

Central versus deployed drinking water treatment

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Abstract. Nowadays, the level of urbanization is in rapid increasing, but the freshwater resources still have the problems of unbalanced distribution of regions and time. Besides, the freshwater resources are still in short supply. However, in fact, there is always a hidden resource in the city - the wastewater. The rapid population growth and increasing urbanization have increased the needs for wastewater treatment and recycling to ensure water resources' adequacy, and then improve the environmental quality. In this day and age, there are two main ways to treat wastewater: centralized treatment and decentralized treatment. Both of these methods can reduce the pollution of wastewater to water resources and provide domestic water. In this article, we will introduce and compare the two approaches with real-world examples: The Shanghai Bailonggang Sewage Treatment Plant, located in Chaoyang Village, Heqing Town, Pudong New Area, and the decentralized sewage treatment system in Germany.

Keywords: Centralized & decentralized water treatment, waste water, water treatment, water system engineering

1. Introduction

Safe and clean fresh water resources are the prerequisite for maintaining normal human production and life and promoting public health. With the growth of population and the improvement of urbanization level, people's demand and quality of water resources are constantly improving. In this context, two main approaches have emerged in the field of water treatment: centralized treatment and distributed treatment systems. Both methods have their unique advantages, but at the same time, they also have unique limitations. The comparative aspects of centralized and distributed drinking water treatment systems are comprehensively discussed in this paper, revealing their respective advantages and limitations [1-5].

First, we will introduce the characteristics of centralized sewage treatment and its advantages and disadvantages. Centralized sewage treatment is widely used, so it is also the sewage treatment method in many cities. "Concentration", as the name suggests, is to gather the sewage in the city from all corners of the city, transport it to the sewage treatment plant, and then carry out unified sewage treatment, and then discharge it to the river, sea, and lake after reaching the discharge standard. The use of centralized

sewage treatment method has a premise, that is, to have a huge capacity, treatment speed of the facility, so we can know that its volume should be very huge. These facilities can remove bacteria, heavy metals, organic matter, etc. from sewage through some chemicals or microorganisms. It is not suitable for all cities because of the need to centrally transport sewage to sewage treatment plants. The city it is suitable for has two remarkable characteristics, that is, the population is very concentrated or the land resources are very limited. If the above two characteristics are not met, the cost of pipeline laying and transportation in the early stage will be very large. It can be seen that centralized treatment measures have the advantage of saving land resources. In addition, it has the advantages of large sewage treatment capacity and unified treatment standards. The large sewage treatment capacity can timely treat the sewage generated by more people. The unified treatment standards are conducive to government supervision and management, and prevent the sewage that does not meet the discharge standards from being discharged into the nature, causing irreparable losses. Nevertheless, everything has two sides. Centralized sewage treatment also has several inevitable disadvantages. As with many large facilities, the upfront investment and maintenance costs of treatment measures and transportation pipelines are very large, and the operating costs are also high. The centralized system requires the construction of a large-scale sewage collection network, and its investment cost accounts for 80% of the total cost. The average design life of the pipe network is 50 years. Both routine maintenance and replacement of centralized systems require significant investment.[6] Large sewage plants cover an area of dozens to hundreds of acres, such as Jingxi underground water purification plant covers an area of 27 acres, Guangzhou Shijing sewage plant covers an area of 328 acres, Guangzhou Lide sewage plant covers an area of 585 acres. Modern cities inch by inch gold, the central city is even more difficult to obtain inch gold, the large-scale occupation of these sewage treatment plants is a serious waste of precious land resources [7]. The cost of a centralized sewage treatment plant to treat ten tons of sewage per day is measured in tens of thousands. Moreover, dealing with a large amount of sewage in a limited space can imagine that a lot of noise and odor will be generated.

