Study on the current situation of municipal sewage sludge disposal and disposal process

Jingbo Jiang *
Tianjin University of Technology, Tianjin, China
*Corresponding author e-mail: 740698990@qq.com

Abstract. In the process of urbanization, each city should actively respond to the call of the country and regard sustainable development as the core of development. Based on this, cities should pay attention to urban environment and ecological benefits. In cities, urban sewage plants should pay more attention to sludge treatment and disposal. Through strict sludge treatment, the impact of heavy metals and pathogens in the sludge on the urban environment will be reduced. Based on the continuous updating of sludge treatment technology and processing equipment in China, urban sewage plants must strengthen the rational disposal of sludge. In order to improve the efficiency of sludge disposal and avoid pollution to the environment, it is particularly important to do a good job in sludge treatment status and technology research. Briefly analyse the source and nature of sludge in urban sewage treatment and the status of sludge treatment and disposal, and focus on the relevant sludge treatment technology to provide reference for better application of sludge treatment technology.

1. Source and characteristics of sludge in urban sewage treatment

1.1. Source of sludge in municipal sludge treatment
In urban sewage treatment, more sludge is often produced, including grid slag, scum, sedimentation tank sediment, dust removal sludge, and secondary sedimentation sludge. The source is more complicated, and the grid source grid or filter screen is garbage-like. The amount is small, and the handling and disposal are difficult. The scum source air floatation tank and the floating slag will contain a certain amount of oil and fat, and the amount is small; the primary sedimentation sludge mainly comes from the primary sedimentation tank, contains more inorganic substances, and has a large amount, and contains diseased bacteria and eggs. It is easy to decay and smell bad. The secondary sedimentation tank of the second sedimentation tank contains more water and organic matter, which is not only difficult to dehydrate, but also easy to rot and smell. Among them, primary sludge and secondary sludge are the main targets of sludge treatment.[1]

1.2. Characteristics of sludge properties in urban sewage treatment
There are many performance indexes of sludge, including water content and solid content, volatile solid content, and sludge dewatering performance. The water content indicates the percentage of water in the sludge, and the solid content is the percentage of dry sludge or solids in the sludge. Volatile solid refers to the part of the solid that is burned in a 600 °C furnace and escapes by gas, which is the main indicator
to measure the stability of the sludge. Sludge dewatering performance is often measured by capillary water absorption time or specific impedance value.[2] The capillary water absorption time refers to the time when the sludge and the filter paper are in contact with each other, and the water permeates the filter paper for 1 cm in length under the action of capillary, and is calculated in seconds. The specific impedance indicates the resistance of the unit dry weight to the cake. The larger the specific impedance value of the sludge, the more difficult the filtration and the worse the dewatering effect.

In the sludge treatment, in addition to the detailed study of the above properties of the sludge, the sludge volume should be roughly grasped to determine a reasonable amount of sludge treatment equipment. When calculating the sludge treatment capacity of the sewage plant, generally refer to the empirical data of Table 1.

Table 1. Empirical data on the determination of sludge levels in sewage treatment plants

| Sludge type                        | Amount of sludge/(L·m⁻³) | Density/(kg·L⁻¹) | Moisture content/% |
|------------------------------------|--------------------------|------------------|-------------------|
| Grit sand in the grit chamber      | 0.04                     | 1.6              | 59                |
| Primary sedimentation tank sludge  | 13-24                    | 1.018-1.02       | 95.1-97.4         |
| Biofilm method                     | 7-9                      | 1.03             | 95-97             |
| Activated sludge process           | 11-19                    | 1.004-1.009      | 99.1-99.5         |

2. Status of sludge treatment and disposal in urban sewage treatment plants

2.1. Problems in sludge treatment and disposal of urban sewage treatment plants

At present, landfill, composting, natural drying, and incineration are the main methods of sludge treatment in China, with landfill accounting for 65% and composting accounting for 15%, and natural drying and incineration accounting for 6% and 3% respectively. In the practice of treatment, there are often some unfavorable problems. On the one hand, China's sludge treatment technology is still in its infancy, the lack of relevant equipment, the technology is not mature enough, and the sludge treatment and disposal are not qualified.[3]

On the other hand, China's standards for sludge treatment are relatively late, and there are many problems in implementation, which need to be continuously explored and improved. At the same time, China lacks systematic planning for urban sludge treatment and disposal. The lack of sludge treatment and disposal in urban planning affects the effect of sludge treatment and disposal to some extent. In addition, the sludge treatment and disposal supervision mechanism is not perfect, resulting in some sewage treatment plants to reduce the cost, the sludge piled up and litter, causing different degrees of pollution to the environment.

