the treatment compensation fee for the sewage entering the plant whose water quality exceeds the standard; On-line monitoring instruments for water quality shall strengthen supervision.

6.5.3 Recommendations for the modernization of sewage treatment systems

To realize the modernization of Shangyu sewage treatment system, we must first establish an intelligent water treatment system, including sewage collection system, incoming sewage water quality control, water treatment process management, and factory tail water quality control and other aspects.

1） Automation of sewage treatment system

Automation of sewage treatment system The sewage pumping station promotes the automation and informatization of sewage and sewage treatment plant sewage treatment production process.

The sewage treatment plant establishes a central control room, and each water treatment unit and sewage pumping station establishes a PLC control station. The automatic control system consists of two parts: PLC/ computer control management system and instrument detection system.

The control mode of the sewage treatment plant equipment is set to three levels of control: local control, on-site PLC control station control, and central control room control. Between the upper and lower control levels, the priority of the lower control is higher than that of the upper. The local control level has two modes of " local /remote control", and each device can be manually operated by switching the "local /remote control" selector switch.

Automatic control system, detection instrument, blast aeration system and CCTV system of water treatment plant is configured according to the operation management mode of unattended operation of water treatment plant and sewage pumping station, fully automatic equipment operation, and centralized monitoring operation of control center.

Three -layer structure of monitoring operation center, PLC control station, and field control equipment . It adopts the latest version of general configuration monitoring software, and has information processing capabilities, dynamic production scheduling, and process control and optimization of the production process.

The computer system hardware of the central control room adopts the mainstream configuration to meet the needs of use and future development. Provide monitoring services, display services, data services, printing services, configure power supply, lightning protection, debugging tools, etc. The central control room should realize real-time monitoring, and display dynamic graphics of the operation of each process unit in the whole plant, the operation parameters of each part and the operation status of various equipment through the large-screen display. The central control room should keep all the automatic control design and software data of the water treatment plant. Use the configured software to maintain, expand and modify the automatic control system of the water treatment plant and each PLC control station.

PLC control station is composed of programmable logic controller, industrial Ethernet switch, PLC cabinet, uninterruptible power supply and lightning protection device. The network of the PLC control station adopts industrial Ethernet technology, and cooperates with industrial switches to form a 100Mbps optical fiber Ethernet ring, which not only has advanced technology, good openness and scalability, but also has redundancy and communication on equipment hardware of high reliability.

All instrument configuration of sewage pumping station and sewage treatment plant should be at the international leading level, and should meet the needs of process parameter detection; meet the needs of control. Adopt intelligent instruments, with on-site display, calibration function, self-diagnosis function, signal protection function and Fault alarm function.

2） Modernization of treatment process management of sewage treatment plants

Comparing with the "Pollutant Discharge Standards for Urban Sewage Treatment Plants" (GB18918-2002) , Shangyu Sewage Treatment Plant's treatment process, operation of treatment structures, mechanical and electrical automatic control facilities and other hardware have all reached modern standards. Process management modernization. The operation monitoring of the sewage treatment plant is to collect the main production data of the sewage treatment plant, and to monitor the inflow and outflow water flow and water quality indicators of the sewage treatment plant. Accurately grasp the operation of sewage treatment plants. The newly built Hangzhou Bay Sewage Treatment Plant should be designed according to the requirements of modernization of treatment process management.

① Incoming sewage water quality monitoring

The quality of the sewage entering the plant meets the requirements of the third-level standard of the "Integrated Wastewater Discharge Standard" (GB8978.1996) , and the COD is strictly 500mg/1 . In order to ensure that the water quality of the factory tail water meets the standard, the water quality of the incoming sewage must be controlled within the required standards. Therefore, online monitoring instruments for water quality should be set up at the sewage discharge outlets of key sewage dischargers, and communicated with the central control room of the water treatment plant to cooperate with the environmental protection department to monitor the key points. Real-time monitoring of the quality of sewage discharged by major polluters.

