International Core Journal of Engineering Volume 10 Issue 5, 2024
ISSN: 2414-1895 DOI: 10.6919/ICJE.202405_10(5).0066

Agricultural Resource Utilization and Sustainable Development of Sewage Treatment Plant Sludge

Xinyi Yang, Yuan Xia, Min Meng, Yahong Zhang

Faculty of Applied Technology, Huaiyin Institute of Technology, Huaian 223001, China

Abstract

Sludge is the precipitated substance obtained in the process of purifying sewage from urban sewage treatment plants. It contains the sediment, fibers, animal and plant residues and other solid particles mixed with domestic sewage or industrial wastewater, as well as the flocculent formed by the condensation of these solid particles. It is a complex composed of a variety of colloids, organic matter and adsorbed metal elements, microorganisms, germs and insect eggs. Today, with the rapid development of science and technology and the significant improvement of people's living standards, China's sludge production is also increasing year by year, and sludge disposal is facing serious challenges. At present, sludge disposal in China is mainly used in agriculture, land landfill and other aspects, and a large part of sludge has not been disposed of. How to scientifically and efficiently use sludge as a potential resource plays a certain role in improving the quality of ecological environment and promoting urban development and construction.

Keywords

Sludge; Sewage Treatment Plant; Agricultural Resource Utilization; Sustainable Development.

1. Introduction

With the advancement of socialist modernization, China attaches more and more importance to the construction of ecological civilization. Among them, the relevant departments have repeatedly emphasized: adhere to ecological and green development, and make contributions to accelerating the construction of a modern socialist country. In recent years, more and more facts have proved that the construction of ecological civilization is of great benefit to air quality and environmental quality in both urban and rural areas. Around the core requirements of the construction of ecological civilization, in order to make the construction of urban ecological civilization step up the pace of sustainable development, many scholars have begun to think about whether it can make a breakthrough in the perspective of urban sludge utilization.

After a period of deep thinking, in order to explore the potential utilization value of sewage treatment plant sludge, we first carried out the research on its agricultural resources. The realization of sludge agricultural resources can not only promote the process of constructing sustainable urban development, but also have great significance in enhancing the urban beautification effect and enhancing the urban image. On the other hand, the realization of sludge agricultural resources, so that sewage plant sludge treatment more scientific, is conducive to the efficient use of resources and sustainable development [1].

Scientific and efficient use of sludge as a potential resource plays a certain role in improving the quality of the ecological environment and promoting urban development and construction. The amount of sludge in urban sewage plants is increasing year by year, and the rational use of this large

ISSN: 2414-1895 DOI: 10.6919/ICJE.202405_10(5).0066

amount of sludge is not only the requirement of urban ecological civilization construction, but also the common expectation of urban residents.

Sludge is a kind of heterogeneous body composed of organic fragments, bacteria, inorganic particles and colloids. Most of the sludge treated by sewage treatment plants is organic sludge, which is more typical in all sludge types. This kind of organic sludge is rich in organic matter, and its particles are finer and the density is smaller. In the process of treatment, the water in the sludge gradually decreases, and the sludge also flows from a pure liquid to a viscous, semi-dry solid shape with the loss of water until it finally becomes a pure solid shape. Normally, the concentration process can reduce the moisture content of the sludge to 85%; When the moisture content is about 75%, the sludge will be in a softer state, when it is not easy to flow; When the moisture content is about 65%, the sludge almost becomes a solid; When the moisture content is lower than 40%, the sludge will show a unique aggregation and dispersion state. If the moisture content is continuously reduced to about 15%, the sludge will become fine powder. The different states of the sludge show the plasticibility of the sludge itself, and according to this plasticibility, it is treated in various processes in its disposal, in order to achieve the purpose of rational utilization.

Sewage produces sludge after treatment, so sludge can be called secondary pollutants. If the sludge is not disposed of and placed at will, it will not only cause great harm to the ecological environment, but also pose a major threat to human health. Due to the huge amount of sludge, it can cause immeasurable environmental pollution, more and more facts prove that the sludge needs to be properly treated, and the sludge needs to be disposed of in a scientific and reasonable way [2]. Not only that, due to the acceleration of the urban process to consume a large number of urban resources, the annual output of sludge has also risen sharply, a large number of sludge to the sewage treatment plant has brought severe tests, the treatment quality of sewage treatment plants should also be paid attention to.