2.2. Government support for sludge treatment and disposal of municipal sewage treatment plants

In recent years, the amount of sludge produced in China has increased year by year, and the situation is grim. For this reason, the country has issued a series of policies and plans to promote the healthy development of China's sludge treatment market. For example, in 2016, the State Council issued the “13th Five-Year Plan for Ecological Environmental Protection”, which clearly stated that vigorously promoted sludge stabilization, harmlessness, and resource treatment and disposal, requiring sludge decontamination treatment in the Beijing-Tianjin-Hebei region to reach 95%. The disposal rate of sludge in the city level and above is 90%. With the strong support of the state, the number of sewage treatment plants in China has continuously increased. In 2018, the number of sewage treatment plants nationwide has exceeded 2,000. During the “Thirteenth Five-Year Plan” period, the central government invested 200 billion yuan to support the sludge treatment of sewage treatment plants. Although the task is arduous and the situation is grim, with the high attention and support of the central government, along with the continuous improvement of the technical level, it is believed that in the near future, the sludge treatment work of China's sewage plants will surely reach a new level.[4]
3. Municipal sewage treatment sludge treatment technology

3.1. Sludge concentration technology
There is moisture in the sludge. When the sludge is disposed, the essence of the sludge concentration technology is to reduce the water in the sludge and control the sludge volume. By reducing the volume of the sludge, the equipment work can be reduced, which will make the equipment more efficient. When the sludge is concentrated, different concentration treatment methods can be adopted, including gravity concentration, mechanical concentration and air flotation. Due to the difference in different treatment processes, the sludge treatment effect is also different. The treatment effects of different sludge concentration and dewatering technologies are shown in Table 2.

| Process name                      | Sludge treatment efficiency | Secondary pollution | Remarks |
|-----------------------------------|-----------------------------|---------------------|---------|
| Gravity concentration tank        | Lower                       | Have                | -       |
| Centrifugal concentration tank    | Higher                      | Have                | -       |
| Pressure filtration process       | Lower                       | Have                | -       |
| Centrifugal separation process    | Higher                      | less                | -       |
| Concentrated dehydration machine | Higher                      | less                | -       |

In combination with sludge treatment requirements, relevant personnel should choose scientific concentrated dewatering technology to ensure the reliable operation of the sewage treatment plant while improving the sludge drying treatment effect of the sewage treatment plant.

3.2. Sludge anaerobic digestion technology
The application of sludge anaerobic digestion technology can transform the organic matter in the sludge, and the microorganism can convert the organic matter into biogas, thereby realizing the mineralization treatment of the sludge organic matter. In the implementation of sludge anaerobic digestion technology, the treatment procedures should be followed, mainly in three stages, namely the intermediate temperature, high temperature anaerobic digestion stage and the two-phase anaerobic digestion stage. In the specific treatment, the sludge anaerobic digestion technology should be selected according to the scale of the sewage treatment plant to improve the technical adaptability. In addition, combined with the daily treatment of sludge volume and sludge dosing rate to design the effective volume of the digester, the calculation formula is:

\[ V = \frac{V'}{p} \times 100 \]  

Where: \( V' \) represents the amount of sludge that needs to be treated every day, \( m^3/d \); \( p \) represents the sludge dosing rate, %. In addition, due to anaerobic digestion, more biogas will be produced. Therefore, when designing the digester, attention should be paid to designing related facilities for biogas collection and storage.

3.3. Pyrolysis (carbonization) technology
When the sludge is treated, an anaerobic or anoxic environment can be created and the sludge is heated. This method is a pyrolysis (carbonization) technique of the sludge. In a hot environment, the stability of organic matter is affected, and thermal cracking occurs, further producing corresponding substances, including charcoal, pyrolysis oil, and fuel gas. Heat some of the substances generated by the cracking include pyrolysis oil and fuel gas can be reused, and the generated cracked carbon can be used to treat the exhaust gas. Pyrolysis of the sludge, the oxygen-free or anoxic environment will block the formation of harmful gases, and at the same time reduce the effectiveness of heavy metals, thus avoiding the more serious environmental risks when reusing resources. The pyrolysis carbon itself can also adsorb the
corresponding substances, so the pyrolysis (carbonization) technology can help achieve high efficiency sewage and waste gas treatment, and demonstrates greater market value.