②Ensuring that the water quality of the factory tail water meets the standard

Industrial sewage strictly implements the new standard "Integrated Wastewater Discharge Standard" (GB8978-1996) Class I standard; domestic sewage strictly implements the Class A discharge standard of "Pollutant Discharge Standard for Urban Sewage Treatment Plants" (GB18918.2002) . This is very demanding for sewage treatment with a high proportion of industrial wastewater and a low B/C ratio. To this end, there must be a targeted sewage treatment process, strong adaptability to changes in the quality and quantity of incoming sewage, and the quality of each process in the sewage treatment process must be guaranteed.

There should be reserves of a variety of chemicals; emergency measures should be set up when the quality of the factory tail water does not meet the standard; there should be an emergency plan for sudden accidents to ensure that the quality of the factory tail water meets the standard.

③Energy saving

The electrical and mechanical equipment shall adopt energy-saving equipment and keep more than 99% of the intact rate .

Efforts are made to improve the treatment efficiency of anaerobic processes. The aeration of the aerobic process adopts a fully automatic control system of dissolved oxygen concentration, and on the premise of ensuring the treatment effect, the dissolved oxygen concentration is controlled to the minimum. The blower in the blower room is equipped with a speed regulation system, which adjusts the operating conditions of the blower according to the oxygenation requirements to make it work in the best efficiency area.

3） Modernization of operation and management of sewage collection system

Drainage operation monitoring is to collect the main production and operation data of the drainage company's drainage pipeline network and drainage pumping station, monitor the drainage volume of the drainage pumping station, the status of pump start and stop, etc. Drainage monitoring and large meter analysis of water supply found stealing drains.

The use of the pipe network GIS system can play a good auxiliary role in enhancing the normative, scientific and sustainable management of sewage pipelines and pumping stations. At the same time, the GIS system comprehensively utilizes satellite positioning technology, which can be further applied in the planning, design, operation, maintenance and management of sewage pipelines and pumping stations, and can provide accurate geographic information for pipeline construction and timely repair, maintenance and management of sewage pipelines. Coordinate positioning, raising the basic file management of the sewage collection system to a new level.

4) Sewage pipeline valve management system and automatic control system

Since there are many sewage pipelines under pressure in the sewage collection system under the jurisdiction of Shangyu District Water Treatment Development Co., Ltd., it is necessary to establish a management system and an automatic control system for sewage pipeline valves.

①On the basis of the establishment of the sewage pipeline GIS system, enter the relevant data attribute information of the sewage pipeline valve.

In order to ensure that the entire GIS system can operate the valve attribute information accurately and quickly, the system attribute information should be read from the GIS pipe network system. The main attribute information should be read from the GIS pipe network system. The main attribute information includes: valve number, X coordinate, Y coordinate, pipeline location, diameter, type, power mode, manufacturer, remarks, etc.

It mainly stores the geographical location of the valve and the connection relationship information of other pipe networks, mainly including three types: the large sample map of the valve, the plan section and the valve photo.

It mainly records the operation information of the valve performed by the water treatment system. According to the analysis of user needs and the results of the current situation investigation, the valve operation record includes: valve number, operation date, operation type and operator, etc.

② Using wireless communication technology to realize online monitoring

Electric butterfly valves are installed at the main sewage pressure main pipe and the outlet of the sewage pipes of large drainage households, and the remote automatic control of sewage flow is realized by means of measurement and control equipment, mobile GPRS wireless communication technology and PID adjustment technology. Establish an information management platform for sewage flow, and use wireless communication technology to realize online sewage volume detection.

③ Play the role of the valve management system in the pipeline network

The use of valve management system and automatic control system can play an active role in the management of urban sewage collection system:

A . Integrated valve management, through the spatial query, positioning and operation management functions of valves, technicians can accurately understand the valve information in relevant areas according to GIS , get rid of the invariance of relying mainly on experience to locate and find the valve. The dynamic display function of the valve can intuitively display the different working states of the valve, which greatly improves the usability and intuitiveness of business information.

