

# Research and Application of Water Resource Recycling Model

## ——Taking Jiaxing City as an Example

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**Abstract:** This paper introduces the water recycling mode and related problems in Jiaxing City, including natural water, as well as domestic sewage and industrial wastewater. This paper then points out that the reasons for the insufficiency of water resources in Jiaxing City include poor water quality and insufficient water reserves. Besides, it proposes the solution of building sponge city and using new water treatment technology.

**Keywords:** Jiaxing; Water Resources; Recycling; Application and Research

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## 1. The Background of Water Recycling in Jiaxing City

Jiaxing City is located in the northeastern part of Zhejiang Province, the Yangtze River Delta Hangzhou-Jiaxing-Huzhou Plain hinterland, east of Shanghai, north of Suzhou, south of Suzhou, Hangzhou, and Ningbo, Shaoxing across the river, in view of the geographical and climatic conditions of Jiaxing, the rainfall is relatively large, so for the recycling of rainwater is particularly important. At this stage, Jiaxing City adopts decentralized rainwater control and utilization system technology. The aims of this technology are to improve the excessive pollution of stormwater runoff in Jiaxing due to construction blocks, to reduce the risk of flooding and to increase the available water resources.

## 2 Problems of Water Recycling in Jiaxing City

### 2.1 Substandard Water Quality

There are many contributors to the poor water quality in Jiaxing, including industrial discharges, agricultural activities, urbanisation and domestic wastewater discharges, as well as factors in the flow of water bodies and water recycling.

(1) Industrial discharges: Jiaxing City has a well-developed economy with a large number of industrial enterprises and manufacturing industries, and the wastewater discharges from these enterprises may contain a variety of pollutants, including organic solvents, petroleum hydrocarbons, pesticides, chemicals, dyes and other organic compounds. It also contains a variety of heavy metals such as lead, mercury, cadmium, chromium, copper and zinc. Suspended particulate matter in wastewater, such as suspended solids, slurries and sediments. These substances can cause turbidity in water bodies, prevent light from passing through them and affect the health of aquatic organisms and watershed ecosystems. At the same time, changes in acidity and pH as well as an increase in overall water temperature due to the higher temperature water often contained in industrial wastewater can cause damage to the ecological balance of the water body.

(2) Agricultural activities: Agriculture is one of the main industries in Jiaxing City, and agriculture often uses pesticides and fertilisers, which contain chemical substances that may flow into water bodies through agricultural wastewater, causing toxic effects on aquatic organisms and polluting water sources. And nutrients and microorganisms from veterinary drugs and livestock manure enter water bodies. These substances can lead to eutrophication of water bodies, resulting in disruption of the water ecological balance. At the same time, soil erosion and agricultural runoff, as well as improper water irrigation and drainage systems can cause water pollution and water quality decline.

(3) Urbanisation and domestic sewage: In the process of urbanisation, population growth and economic development

increase the demand for water resources, and in order to meet the needs of urban residents for drinking, living and industrial water, a large amount of water resources are extracted, leading to the over-exploitation and depletion of water sources, which affects the quantity and quality of water bodies. The daily life activities of urban residents generate a large amount of sewage, including domestic drainage, sewage from commercial and industrial areas. These effluents contain a variety of harmful substances such as organic matter, heavy metals, nutrients and microorganisms. The harmful substances and nutrients therein will lead to eutrophication of water bodies, resulting in the pollution of water quality.

(4) Water flow and water circulation: Jiaxing City is located between rivers and lakes, and water flow conditions may affect water quality. Pollutants from upstream cannot be effectively treated or diluted, affecting the water quality of Jiaxing City. Jiaxing City is located at the southern end of Taihu Lake, and the pollution level in the upstream exceeds the self-purification level of the water body due to the excessive discharge of pollutants, which in turn deepens the impact on the water quality of the water source obtained by Jiaxing City.

## **2.2 Insufficient Water Resources Reserves**

Although Jiaxing City is in the Taihu Lake basin, water resources mainly come from Taihu Lake. But the amount of water in Taihu Lake is also affected by seasonality and climate change. And Jiaxing City is in the downstream of the Taihu Lake basin, water resources access is relatively small. Secondly, Jiaxing City has a subtropical monsoon climate with hot and humid summers and uneven precipitation. Precipitation is concentrated in summer and relatively less in other seasons, which leads to the uneven supply of water resources. At the same time, the population of Jiaxing City is growing rapidly, accompanied by rapid economic development. It is because of the population increase and economic development, which puts higher requirements on water resources demand, exacerbating the tension of insufficient water resources reserves.

And is in a tense state of water reserves, water waste, water use efficiency and other unreasonable phenomena are still widespread. At present, the annual water consumption of agricultural irrigation in Jiaxing City is about 1.05 billion tones, accounting for 55% of the city's total water consumption. Although compared with the previous irrigation water consumption is greatly reduced, but still in a huge amount. And China's agricultural irrigation water use coefficient is only 0.565, water use rate is low, is still in a need to improve the stage of upgrading. And Jiaxing city industrial water consumption is also large, about 430 million tones, accounting for 23% of the city's total water consumption. At the same time, due to the aging of water supply pipe network in Jiaxing City, over-limit service, some pipe materials are poor, lack of perfect management and other reasons, resulting in the leakage rate of urban water supply pipe network of 9.5%. At the same time, in order to meet the demand for water resources, China's water resources development rate has reached 20 per cent, which makes the water reserves even tighter.

