

# Research on the Value of Sludge Resource Utilization in A Sewage Treatment Plant in A Certain City in Southwest China

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**Abstract:** With the acceleration of urbanization and the improvement of living standards, environmental issues are receiving increasing attention. In recent years, the National Development and Reform Commission and other three departments have issued the "Implementation Plan for Harmless Treatment and Resource Utilization of Sludge", proposing to implement harmless treatment of sludge and promote resource utilization, which is an important measure to build a beautiful China. In order to prevent water pollution and improve environmental quality, the sewage treatment capacity in the Southwest region has rapidly increased, and the sludge production has also sharply increased. The sludge contains various organic pollutants and nutrients, and the resource utilization of sludge has attracted people's attention. Analyzing the properties and nutrients of sludge is a prerequisite for scientific and reasonable sludge resource utilization. Therefore, this article takes sewage treatment plant sludge as the research object, conducts in-depth research on sludge properties and nutrients, and conducts in-depth research on the resource utilization value of sludge.

**Keywords:** Sewage treatment plant; Sludge properties; Sludge nutrients; Resource utilization.

## 1. Introduction

In recent years, China's urban sewage treatment has achieved significant results, with the urban sewage treatment rate increasing from 78.47% to 93.55%, basically achieving comprehensive collection of urban domestic sewage<sup>[1-3]</sup>. With the increase in sewage treatment capacity, the annual sludge production has also increased to 39.23 million tons (80% moisture content) of sludge<sup>[4-6]</sup>, with a huge amount of sludge. Its ultimate destination has become a hot topic of concern<sup>[7-9]</sup>. In recent years, the country has proposed in the "14th Five Year Plan for Urban Sewage Treatment and Resource Utilization Development" that using organic rich urban sludge for agriculture is an effective way of resource utilization. However, the composition of sludge in urban sewage plants is complex, and the sludge contains various organic pollutants and nutrients<sup>[10]</sup>. The resource utilization of sludge has attracted people's attention, and analyzing the properties and nutrients of sludge is a prerequisite for scientific and reasonable sludge resource utilization<sup>[11-13]</sup>.

## 2. Organization of the Text

### 2.1. Pre treatment of sludge samples

From January 2022 to October 2022, dewatered sludge from typical sewage treatment plants in the southwest region was collected quarterly, with a total of four samples collected<sup>[14-15]</sup>. After removing foreign objects such as stones and animal and plant residues from the sludge sample, grind it with a grinder, sieve it with 100 mesh copper, mix well, seal it and place it in a dryer for later use. Take a portion of fresh samples for sludge testing.<sup>[16-18]</sup>

### 2.2. Measurement method

The moisture content and organic matter are measured by

weight method (CJ/T 221-2005); The pH is measured using the glass electrode method (CJ/T 221-2005); The total nitrogen was determined by alkaline potassium persulfate digestion and UV spectrophotometry; Total phosphorus was measured by molybdenum antimony anti spectrophotometry after melting with sodium hydroxide; Total potassium is determined by flame atomic absorption spectrophotometry after atmospheric pressure digestion<sup>[19-20]</sup>

## 3. Results and Discussion

### 3.1. PH and moisture content of sludge

By conducting research on 20 sewage treatment plants in a certain city in the southwest region (denoted as 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20), the pH and moisture content of sludge are shown in Tables 1 and 2.

It can be seen that the annual average pH range of sludge from 20 sewage treatment plants in the city is between 6.55 and 7.23, with a total annual average of 6.94, which is basically neutral. Meets the standards for sludge quality in urban sewage treatment plants, control standards for agricultural sludge pollutants, and requirements for sludge disposal in urban sewage treatment plants (landscaping, land improvement, mixed landfill), and will not have a significant impact on soil acidity and alkalinity. It is generally believed that sludge fermentation takes place within the pH range of 6-9, and the optimal pH value is around 8. Li Yanxia et al. <sup>[21-22]</sup> studied the pH of sludge from domestic sewage treatment plants, and found that the pH values were all between 6 and 9. Therefore, the sludge from 20 sewage treatment plants in the city does not require pH adjustment to ferment.

According to the characteristics of seasonal changes, the samples collected and tested in January 2022 are classified as spring, the samples collected and tested in April 2022 are classified as summer, the samples collected and tested in July

2022 are classified as autumn, and the samples collected and tested in October 2022 are classified as winter. The pH range in spring is between 6.43 and 7.92, with an average of 6.98 in spring. The winter pH range is between 6.51 and 7.24, with an average winter value of 6.90. The pH range in summer is between 6.36 and 7.32, with an average of 6.91 in summer. The pH range in autumn is between 6.69 and 7.72, with an average of 7.05 in autumn.

At present, the annual average moisture content of sludge after dewatering treatment from 20 sewage treatment plants ranges from 75.7% to 85.8%, with a total annual average of 81.4%. There is not much difference in sludge moisture content among the sewage treatment plants. The annual average moisture content of sludge from 20 sewage treatment plants exceeds the four standard values for land use of sludge from urban sewage treatment plants, which does not meet the control standards for agricultural sludge pollutants and the requirements for sludge disposal in urban sewage treatment plants (for landscaping, mixed landfill, and land improvement). Further analysis of the changes in sludge moisture content in different seasons reveals that the spring moisture content of sludge from 20 sewage treatment plants ranges from 76.9% to 87.2%; The moisture content in summer ranges from 73.5% to 86.1%; The moisture content in autumn ranges from 74.1% to 85.9%; The moisture content in winter ranges from 71.3% to 88.5%. The moisture content in spring and winter ranges from 71.3% to 88.5%, and the quarterly average moisture content in spring and winter is higher than that in summer and autumn.