B . Accident emergency repair, maintenance early warning and valve closing analysis function modules can quickly help engineers and technicians locate the location of the pipeline where accidents (such as pipe bursts) have occurred, and quickly formulate a valve closing plan, print out the valve position map, and reduce sewage accidents as much as possible. The resulting sewage overflow will reduce the social impact and environmental pollution caused by the untimely treatment of the accident.

C . Maintenance of pipelines. Sewage pipes are easy to deposit sludge and sundries and should be flushed regularly. The management and automatic control system of pipeline valves can quickly generate the flushing time of pipe sections, flushing routes, valves to be opened and operating procedures through the flushing scheme generation function, which provides strong support and reference for the safe operation and management of sewage pipelines.

④ Construction of emergency management system for pipeline network

Emergency management system for pipe network emergencies: It is an important part of pipe network operation and management. Drainage enterprises should conduct safety and risk assessment of the pipe network system, establish drainage safety early warning and emergency response plans, and pay equal attention to prevention and disposal. The combination of assessment and control makes emergency response management predictable and targeted. At present, according to the actual needs of the operation and management of the pipe network, corresponding emergency plans for emergencies, large-diameter pipe network burst emergency plans, and emergency plans for water supply and drainage emergencies have been established. Determine the emergency response plan, guarantee the emergency repair force, implement post-emergency evaluation, etc., systematically, rationally, and normatively make provisions for emergencies, establish an organizational structure, clarify the corresponding responsibilities of each department, manage at different levels, and respond at different levels , overall coordination, division of labor and cooperation, systematic prevention, scientific decision-making, to ensure the safe operation of the drainage system.

Construction of emergency management stations: With the continuous extension of sewage pipelines and the increasing number of management pumping stations, in order to quickly deal with emergencies in the drainage network and manage the drainage network better and more efficiently, 4 new management stations are required. Offices: Yudong Station (Xietang) , Yunan Station (Lianghu), Yuxi Station (Dongguan), Yubei Station (Chemical Park) e In addition, rural pollution control work involves 20 townships in the region (street), 322 administrative villages, with more than 1,500 treatment stations, with a wide range of points, in order to quickly deal with emergencies in the drainage network and treatment stations, and manage the drainage network and treatment stations better and more efficiently , it is recommended to establish rural pollution control management offices in suitable locations.

5） Realize the modernization of sewage treatment system operation

In the age of automation, e-phone, and digitization, people come first. Therefore, employees of Shangyu District Water Treatment Development Co., Ltd. should conduct regular vocational skills training to improve the quality of employees and the response rate of the entire team to emergencies. Strengthen employees' awareness of environmental protection, standardize operating procedures, improve the quality of sewage treatment, and gradually realize the modernization of operation and management.

6.5.4 Smart Water

1） Overview of Smart Water

Smart water is an important part of a smart city, which refers to the real-time perception of the running status of the urban water supply and drainage system through online monitoring equipment such as data acquisition instruments, wireless networks, and water quality and water pressure meters, and the organic integration of the water management department and the water management department in a visual way. Water supply and drainage facilities form the "Urban Water Affairs Internet of Things", which can analyze and process massive water affairs information in a timely manner, and make corresponding processing results to assist decision-making suggestions, and manage the entire production, management and service process, so as to achieve a "smart" state.

Under the guidance of the concept of "smart water affairs", the management of water affairs groups has undergone changes. They use sensing equipment such as data acquisition and transmission to detect the running status of the water affairs system online, and organically integrate the facilities of the water affairs management department in a visual way. "The Water Affairs Internet of Things Gas Group analyzes and processes massive data in a timely manner through the water affairs digital management platform, that is, installs data acquisition front-end machines or data collection DSP modules in various sewage treatment plants and pumping stations, and records the production and operation data in the automatic control system. Real-time transmission to the group headquarters through the 3G network for centralized storage and application. Through real-time monitoring and intelligent analysis of various key data, classification and graded early warning are provided, and the relevant person in charge is notified by SMS, light, and alarm sound. The corresponding processing results are given to assist decision-making suggestions, and the entire production, management and service process of the water operation system can be managed in a more refined and dynamic way, making it more digital, intelligent and standardized, so as to achieve a "smart" state.