## **3. The Solution to the Problem of Water Recycling in Jiaxing City**

In order to solve the shortage of water resources in Jiaxing City and achieve the purpose of full recycling of water resources, Jiaxing City has implemented the construction of sponge city and the use of new water treatment technology to achieve this purpose.

### **3.1 Construction of Sponge City**

Since 2018, Jiaxing City has been the first pilot city for the construction of sponge cities in the country, and after five years of operation, the effect has been remarkable. The sponge city takes the lowest degree of impact on the natural ecological environment as the guiding ideology, and improves the construction of the system through the six-word guideline of "seepage, stagnation, storage, purification, use and drainage", so as to realize a new model of sustainable development between human beings and nature. Low-impact development technology is mainly rainwater infiltration technology, rainwater collection and use of technology, rainwater storage technology and ecological barge technology four aspects.

Through the construction of sponge city, Jiaxing City has been listed as a model city by the National Water Resources Special Office, and has carried out low-impact development demonstration projects on a number of urban greenways, parks, districts, and roads, with a preliminary forecast of a catchment area of  $5.9 \times 10 \text{ km}^2$  after completion, and the concentrations of ammonia nitrogen, total phosphorus, and COD have dropped by 30% to 40%. As of 2020, the city's total annual runoff control rate of 75%, rainwater resource utilization rate of about 8%, sewage reuse rate of not less than 20%, black smelly black channel comprehensively eliminated and maintained, drinking water quality of water sources to meet the standard rate of not less than 50%.

## 3.2 Use of New Water Treatment Technology

### 3.2.1 Micro-Ecological Living Water Direct Purification Process (HDP)

The basic principle of the HDP process is the principle of biological contact oxidation, through special equipment and materials, in the polluted water body inside the construction of efficient microbial purification system, the use of microbial decomposition of organic matter to maintain the survival of life activities, and then deep biological purification of water. This biochemical system in the water body is equivalent to the immune system of the water body, which greatly improves the self-purification ability of the water body. This process plays a significant role in the treatment of black odor water and its ecological restoration.

### 3.2.2 Fenton Oxidation and Iron-Based Fenton System

Fenton oxidation is a commonly used and highly efficient oxidative treatment technology for the degradation and removal of wastewater and pollutants. The method uses hydrogen peroxide and iron ion catalysts to generate highly reactive hydroxyl radicals ( $\cdot\text{OH}$ ), which convert organic pollutants into more stable substances through oxidation reactions.

Since Jiaying's printing and dyeing wastewater discharge accounts for about 55% of the city's industrial wastewater, the traditional oxidation method can no longer meet the demand for treatment of wastewater with high color, high COD, high alkalinity, and high content of organic matter. The use of iron-based Fenton catalyst agent in the field of printing and dyeing wastewater treatment effect is remarkable. At the same time, Jiaying City also has a small portion of coking wastewater discharge, coking wastewater is difficult to treat due to the presence of inorganic compounds such as ammonia, cyanide, fluoride, and organic pollutants such as phenols, polycyclic aromatic hydrocarbons, quinoline, pyridine and other organic pollutants in high concentrations 148 Issue S1. However, the addition of iron-based Fenton system to treat coking wastewater can solve the problem of incomplete removal of difficult-to-degrade organic compounds in the traditional coking wastewater treatment process, and the removal effect is better. At the same time, the iron-based Fenton system can promote the rapid decomposition of phenol and other phenolic substances, improve the degradability of phenolic wastewater, and reduce the biological toxicity of phenol-containing wastewater.

Refuse leachate has high ammonia and nitrogen content, and may also contain heavy metal pollutants, which will cause serious pollution to the environment if discharged randomly. Class Fenton system can fully react with its contained difficult to degrade organic pollutants, to solve the problem of conventional biochemical treatment means process is difficult to solve, to ensure that the effluent water quality standards.

Jiaying City, the level of medical care in the upper echelon, but also discharges a large amount of medical wastewater, which contains antibiotic wastewater. Antibiotic wastewater has a large amount of water, complex composition, containing a large number of difficult to degrade organic substances, residual concentration and other characteristics, the traditional process is difficult to deal with. Compared with other technologies, Fenton oxidation is widely used in the treatment of antibiotics because of its low cost, wide range of treatment of difficult-to-degrade organic substances, and no secondary pollution.

## 4. Conclusion

Jiaying city water resources are not sufficient, and the water quality of water resources is poor, only to improve the water treatment technology, and can strengthen the recycling of water resources, in order to alleviate the difficulties of insufficient water resources in Jiaying city. This paper introduces the mode of water resource utilisation and problems in Jiaying City, and puts forward solutions, hoping to improve the real life.

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