Sewage treatment plant is the first step of sludge disposal, and its importance is self-evident. In recent years, many jerry-cutting sewage treatment plants have been exposed to the public, and the sludge produced after sewage treatment is not only difficult to use, but even has a variety of factors that harm human health; Some sewage treatment plants even do not treat the sludge, will be discarded at will..... This kind of action has added numerous hidden dangers to the quality of the natural ecological environment.

The study found that only by strengthening the disposal of sludge step by step and expanding its utilization ways, can the adverse effects of sludge containing a variety of pollutants be minimized. In fact, effectively solving the sludge problem has already become an extremely important issue in the development process of China's major cities.

Sustainable development not only emphasizes development, but also clarifies the need for such development to be sustainable, including the sustainable economic development and social development, at the same time, it should also be sustainable in ecological development to create a better development environment. We think about how to make due contributions to sustainable development, and then think of from the perspective of sludge resource utilization, the harmful substances carried in it are removed as far as possible, so as to find ways to use it, such as the role of horticultural plant cultivation. In the process of step by step exploration, we gradually discovered the significance and relevant strategies of recycling sludge. According to the relevant research and investigation analysis, this paper summarizes the characteristics of sewage treatment plant sludge, the current situation of agricultural treatment, agricultural recycling and its future sustainable development.

2. Analysis of Current Situation of Sludge Agricultural Treatment in Sewage Treatment Plant

Western developed countries due to the early industrialization process, economic strength, sludge treatment technology is more advanced, the level of treatment is also higher. And each country and

ISSN: 2414-1895 DOI: 10.6919/ICJE.202405_10(5).0066

region according to their geographical location, environmental conditions, economic strength, transportation and other factors to determine which treatment method is more suitable, but agricultural use occupies a large proportion, such as the UK's sludge agricultural use accounted for 42% of the total treatment capacity [3]. In France, Italy, Sweden and other countries in the mid-1980s, the proportion of sludge agricultural use in the total treatment capacity has reached 28%, 34%, 60% [4].

Most of the completed sewage treatment plants in China do not have supporting facilities for sludge treatment. Some data show that in China's sewage treatment plants, the sludge without any treatment for direct agricultural use accounts for more than 60% [5], even in the sewage treatment plant with digestion tank, the digested sludge is only slightly dehydrated after direct agricultural use, without any harmless treatment, still does not meet the sanitary standards for sludge agricultural use. At present, sludge disposal in China is mainly used in agriculture, land landfill and other aspects, and a large part of sludge has not been disposed of. Under the situation of the rapid development of urban construction level, the construction of sewage treatment facilities has also achieved rapid development, which has led to the sludge disposal has completely failed to keep up with the rate of sewage treatment [6]. Many places in China do not have a comprehensive understanding of the importance of sludge disposal, and the disposal focus is on sewage treatment, which is strictly supervised, while the supervision of sludge disposal is relatively backward, resulting in a slow development of sludge disposal in China [7-8].

3. The Main Risk Analysis of Sludge Reclamation for Agricultural Use based on Environment

3.1 The Content of Heavy Metals and Pathogenic Bacteria in Sludge Should Not Be Underestimated

Although the land use of sludge has the advantages of low energy consumption and recycling of sludge nutrients, it also contains a large number of pathogens, parasites (eggs), heavy metals such as copper, aluminum, zinc, chromium, mercury and other toxic and harmful substances that are difficult to degrade. Heavy metal ions are most easily taken up by plants and accumulate in roots, stems, leaves and fruits [9]. The accumulation of heavy metals in vegetables causes indirect harm to human body, and the nitrate in sludge pollutes groundwater. Nitrogen is the main fertilizer component of crops, but too high a concentration will cause the branches and leaves of crops to grow and fall over. Therefore, the sludge land disposal must be non-toxic and harmless treatment to use, otherwise the sludge toxic and harmful substances will lead to soil, crops heavy metal pollution and groundwater N, P exceeded.

3.2 Immature Sludge Treatment Technology Can Easily Lead to Secondary Pollution

The sludge treatment in China started late, the technology development is not mature, there are still many places to learn, and the reasonable way of sludge agricultural use needs to be studied urgently. Sludge treatment technology is one of the important problems in the sustainable development of sludge resources in our country. The immature treatment technology means that the treated sludge may still contain many harmful substances, such as pathogens, which are not only harmful to the human body, but also have great harm to the environment. The damage caused by secondary pollution to the environment is not just talk, in recent years, many cases show that the sludge has not been properly disposed of and the damage caused to the environment is as great.