2） " Intelligent " water and sewage systems

Smart water affairs include collection, transmission, storage, processing and service of water affairs information, which completely improves the efficiency and effectiveness of water affairs management, realizes more comprehensive perception, more active services, more integrated resources, more scientific decision-making, and more automatic control. and more timely responses. There are more and more sewage treatment plants in my country and they are widely distributed. The traditional supervision method can no longer meet the current development. With the improvement of efficiency, the operating cost is also rising. How to effectively supervise the plants and stations, this is the management level of the water group. higher requirements.

" intelligent " construction of the sewage system enables the production and operation managers to realize the key production indicators (inflow and outflow water volume, inflow and outflow water volume, inflow and outflow) of the water affairs group to the subordinate sewage treatment plants, pump stations, and main pipeline networks through the Internet of Things digital technology. Automatic collection, remote real-time monitoring, and intelligent early warning of water pollutant concentration, water level in water collection wells, etc.), production and operation data (equipment switch, current, voltage, etc.) . Using advanced information technology, the sewage operation system is more efficient, the production is more intelligent, the management is more refined, the decision-making is more scientific, the service is more personalized, and the intelligence is realized.

Relying on the " intelligent " construction of the sewage system, and the innovation of the management mechanism, it integrates and shares various operating data of the production site and conducts analysis and data mining to form an application system based on the data center, so that the entire urban sewage system has real-time operation monitoring, comprehensive Functions such as process control, process operation simulation, early warning of abnormal operation, and optimal operation decision-making provide various operating companies with services such as process analysis, equipment analysis, cost analysis, and risk analysis for overall comprehensive operation decision-making, and support comprehensive sewage management and cross-border water-related affairs. The industry coordinates management and provides personalized services to the public, so as to achieve the state of smart sewage.

3） Shangyu Smart Water Construction

At present, the construction of smart water affairs in China is developing rapidly. Jiangsu, Shenzhen and other places have taken the lead in carrying out the construction of "smart water affairs". Shangyu District has also actively responded to the relevant national policies for the construction of smart water affairs. Shangyu District Water Affairs Group Co., Ltd. The basic concepts and important contents are actively studied and discussed, and basic work such as sorting out Shangyu water affairs information, building its own data center, etc., and actively carrying out the " smart " construction of various subsystems such as sewage system and water supply system. [21-27]

6.6 Environmental protection and energy saving and emission reduction

6.6.1 Environmental protection

1）Overview of the current situation of the environment

According to the "Environmental Functional Location Planning of Shangyu District, Shaoxing City", the overall environmental quality in the planned area is relatively good, and industrial pollution has been effectively controlled. The deterioration of surface water quality in the planning area has been curbed, but the water quality has been further improved; the noise pollution sources in the planning area are mainly urban traffic and social life, etc., and the sound environment quality is good; the solid waste is mainly domestic garbage and industrial enterprise sludge, and the basic Realize full coverage of solid waste safe disposal.

2） Analysis of main pollution sources

This plan is a sewage system plan, so it is mainly considered that the final environmental pollution source of the whole system is mainly the pollution source during the operation period, and the pollution source during the construction period is suggested to be analyzed in combination with the specific implementation of the project.

The pollution sources during the operation period are mainly solid waste pollution, noise sources and air pollution from sewage treatment plants and sewage lifting pump stations.

3） Environmental impacts and strategies during the operation period

① The impact of the sewage treatment plant on the surrounding environment

The sewage treatment plant itself is an environmental protection project. After its completion, it will definitely play a great role in improving the regional environment and inland water quality. However, the operation of sewage treatment facilities will also have a certain impact on the surrounding environment. Therefore, in terms of environmental protection, certain measures need to be taken.