3.4. Lime dosing technology
After dewatering the sludge, lime and sulfamic acid should be added to the sludge, but the lime dosage and the dosage of sulfamic acid should be controlled, and the lime should be placed according to 10%-15% of the wet mud amount. And sulfamic acid was applied at 1% of the lime dosage. When using lime dosing technology, it can create a strong alkaline environment and thus can be more thoroughly sterilized. At the same time, most of the metal ions can be precipitated to control their solubility and activity. The lime dosing technology can also remove the odor from the sludge and achieve control of environmental pollution. The technology can be automated during implementation, making it easier to operate. Further, by adding a small amount of sulfamic acid, ammonia gas can be generated by the reaction, and sterilization can be performed more efficiently.[5]

3.5. Sludge incineration technology
When more sludge is present, the sludge can be incinerated. The analysis of the substances in the municipal sludge shows that it mainly includes organic matter and fiber lignin. If it is dehydrated and dried and incinerated, the carbonization of the organic matter can be achieved, and the pathogens in the sludge can be completely killed to form a stable ash, thereby further reducing sludge volume. When incinerating sludge, it is necessary to use reasonable incineration equipment.

4. Disposal process of municipal sewage sludge

4.1. Farmland forest application
The sludge discharged from the municipal sewage treatment plant is rich in organic nutrients and trace elements. It can improve the soil quality by applying it to the soil through reasonable extraction and utilization of sludge components, including nitrogen, phosphorus and potassium. Sludge can be used as a fertilizer to nourish the soil. Compared with ordinary farmyard manure, sludge can improve soil fertility more effectively, and it can promote its growth for crops in the soil. When applying sludge to farmland forest land, the corresponding process should be followed: the sludge should be treated first, including composting, etc. Through this step, sludge can be sterilized and deodorized, and qualified sewage can be treated. Mud can be used as a fertilization operation for urban gardens and forestry land. According to engineering practice, applying the treated sludge to the application of farmland forest land can increase the yield of farmland forest land and improve the quality of vegetables to some extent.[6]

4.2. Production of building materials
Sludge itself can be seen as a potential resource that can be applied to the production of building materials and used as a raw material to reduce resource consumption. By applying sludge to the production of building materials, it is in line with the resource management concept of sludge. When the sludge is applied to the production of building materials, the sludge ash can be mixed with the asphalt, and the performance difference between the two is small compared with the conventional materials. After the sludge is dried, it can be put into the brick making process, and by fine-tuning its composition, it can replace the clay to complete the brick making. The sludge can be used in the building materials, and the organic matter in the sludge can be treated and converted into sludge resin. By co-pressing it with the waste material, it can be made to meet the national third-class hard fiber board. Standard new sheet.

4.3. Soil remediation
In many cities in China, there is a certain phenomenon of ecological destruction. For areas with ecological damage, there is a problem of soil infertility. Therefore, it is necessary to repair the soil, based on the colloidal morphological characteristics of the sludge, and has good water absorption properties
and viscosity, so that it can be better adhered to the surface, and the corresponding nutrient elements in the sludge can realize the soil. The purpose of the improvement is to help the ecological restoration of balance and achieve an effective improvement of soil fertility.

5. Conclusion
With the continuous development of the national industrial production industry, the amount of sludge generated in urban sewage treatment plants is increasing, and the increasingly serious environmental pollution has made the sludge treatment workers pay more attention to the effective treatment of sludge. When treating sludge in a sewage treatment plant, it is necessary to adopt reasonable treatment technology and scientific disposal technology. The government should strengthen policy support, the society must achieve co-governance, and the sewage treatment plant must strengthen quality measures and follow the process of production. The principle of environmental protection, truly taking into account ecological and economic benefits, and ensuring that the sludge treatment and disposal methods adopted meet the requirements of industry development and urban development.

The sludge treatment involves many links. The sewage treatment plant should clarify the key points and difficulties of each treatment link. By updating the equipment, optimizing the treatment process, continuously improving the sludge treatment level, and making due contributions to the sludge treatment work in China.

References
[1] Fuling Yang. Investigation and Post-evaluation of Sludge Treatment and Disposal in Xi'an Wastewater Treatment Plant[D]. Xi'an University of Architecture and Technology, 2015.
[2] Tingting Zhang, Xia Liu, Qunqi He. Study on Urban Sewage Sludge Disposal Technology and Resource Utilization Progress [J]. Light Industry Technology, 2019 (06).
[3] Xin Zhang. Analysis of the Influence of NaCl Salinity on Activated Sludge Treatment System[J].Science and Technology Innovation and Application, 2019 (16)
[4] Linli Yu. Research on the importance of urban sewage treatment in environmental protection projects [J]. Green technology,2019(12):75-76.
[5] Yaliang Zhou, Dongyue Huang. Energy consumption analysis and energy saving measures for urban sewage treatment plants [J].Environment and Development, 2019 (05): 30+34.
[6] Mingren Liu, Tao Sun, Zekun Li, Yegang Xu. The importance of urban sewage treatment in environmental protection projects Essential analysis [J].Comprehensive utilization of resources in China, 2019, 37 (04): 38-40.