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Current research trend on urban sewerage system in China

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Abstract. The research emphasis has always been on sewerage treatment technology in China, though urban drainage system has gained little attention. In the context of urban drainage system and the problem associated with rain, the focus is still mainly toward the simple "emissions". While the relationship between conservation and utilization of rainwater resources and urban ecology are popular, the relationship between rainwater discharge and non-point source pollution are often neglected. The reasonable choice of sewerage system is dependent on the collection and discharge of urban sewerage, the applicability and economic benefits, along with the ability to meet the water quality requirements and environmental protection. This paper analyzes and summarizes the development of urban drainage system in china, and introduces different drainage forms. The choice of drainage system should be based on the overall planning of the city, environmental protection requirements, the local natural conditions and water conditions, urban sewerage and water quality, the original drainage facilities, and local climatic conditions. It must be comprehensive to meet the environmental protection requirements, through technical and economic comparison.

1. Introduction

With the rapid economic development and urbanization in China, there is a significant increase in the number of high-rise buildings in cities. However, the construction of underground sewerage system is generally ignored. Due to historical reasons, lack of scientific research, and shortage of funds, many fast-growing cities have largely focused on relatively rapid construction of sewage treatment plants, while the construction of underground sewerage system that collects and channels the sewerage to the treatment plant is slow.[1] This would result in many years of inadequate collection of sewage or low concentration of sewage. While there is a serious shortage of funds, and water pollution problems in these cities, heavily invested sewage treatment plants would not be utilized fully to their design capacity. [2]

Several old combined sewerage system in these cities have problems such as aging, small sewerage capacity, and rainy season overflow pollution. Thus, many cities are gradually phasing out the old system and designing a complete separate system. Some cities effectively transform and completely convert these old combined sewerage systems into complete separate systems, while other cities retain, modify and utilize these systems to maximize the return on investment. In this context, this paper analyzes and summarizes the development of urban drainage system in China, and discusses various



types of drainage systems. Finally, the paper discusses an optimal sewage system for China.[3]

2. Urban sewerage system

The urban sewerage system, which is known as the urban conscience, is an engineering facility for the treatment, removal and discharge of municipal sewerage and rainwater. It is an integral part of urban public facilities. The purpose of the general urban drainage system is to timely discharge the rainwater, residential sewerage, industrial wastewater, and flood water from the city through the urban underground drainage system to protect urban residents and to ensure normal life in urban areas. The treatment and reuse of urban rainwater, sewerage, wastewater and flood can also save the water resources and protect the environment.[4]

2.1 Development of urban drainage system

2.1.1 First stage - "Creation". The initial stage of sewerage construction in China began in 1950s. The main goal of the construction of urban sewerage was to eliminate the hazards of rain waterlogging. After the founding of the New China, during three years of economic recovery, the government introduced the "work-for-relief" approach, where the residents involved in cleaning up the accumulation of waste and water through the patriotic health campaign. This generally solved the problem of drainage in some areas, and improved the environment of the city.

2.1.2 Second stage - "point source pollution treatment". Urban drainage facilities were constructed rapidly in the 1980s due to the acceleration of urbanization and increased awareness of urban water pollution. Government invested significant amount in laying sewerage pipes and constructing treatment plants to improve the sewerage collection and treatment rate. Furthermore, tail water emissions were strictly controlled in the industrial wastewater and sewerage treatment plant. It is also called "point source pollution" treatment.

"Provisions on technology to prevent water pollution" and other documents stipulate that a few large enterprises or enterprises away from the town can reuse or discharge their sewerage water after reaching the threshold values prescribed by the standards, while the others need to discharge their sewerage water into the urban sewerage pipe network. Enterprises only need to pre-treat the sewerage for heavy metals and toxic biodegradable substances, before discharging into the sewerage pipe network after meeting the city sewerage pipe discharge standards. The rest can directly discharge the sewerage into the city sewerage network, which is a centralized integrated sewage treatment plant, if they meet the city sewerage pipe discharge standards for industrial wastewater.[5]

2.1.3 Third stage - "Ecological concept of sponge city". Storm water and sewerage mixed water should to be treated and disposed before overflow to ensure that the water quality is within the control objectives after the overflow. Development of new regulation and treatment facilities such as detention pond, and sedimentation pond at appropriate locations in the existing secondary sewage treatment plants is a key supplementary measure to further reduce the pollution of urban water bodies. It can intercept the first "scouring" of pollutants during the storm at the wastewater treatment plant, reducing the number of mixed effluent discharges, and thereby improving the water quality, and balancing the amount of mixed sewerage entering the sewerage treatment plant. It can also undertake the initial treatment of rainwater. "Sponge City" is the integration of a series of specific rainwater management technology, and is the summary of vast practical experience. It covers concepts and technologies such as Low Impact Development (LID) in the United States, Sustainable Urban Sewerage Systems (SUDS) in France, and Water-sensitive Urban Design (WSUD) in Australia. [6]

3. Drainage form

Domestic sewerage, industrial wastewater and rainwater can be collected through one set of pipe

network system or two or more, or can be a separate pipe network system to exclude the different form of sewerage system, known as the drainage form.