A. Sewage from sewage treatment plants

The sewage effluent of the planned sewage treatment plant must meet the first-class A discharge standard. After the Shangyu sewage treatment plant has been upgraded and renovated, the sewage effluent standard can reach the first-class A discharge standard. The existing process, transformation process and new process of the sewage treatment plant are relatively mature in technical casserole. The main equipment adopts domestic high-quality equipment and imported equipment, and the automatic monitoring level is high. Therefore, the normal operation of the sewage treatment plant is guaranteed, and the corresponding effluent quality can be achieved without causing pollution to the discharged water body. In addition, the entire sewage system plans emergency communication facilities between each sewage treatment plant, which improves and guarantees the sewage treatment rate and avoids the pollution of the water body caused by the accidental discharge of the sewage treatment plant.

B. Solid waste from sewage treatment plants

The solid waste in the sewage treatment plant is mainly grid slag, sand settling, sludge and domestic waste. The screen slag is pressed and dehydrated and disposed of together with municipal waste; the sand is dewatered and washed and then transported out to be used as building materials. As long as the above-mentioned solid waste is cleared and transported in time, it will basically have no impact on the plant area and the surrounding environment. After the sludge is dewatered by advanced dewatering equipment, the sludge disposal company conducts reasonable disposal, which has less impact on the environment.

C. The impact of odors on the environment

Since many sewage treatment facilities in the sewage treatment plant are open pools, the odor of sewage is emitted into the atmosphere, which is bound to affect the surrounding areas. From the statistics of the olfactory connection, it can be seen that within 100m downwind of the sewage treatment facility , the odor is very obvious to people, and beyond 300m , the odor can hardly be smelled. However , the odor is no longer obvious 20m upwind of the sewage treatment facility . Therefore, the downwind direction of the sewage treatment plant generally needs to meet the 300m isolation zone in order to have a residential area. Shangyu District Sewage Treatment Plant and Hangzhou Bay Sewage Treatment Plant are located in the industrial area, far away from the city center, and there are no concentrated residential areas around, so the odor has less impact on the surrounding areas.

D. The impact of noise on the environment

The noise of the sewage treatment plant comes from the noise generated by the machinery in the field, the noise of the sludge (water) pump, and the noise of vehicles entering and leaving the plant. The noisy equipment in the sewage treatment plant, such as sewage pumps and sludge pumps, are installed indoors. After the sound insulation of the landscape wall, it has been attenuated a lot when it spreads to the surrounding environment. According to the relevant survey data, the noise value measured 30m away from the pump room has reached the standard value of the national "Environmental Noise Standard for Urban Areas". Therefore, the impact of its noise on the environment is not significant.

②Influence of sewage lifting pump station on surrounding environment and countermeasures

A. Solid waste from sewage lifting pumping station

The solid waste in the sewage pumping station is mainly grid slag. The grid slag is processed together with the municipal waste after being pressed and dehydrated. As long as it is cleared and transported in time, it will basically have no impact on the surrounding environment.

B. The impact of odors on the environment

The sewage pumping station is generally located in the central area of the city, and the odor is strong. Therefore, it is recommended that the sewage pumping station be equipped with corresponding deodorization facilities and devices. It is recommended to cover the grid wells in densely populated plots, and clear and transport them in time.

C. The impact of noise on the environment

The noise of the sewage pumping station mainly comes from the sewage pump, so it is recommended to use a low-noise submersible pump for the sewage pump, and the pump room adopts an underground type to reduce the impact on the surrounding environment as much as possible.[21-27]

6.6.2 Energy saving and emission reduction

1） Diversion and emission reduction: In the drainage system , diversion is the main way, followed by closure and confluence. Industrial enterprises should separate the turbidity, reduce the discharge of industrial wastewater, and divert domestic and residential sewage.