Compared with centralized sewage treatment, through the word “decentralized” it can be seen that decentralized sewage treatment does not set up huge sewage treatment facilities, but makes sewage treatment facilities smaller and dispersed to all corners of the city. Because it does not need to transport sewage over long distances, this sewage treatment method is more suitable for large areas and sparsely populated cities and villages. It can be seen that this method is more flexible and more adaptable than centralized sewage treatment. Decentralized sewage treatment also saves a large amount of construction costs and shortens the long construction cycle because it does not require the laying of pipelines. It takes three to six months to lay the 135 square meter area pipe and each meter of pipe costs 150 to 200 yuan. Compared with centralized sewage treatment, there is also a significant advantage, that is, basically no sludge generation, no need to regularly treat sludge, saving a lot of labor costs. For example, the MBR integrated sewage treatment equipment achieves almost zero sludge discharge through membrane plus biological reaction, and even there is no sludge outlet in the equipment [6]. And its operating costs are very low. The cost of this new type of distributed water distributor is small, and the investment of tons of water is only about 4,000 yuan, compared with the investment of sewage plants and pipe networks (about 10,000 yuan of tons of water), which can be described as a province [8]. In addition to the early construction costs, the later cost is much less than the centralized sewage treatment. Because it does not use facilities such as blowers and uses microorganisms, there is not a lot of noise and odor. However, it also has an obvious disadvantage: it is difficult to supervise. The dispersion of such wastewater treatment facilities poses challenges in terms of supervision, resulting in inadequate compliance with standards and subsequent discharge, thereby causing adverse impacts on the natural environment.

In this article, we will make a more detailed comparison between centralized sewage treatment and decentralized sewage treatment, and then make a more detailed analysis of the water quality, cost, and environmental impact of the two treated sewage. We will compare the two by giving an example and analyzing it. The aim is to provide organizations in the future, who are deliberating between various sewage treatment methods, with informative suggestions tailored to their specific circumstances, enabling them to make an optimal choice for themselves.

2. Centralized sewage treatment

The Shanghai Bailonggang Sewage Treatment Plant, located in Chaoyang Village, Heqing Town, Pudong New Area, can handle up to 2 million cubic meters per day. It is the largest sewage treatment plant in Asia and also one of the largest one in the world accounting for about one-third of Shanghai's municipal sewage treatment capacity. In Shanghai, the population density is large, and the land resources are limited, so it then adopted the centralized sewage treatment system. The treated wastewater is then discharged into local lakes, rivers or oceans after meeting the tested standards, which help to ensure that the treated water does not have negative impacts on the environment.

The Newtown Creek Wastewater Treatment Plant, located in Brooklyn, New York, USA, is the largest of 14 wastewater treatment facilities in New York. After several renovations and expansions, it can now treat up to 5.7 million litres of sewage per day. After a rigorous series of treatments, it releases the treated water into the Atlantic Ocean. Among others, it treats large amounts of sludge properly, producing fuels such as methane, saving operating costs, and reduce annual greenhouse gas emissions by 90,000 tons.

3. Decentralized centralized processing

Compared with centralized sewage treatment, some countries are more attracted by the unique characteristics of decentralized sewage treatment.

Germany's decentralized sewage treatment system can be a suitable example here. Germany, well-known for its great environmental awareness, advocates decentralized sewage treatment. Many German cities and villages use decentralized sewage treatment systems, which are characterized by smaller processing equipment, and these processing systems are usually installed within a single home or community.

Decentralized wastewater treatment systems offer several advantages, especially in areas with severe resource constraints. They allow for efficient wastewater management on a smaller scale, minimizing the need for extensive infrastructure and centralized treatment plants. In addition, the decentralized system can also be adapted to local needs and conditions, making it a flexible and adaptable solution.

4. Comparison between decentralized and centralized sewage treatment

The choice of centralized and decentralized wastewater treatment methods depends on a variety of factors, including population density, available resources, environmental objectives, and infrastructure requirements. Centralized treatment is particularly effective in densely populated urban areas where efficient management of large sewage volumes is necessary. It offers advantages such as economies of scale, centralized maintenance and monitoring. The Beijing Municipal Wastewater Treatment Plant and the New York City Wastewater Treatment plant serve as examples that highlight the effectiveness of centralized systems in reducing environmental impact and ensuring clean water supplies. On the other hand, decentralized processing systems found in Germany thrive in smaller communities or regions facing unique challenges. They offer benefits such as reduced infrastructure costs and suitability for local adaptation. Additionally, decentralized systems are environmentally friendly by minimizing energy consumption and distribution losses.

5. Conclusion and outlook

In short, centralized and decentralized sewage treatment methods are two effective ways to solve urban sewage. Although they have been adapted to some of these different urban characteristics, in today's increasing urbanization level, these two ways can still ease the pressure of urban water supply and sewage treatment.

Revised sentence: Although they operate differently, to some extent, they complement each other. These two methods can be locally selected based on the characteristics of the urban area and population, providing high-quality fresh water resources for the city in an economical, environmentally friendly, and efficient manner. Wastewater treatment and reuse not only maximizes resource utilization but also protects the environment. Despite their differences, both approaches aim to safeguard water resources,

enhance environmental quality, balance urbanization with sustainable development and ensure sufficient clean and safe water for future generations.

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