

Research on residual sludge disposal and resource utilization technology of urban sewage treatment plant

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Abstract: Urban sewage treatment plants play a pivotal role in the process of urban sewage treatment in China, but due to the implementation of the daily urban sewage treatment process will appear a large number of residual sludge, if not timely and properly disposed of, it will affect the surrounding natural environment, and even endanger human health. Therefore, taking effective measures, such as reasonable treatment of sludge, can efficiently convert waste into resources and achieve efficient use of resources. This paper aims to deeply explore the most commonly used sludge treatment technologies, and compare and analyze the advantages and disadvantages of various technologies, in order to provide useful suggestions and references for environmental protection and engineering applications.

1. Introduction

Sewage treatment is a key link in the recycling of water resources, and its treatment effect and pollutant discharge directly affect the quality of water bodies. The activated sludge method has unique technical advantages, which can effectively dispose of municipal sewage, thereby significantly improving the environment, ensuring water quality and promoting the development of natural resources. With the passage of time, China's sewage treatment capacity has been continuously improved. By the end of 2018, the national urban sewage treatment capacity had reached 201 million cubic meters per day [1]. The activated sludge method is currently one of the most widely used wastewater treatment technologies [2] because of its high flexibility, large treatment capacity and stable effluent quality. With the development of urban sewage treatment technology, the activated sludge method has formed the leading way of urban sewage disposal in China. However, with the expansion of the scale and quantity of sewage treatment plants, the content of residual sludge is also increasing, and how to properly treat these sludges has become a major challenge for the current urban development, which not only affects the economic development of small towns, but also affects the environmental quality of cities. This paper will explore several effective residual sludge disposal and resource utilization technologies in depth.

2. Characteristics of residual sludge from urban sewage treatment plants

The sources of urban sewage include domestic sewage, industrial wastewater, and some

rainwater. Due to the complex composition of urban sewage, the composition of sludge is also complex and mostly contains toxic substances, and the content of heavy metal ions depends on the discharge of industrial wastewater into sewage treatment plants.

3. Status quo of residual sludge treatment in urban sewage treatment plants

In recent years, due to the development of China's economy, environmental pollution has become increasingly prominent, although the domestic sewage treatment technology has been relatively perfect, but the treatment process of the remaining sludge of urban sewage treatment plants has not yet reached international standards. To this end, the "Sludge Harmless Treatment and Resource Utilization Measures" has been officially promulgated and implemented, which shows that the state is shifting from paying attention to sewage treatment to paying attention to sludge treatment, so sludge treatment and disposal has become an important task of urban sewage treatment plants.

4. Disposal technology for residual sludge

"Harmlessness", "reduction" and "recycling" are the goals of wastewater management, while the remaining sludge disposal technology is diversified, involving sanitary landfill, incineration disposal, aerobic composting, building materials and land use to meet different environmental needs.

4.1. Sanitary landfill

Since the 60s, sludge sanitation backfilling has been a single scientific research construction method, it takes environmental protection as the starting point, through scientific and reasonable selection and necessary on-site protection management, and the implementation of strict rules and regulations, so that sludge disposal technology has been greatly developed, sludge through a simple aseptic treatment process, can be dumped straight into the valley area, thereby creating artificial soil.

Advantages: 1. Low treatment cost, no need for excessive dehydration or natural drying, not only can treat sludge, but also save urban construction land, less investment, large capacity, and significant effect. 2. The toxic and harmful chemicals present in sewage will cause strong environmental pollution to groundwater and atmospheric environment if they cannot be disposed of as soon as possible. Therefore, when implementing sludge landfill, local geology, hydrology and soil conditions should be fully considered to ensure the effectiveness and safety of backfill. 3. In order to protect environmental hygiene, we should lay a high-density PE leak-proof layer in the backfill site, and configure leachate recovery equipment and air purification equipment. This prevents secondary hazards to water and the environment.