2） System optimization: focus on optimizing the urban sewage system, make use of terrain slope and gravity gravity flow of sewage pipes as much as possible, reduce sewage pumping stations, and reduce operating costs .

3） Process update: new and reconstructed sewage treatment process, use energy-saving biological treatment process as much as possible, and reduce the energy consumption of energy-consuming equipment such as aeration volume through multi-directional adjustment and control.

4） Equipment selection: The equipment is given priority to the well-developed high-efficiency and energy-saving equipment, and pay attention to the reasonable collocation of the equipment, so that the entire system is always in the high-efficiency section under different working conditions .

5） After the completion of the planning and construction in the near future, the efficiency of sewage collection and transportation will be further improved, the sewage treatment capacity will be further enhanced, and the standard of tail water will be further improved, which can greatly reduce the amount of sewage and pollutants entering the Cao'e River and Qiantang River, thereby To achieve the purpose of energy saving and emission reduction.

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Chapter7

CONCLUSION AND PROSPECT

CHAPTER EIGHT: CONCLUSION AND PROSPECT

7.1 Conclusion

Zhejiang province is economically developed, with the increasing urbanization of Zhejiang province, the demand for various types of water resources is increasing, resulting in an oversupply of water resources. In particular,Zhejiang province vigorously develops industry, which brings more waste water while increasing water consumption, increasing the risk of water environment pollution. The rapid development of industrialization in Zhejiang province and the change in the lifestyle of rural residents, coupled with the larger total size of the rural population and more dispersed living, have caused serious damage to the local rural ecological environment. The garbage generated by villagers in their daily lives, pollutants brought by agricultural production and industrial waste from township enterprises have caused varying degrees of damage to the water environment in rural areas. Moreover, the treatment of domestic and industrial sewage rural wastewater seems more complicated compared to urban sewage treatment, so the pollution of the water environment is more serious. And in rural areas, constrained by the dual economic structure of urban and rural areas and centralized development policies, the lack of water infrastructure and the great development of rural enterprises, bringing such as water shortages, unsafe drinking water, water pollution and arbitrary disposal of wastewater and a series of problems, the rural water environment is under enormous pressure. Based on this, this paper takes the rural areas in Zhejiang province as the research object, analyzes the rural water resources and their utilization characteristics, studies the water resources system problems, and forms the "sustainable development" based on the rural water environment pollution control and water resources planning method proposal.The structures are explored as follows:

In Chapter 1， RESEARCH BACKGROUND AND PURPOSE OF THE STUDY. Firstly, the background and purpose of the study are outlined. The background to the issue of optimising water resources systems is presented from a number of perspectives, and the significance of the research is pointed out. A comprehensive overview of the global water resources crisis and the water resources situation in China is presented, together with an analysis of the current situation and models of rural wastewater management of international. It also provides an overview of the history and progress of domestic and international research. Finally, the content and framework of the study are presented.

In Chapter 2， THEORIES AND METHODOLOGY OF WASTEWATER RECYCLING AND PLANNING . Briefly introduces the theory of sustainable development, the theory of wastewater resourceisation and the theory of water resources planning. Based on an analysis of the characteristics of water resources in Zhejiang, the current water problems and their harmful effects on socio-economic development are identified and corresponding countermeasures are proposed. On the basis of the integration of disciplinary results, the theory of "sustainable development" is applied to the study of the countermeasures of wastewater resourceisation and water resources planning, deepening and improving the existing water resources planning theory, and forming a water resources planning theory based on the concept of "sustainable development "theory.

In Chapter 3， ANALYSIS OF THE STATUS QUO AND COUNTERMEASURES OF WATER POLLUTION IN ZHEJIANG RURAL AREAS. Wastewater treatment is the basis of water resources recycling and a prerequisite for better implementation of wastewater resource utilization, which is related to the survival and development of human beings. Nowadays, the situation of water recycling in Zhejiang is not optimistic, water resources are wasted and polluted, and water conflicts are also very acute. First of all, the current situation of water pollution in Zhejiang and the current situation of rural sewage treatment systems are analysed. The existing policy measures and difficulties in the treatment of rural wastewater are pointed out, and measures are proposed to address the problems in the resourceisation of rural wastewater and the recycling of water resources .