### 3.2. Nutrient content of sludge

Urban sludge contains a large amount of nutrients required by plants, such as organic matter, nitrogen, phosphorus, potassium, etc. The nutrients in sludge can be slowly released and have long-term effects. It is a good organic fertilizer resource and can partially replace chemical fertilizers. It can be seen that the annual average of organic matter in the sludge of 20 sewage treatment plants in the city is between 41.2% and 69.2%, with a total annual average of 53.8%, which meets the requirements of agricultural sludge pollutant control standards and urban sewage treatment plant sludge land use (for landscaping, mixed landfill, and land improvement).<sup>[23]</sup>

Sludge is a soil amendment, which not only contains rich organic matter, but also contains nutrients needed by plants such as phosphorus, nitrogen, potassium, etc. The annual average value of total nitrogen in the city's sewage treatment plants ranges from 2.55% to 5.19%, with an annual total average value of 3.77%. The highest total nitrogen content is found in 10 sewage treatment plants, and the lowest is found in 2 sewage treatment plants. The annual average of total phosphorus (calculated as  $P_2O_5$ ) (see Table 7) ranges from 3.35 to 7.12%, with an annual total average of 4.84%, all of which are higher than the total phosphorus content in Chinese urban sludge, American urban sludge, Chinese pig manure, and Chinese pig manure. The annual average value of total potassium in sludge (calculated as  $K_2O$ ) (see Table 8) ranges from 0.74 to 1.42%, with a total annual average of 1.11%. The highest content is found in 7 sewage treatment plants, and the lowest content is found in 6 sewage treatment plants.

From Figure 1, it can be seen that the annual average value of total nutrients in 20 sewage treatment plants ranges from 7.69% to 12.4%, with 19 sewage treatment plants having the highest content and 7 sewage treatment plants having the lowest content, all of which meet the control standards for

agricultural sludge pollutants and the requirements for sludge disposal in urban sewage treatment plants (for landscaping, mixed landfill, and land improvement).

### 3.3. Nutrient content of sludge

It can be seen that the annual average content of organic matter, total nitrogen, total phosphorus, and total potassium in the sludge of Chongqing sewage treatment plant is 53.8%, 3.77%, 4.84%, and 1.11%, respectively. Compared with Table 7, the organic matter content of sludge in this city is higher than that of Chinese urban sludge, American urban sludge, Chinese pig manure, and Chinese pig manure. The total nitrogen and phosphorus content is much higher than that of Chinese urban sludge, American urban sludge, Chinese pig manure, and Chinese pig manure. The total nitrogen content is four times that of Chinese pig manure, the total phosphorus content is ten times that of Chinese pig manure, and six times that of urban sludge in the United States. The total potassium content is higher than that of Chinese urban sludge, American urban sludge, and Chinese pig manure, slightly lower than that of Chinese pig manure. The annual average value of total nutrients is 9.72% (TN+TP+TK), which is in line with the national standards for sludge disposal in urban sewage treatment plants, including land improvement, mixed landfill, landscaping, and agricultural sludge pollution control. The organic matter content of urban sludge in Chongqing meets the disposal standards for land improvement and landscaping of urban sewage treatment plant sludge. Therefore, compared with traditional Chinese pig manure and Chinese pig manure, the sludge from 20 sewage treatment plants in the city contains a large amount of organic matter and total nitrogen, phosphorus, potassium, etc., which has good value in agriculture, landscaping, and organic fertilizer use.

## 4. Conclusion

The annual average pH range of sludge from 20 sewage treatment plants in a certain city in southwest China is between 6.55 and 7.23, with a total annual average of 6.94, which is basically neutral. The pH does not change much with the seasons, and the pH of sludge from each sewage treatment plant is relatively stable, which can be directly used for resource utilization.

The annual average range of moisture content is between 75.7% and 85.8%, with a total annual average of 81.4%. The moisture content in spring ranges from 76.9% to 87.2%, with an average of 82.9%; The moisture content in summer ranges from 73.5% to 86.1%, with an average of 80.4%; The moisture content in autumn ranges from 74.1% to 85.9%, with an average of 80.4%; The moisture content in winter ranges from 71.3% to 88.5%, with an average of 81.2%. In summary, the moisture content of the sludge from the 20 sewage treatment plants in the city has been high for four quarters and cannot be directly utilized as a resource.

The annual average of organic matter ranges from 41.2% to 69.2%, with a total annual average of 53.8%; The annual average value of total nitrogen ranges from 2.55% to 5.19%, with an annual total average value of 3.77%; The annual average value of total phosphorus (calculated as  $P_2O_5$ ) ranges from 3.35% to 7.12%, with a total annual average of 4.84%, which is higher than the total phosphorus content in Chinese urban sludge, American urban sludge, Chinese pig manure, and Chinese pig manure; The annual average value of total potassium in sludge (calculated as  $K_2O$ ) ranges from 0.74 to 1.42%, and the annual total average value is 1.11%. The

annual average value of total nutrients ranges from 7.69% to 12.4%, indicating high nutrient content and high resource utilization value.

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