Disadvantages: High transportation costs are a factor hindering healthy wastewater recycling.

4.2. Incineration disposal

Incineration is an efficient disposal process that uses excess air and organic waste to be oxide dissolved in a waste incinerator, so that toxic and harmful chemicals are efficiently decomposed and degraded. This method can not only effectively reduce the amount of sludge, but also achieve efficient use of resources. Waste incineration is an efficient way to dispose of waste, which can convert harmful substances into harmless chemicals, and can minimize the generation of new exhaust gases, thus avoiding secondary pollution. In recent years, wastewater energy has been used efficiently thanks to suitable pretreatment processes and incineration technologies, thus meeting increasingly stringent environmental protection requirements. Incineration disposal is a very

efficient, fast and economical sludge treatment method, which is regarded as the most efficient sludge treatment technology.

Waste incineration is a method of treating sludge, which can be divided into two categories: direct combustion and dry combustion. Vertical combustion refers to the vertical placement of high-temperature sewage (with a moisture content of more than 85%) into the combustion furnace, and the heat of the supplementary fuel oil is used to treat the sludge. However, due to the high moisture content and low calorific value of the sludge, a certain amount of auxiliary fuel must be consumed. With the development of technology, the operating cost and equipment investment of vertical combustion sludge are gradually reduced, and dry combustion is a more cost-effective technical means, which can effectively reduce the water content of sludge, but also reduce the amount of exhaust gas, thereby reducing the difficulty of operation control. At present, incineration technology can be divided into three ways: separate combustion, collaborative treatment of hot spot plants and collaborative treatment of cement kilns.

Advantages: Reduce the generation of new pollutants to avoid secondary pollution

Disadvantages: The treatment in the early stage is more complicated and consumes more energy

4.3. Aerobic composting of sludge

Aerobic composting is a process that uses bacteria to ferment and rot to turn sewage into fertilization. In this process, organic matter is broken down into carbon dioxide, water and heat, which can be used in agriculture. In addition, high temperatures kill pathogenic bacteria and parasite eggs. However, the harmful substances that are difficult to degrade, such as heavy metals in the sludge during the composting process, have not been removed, and problems such as odorous gases will be generated in the compost, which will continue to damage the environment and cause secondary pollution.

Advantages: extremely high fermentation efficiency, extremely short stabilization time, very little odor, and complete sterilization; the moisture content can be reduced to less than 40%

Disadvantages: long composting time; it will also produce problems such as odorous gases, which will continue to damage the environment and cause secondary pollution

4.4. Building materials and land use

Sludge construction application is a method of using sludge as the main raw material, which can be used to make various new building materials, such as bricks, concrete, ceramic particles, activated carbon, molten lightweight composite materials and biochemical fiberglass board. By scientifically treating the remaining sludge and converting it into fertilization or soil improvement resources to meet the needs of farmland water conservancy, urban sanitation and soil remediation, it is an effective sludge disposal method with great development potential. In developed countries, land use has achieved remarkable results and is closely integrated with rural areas, but in China, the road to sludge land use is very difficult. Due to the long-term mixed treatment of industrial sewage and domestic sewage in the past, in order to prevent the pollution of organic heavy metals in wastewater, "organic fertilizer" is strictly prohibited by the Ministry of Agriculture to be discharged into cultivated land, and can be used as afforestation soil, landfill soil, roadbed soil, etc.

5. Recycling technology for residual sludge

The best disposal method of residual sludge is resource treatment, but China's residual sludge resource technology still has a certain gap compared with foreign countries, but there are also many good disposal technologies in China, such as dry distillation treatment sludge, cement kiln

collaborative treatment sludge, anaerobic digestion technology, etc.