3.1 Straight emission combined sewerage system

This system discharges the mixed sewerage directly into the nearby water body without any treatment. As the sewerage is directly discharged without treatment, the receiving water bodies are highly polluted.

3.2 Intercepting combined sewerage system

On the basis of the straight emission combined sewerage system, the intercepting pipe is buried, and the lower than the intercept multiples sewage is drained to intercepting pipe before drained into the water body by the overflow well. Collected sewerage is transported to the sewerage treatment plant.[7] The advantage of intercepting combined sewerage system is that the sewerage on sunny day can be collected through the intercepting well, and transported to the sewage treatment plant for the treatment of water pollutants. The drawbacks of the combined drainage system are as follows: (1) deposited sediment at the bottom of the pipe is washed away when the water velocity in the confluence pipe is higher; (2) mixed sewerage exceeding the capacity of the intercepting pipe can be discharged into the water bodies, resulting in their periodic pollution; (3) water quality during sunny and rainy days, and water volume in cutoff pipe significantly vary, resulting in changes in sewerage water quality, and water volume. It makes operation and management of sewerage treatment plant difficult.

3.3 Completely divided sewerage system

Completely divided sewerage system is divided into two separate pipe networks for sewerage and stormwater. The former collects and delivers domestic sewerage and industrial wastewater to the treatment plant, while the latter collects and discharges the stormwater and clean industrial wastewater into the nearest water bodies through a variety of drainage facilities. However, stormwater runoff, especially the first flush runoff, is highly polluted water.[8]

3.4 Intercepting divided sewerage system

In recent years, stormwater pollution, especially due to the initial rainwater runoff or first flush runoff, has attracted significant research attention. Therefore, it is necessary to strictly control the initial rainwater runoff. Intercepting divided sewerage system has both sewerage and rainwater pipe system, and it is different from the divided sewerage system, since it discharges the initial rainwater into the sewerage pipeline using special facilities, such as the rainwater interceptor wells. During light rain, stormwater and sewerage are drained together through the initial rainwater interceptor trunk into the sewage treatment plant. During heavy rain events, the stormwater is drained into the water body through the intercepting main pipe. The key feature of divided sewerage system is the initial rainwater intercepting well. It is necessary to ensure that the initial rainwater is drained into the interceptor, and the mid-rain directly into the water body, while the interception of the sewerage cannot spill into the water body. Because only the sewerage and the initial rainwater are accepted, the cut-off section of the interceptor is smaller than that of the intercepting combined sewerage system. The flow and water quality in the interceptor pipe are relatively stable, and the operation and management costs are also reduced in the sewerage treatment plant.

3.5 Choice of drainage system

The choice of drainage system should be based on the overall planning of the city, environmental protection requirements, local natural conditions and water conditions, urban sewerage and water quality, original drainage facilities, and local climatic conditions. It must be comprehensive to meet the environmental protection requirements through technical and economic comparison.

A city usually uses a mixed system of drainage, that is, both the divided sewerage system and the

combined system, which are associated with different periods of urban development. In the early period of urban construction, the surrounding water body is good, and the project is restricted by the construction fund. Hence, the combined sewerage system is adopted. After the development of the city, the merging system is gradually transformed into the divided sewerage system.

Drainage network planning and design are based on overall urban planning. Therefore, the basic data on drainage planning and design should be based on the regional planning and design of urban and industrial enterprises. Overall, the divided sewerage system is more flexible than the combined system, and its construction can meet the needs of social development. The divided sewerage system is easier to adjust if there is an increase in the pollution load or changes in environmental requirements. However, it is feasible to use a combined system, where there are large water bodies in the vicinity, small towns with restricted development, or areas where the rainfall is scarce.

4. Conclusions

This paper analyzes and summarizes the development of urban drainage system in china, and introduces different drainage forms. The choice of drainage system should be based on the overall planning of the city, environmental protection requirements, local natural conditions and water conditions, urban sewerage and water quality, original drainage facilities, and local climatic conditions. It must be comprehensive to meet the environmental protection requirements through technical and economic comparison.

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