In Chapter 4 , INVESTIGATION ON WATER POLLUTION DATA FOR WATER PROTECTION MEASURES—CASE STUDY ON SHANGYU. In this chapter, taking Shangyu in Zhejiang Province as an example, based on the investigation and analysis of water resources and water environment of point and surface pollution sources, carried out water function zoning, pollution capacity calculation, pollutant input estimation, proposed pollutant control and reduction amounts .On this basis, study the countermeasures for water environment protection in Shangyu , and take engineering and non-engineering measures to gradually restore the self-purification capacity of the rivers .

In Chapter 5, TECHNOLOGY RESEARCH OF WASTEWATER RECYCLING. Analyzed the requirements and uses of wastewater recycling and typical technology for wastewater recycling. Studied the use of membrane separation technology in the recycling of water resources and the conversion of salt in wastewater into resource.A combination zero liquid discharge of RO, ED and BMED for salt concentration and acid/base production, with optimal operating parameters, is proposed to process the cold-rolling wastewater.

In Chapter 6, STUDY OF WASTEWATER PLANNING —CASE STUDY ON SHANGYU . A case study of wastewater planning using Shangyu as an example. Firstly, on the basis of an overview of the social-economic and water resources profile of Shangyu, the results of wastewaterresourceization are analysed. This is followed by a survey of the current drainage situation and recommendations for the development and use of water resources in Shangyu .Formation of a flow chart for planning the main network of the sewage system in Shangyu .

In Chapter 7, CONCLUSION AND PROSPECT. This chapter summarises the management of pollution in the rural water environment and provides suggestions for the future implementation of water resources planning .

The effective prevention and control of rural water environment pollution will become one of the difficulties and challenges facing the sustainable development of rural areas. At present, whether it is the technical model or the business model, there are few mature models available abroad for China's rural wastewater treatment. Based on this, this paper, based on the theory of"sustainable development", starts from the concept and role of wastewater resource utilization, applies the theory of "sustainable development" to the study of countermeasures of wastewater resource utilization and water resources planning on the basis of the integration of disciplinary results, deepens and improves the existing Based on the integration of disciplinary achievements, we apply the theory of "sustainable development" to the study of countermeasures for wastewater resourceization and water resources planning, and deepen and improve the existing water resources planning theory, and form a water resources planning theory based on the concept of "sustainable development "theory.

7.2 Prospect

Taking the rural areas in Zhejiang province as the main research object, through the analysis of rural water resources and their utilization characteristics, the concept of "sustainable development" is extended downward to pay more attention to water resources system issues and rural special situations; while water resources planning is extended upward, with "sustainable development " "intelligent water" concept, while horizontally combined with the local characteristics of rural areas, the formation of "sustainable development" based on the rural water resources planning methods, to change the current situation of water resources system passive response to social and economic development. At the same time, we draw on some successful experiences of rural water pollution management in foreign countries, and combine them with the actual situation of rural areas in Zhejiang province to propose countermeasures and suggestions suitable for local rural water pollution management and water resources planning, so as to provide methodological guidance and experience for sustainable planning of rural water resources in Zhejiang province , which in turn can provide vivid research materials for rural water pollution management in the south of China, and provide a good basis for China.In turn, it can provide fresh research materials for the management of rural water pollution in southern China, and provide a systematic and complete reference basis for the management and planning practice of rural water environment in China.

As described above, this study analyzes the characteristics of rural water resources and their use, forms a methodology for rural water resources planning, and explores measures suitable for local rural water pollution management and planning based on the actual conditions in rural Zhejiang Province. A series of research results provide new insights into the field and contribute to promoting the sustainable development of rural water.