5.1. Sludge is treated by dry distillation

The carbonization process can be divided into three categories: high-heat carbonization, medium-temperature carbonization, and low-pressure carbonization. At the same time, high-temperature carbonization is to dehydrate the sludge to reduce its moisture content to 30%, and then send it to a closed, oxygen-free, non-burning carbonization furnace for dry distillation treatment, this process includes vaporization, pyrolysis, dehydrogenation, heat condensation, carbonization and other chemical reactions. Through high-temperature heating, the water in the soil is volatilized, and the organic matter is converted into combustible gas and organic carbon, and finally biomass oil, biochar, non-condensable gas and water are formed, which can effectively use the principle of thermal decomposition to achieve the purpose of purifying the soil. [3]

By treating sludge by dry distillation, a variety of advantages can be obtained: (1) a wide range of application, sludge with a moisture content of $\leq 85\%$ can be disposed of; (2) The temperature control of the dry distillation pyrolysis chamber can reach more than $600\text{ }^{\circ}\text{C}$, which can effectively eliminate germs, insect eggs, etc. in the sludge, and thus facilitate the sustainable use of land; (3) It can control the discharge of harmful heavy metals in sludge, especially metal materials such as Hg and Ti, and can passivate harmful heavy metals in ash and carbon, thereby greatly reducing the hazard to the surrounding environment; (4) The final product is biochar, which can effectively improve the performance of sludge, further improve the disposal efficiency of the remaining sludge, greatly reduce the discharge of waste, and then achieve environmentally friendly sludge treatment results. Biochar has good chemical stability, can be stored for a long time, can be applied in rural and garden and other fields, its recycling economic benefits are also very high, combustible gas or tar can be reused, promoting the recycling of these resources; (5) The final treatment of biochar can complete the collection and replacement of local carbon, greatly reduce the emission of carbon dioxide, and help solve the problem of global warming.

5.2. Cement kiln synergistic treatment of sludge

Through the cement kiln collaborative treatment process technology, the sewage can be sent from the kiln tail smoke room into the kiln tail high temperature chamber, in the high heat environment, the organic waste gas is fully incinerated, and quickly dissolved, and the organic heavy metal molecules are solidified into the concrete clinker lattice, so as to achieve the purpose of purifying the environment. [4]

The cement kiln synergistic sewage treatment process has significant advantages, such as non-toxicity, comprehensive natural resources and economic benefits. The cement kiln has a high heat capacity, stable temperature, effective removal of harmful gases, large-scale treatment of sludge, and finally conversion to cement clinker production, without leaving any waste. The advantages of cement kiln collaborative treatment sludge process are that it has less investment, short construction period, does not occupy land funds, and can effectively use one-time funds, so it has received more attention and attention.

Advantages: high sludge combustion rate, no incineration residue, acid gas absorption, cement solidification of heavy metals, large sludge treatment capacity

Disadvantages: less engineering investment, technology trapped by high sludge moisture content, low project profit margin

5.3. Anaerobic digestion technology

Anaerobic digestion is an effective sludge treatment method that uses anaerobic microorganisms to act in an oxygen-deficient environment to dissolve the organic matter in the sludge into stable products such as methane and carbon dioxide, thereby producing clean energy and being able to be used for land use. Compared with aerobic fermentation, anaerobic digestion technology has the advantages of simple facilities and low operating costs, which can effectively save energy, environmental protection and enhance sludge treatment functions. However, due to the complex operation process of anaerobic digestion treatment technology and high requirements for professionals, the development prospects of this technology are restricted.

6. Conclusion

The goal of treating residual sludge should be to achieve recycling, reduce the discharge of waste, and eliminate hazardous waste, and reduce environmental secondary damage. However, current technology has certain limitations, and the utilization of resources in sewage is low. Therefore, future research should focus on the development of sludge resources to achieve environmental and economic benefits. China's sludge production is large, inorganic content is high, and China's sludge disposal level is only volume reduction, obviously the traditional sludge disposal method has not met the current stage of development requirements, how to use new technical means and processes to achieve sludge resource treatment has been urgent.

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