The secondary pollution caused by the immature sludge treatment technology may pollute the air quality and pollute the surrounding environment. The original good environmental conditions placed into the sludge after reasonable disposal may also be assimilated, and even make the environmental quality worse.

3.3 Sludge is Easy to Pollute Water Bodies

Sludge is usually rich in various nutrients such as nitrogen and phosphorus, but if it is applied in large amounts in loose soil in areas with large rainfall, the decomposition rate of organic matter in the land

ISSN: 2414-1895 DOI: 10.6919/ICJE.202405_10(5).0066

will be greater than the absorption rate of nitrogen and phosphorus by plants, so that these nutrients are easy to be lost with water. Not only that, the organic matter and ammonia, nitrogen and other elements in the sludge may also consume a large amount of oxygen in the water body, which will cause the deterioration of the water quality and seriously affect the survival of aquatic organisms.

The nutrients in the sludge enter the surface water and cause the eutrophication of the water body, resulting in the malignant proliferation of algae, resulting in the phenomenon of red tide and green tide in the water body, which seriously affects the domestic water and industrial and agricultural water use, and leads to the decline of fishery production. In addition, sludge leachate into the ground may also cause nitrate pollution of groundwater.

4. Significance of Sludge Resource Utilization

4.1 Sludge Resource Utilization is the Basic Requirement of Ecological Environmental Protection

Sewage treatment plant in the sludge source is not the same, some can be the sewage produced in life, and some can be industrial production of wastewater, because of this, some of the sludge may contain a large number of heavy metal elements or parasites, pathogens, etc., will be discharged at will or unreasonable disposal, its pollution to the environment and ecological damage will be huge.

Taking ecological environment protection as the main purpose to improve the utilization rate of sludge, and rationalizing the utilization of sludge as a resource, it can "turn waste into treasure". The potential value of sludge is transformed in the process of using it, which will not only cause pollution to destroy the ecological environment, but also provide a certain guarantee for environmental protection.

4.2 The Resource Utilization of Sludge Can better Protect Human Health

Nowadays, there are still many large and medium-sized cities in our country that will dispose of the sludge treated by sewage treatment plants at will and discharge it wantonly. This unreasonable disposal or discharge method may not only pose a huge threat to the balanced development of the ecosystem, but also become the fuse that induces soil pollution and water environment pollution, resulting in a series of derived environmental problems. These environmental problems not only affect people's water safety at all times, but also the growth of animals and plants will be correspondingly affected, water safety and the growth of animals and plants are all related to human life, which is not difficult to foresee that the sludge without reasonable disposal will eventually threaten human health and human daily life.

In order to improve the utilization rate of sludge for the purpose of protecting human health, the treatment of sludge can be further rationalized, and it can be revitalized. The resource utilization of sludge not only does not affect the growth of plants, but also can rely on its own characteristics to play a certain role in promoting the growth of these plants, but also brings great benefits to human daily life and physical health.

4.3 The Realization of Sludge Resource Utilization is a Potential Requirement for Resource Conservation

The process of urbanization construction in China is gradually accelerating, so the output of sludge is also increasing year by year, and these sludge contain rich nutrients such as nitrogen, phosphorus and potassium. If these nutrients are rationally used, it is conducive to environmental protection and more conducive to the sustainable development of resources. Based on this, the unscientific disposal of sludge is a waste of resources.

In order to achieve resource conservation for the purpose of improving the utilization rate of sludge, a large number of sludge into a large number of available substances, its existence is no longer a hazard but a performance of resource conservation, can make its maximum value. Sludge production is huge, with a reasonable and timely treatment of it, it will be a large number of useful resources, the

ISSN: 2414-1895 DOI: 10.6919/ICJE.202405_10(5).0066

use of such resources to their maximum use, in resource conservation and its sustainable development is of great significance.

5. Conclusion

The use of sludge as a resource in soil can not only solve the problem of sludge stacking, but also improve the soil and supply the nutrients required for plant growth. The sludge can be directly applied to the soil, composted or used as a substrate, and the resource of the sludge can be transformed through the biochemical reaction of microorganisms to achieve the reduction, stabilization, harmless and resource of the remaining sludge. Resource utilization is the main direction of sludge development, because the sludge is used in green space does not enter the food chain and cause harm, and the sludge contains a lot of organic matter and nutrient elements, which is of great help to soil improvement, China's arable land area is limited, coupled with salinization, desertification, barren and other phenomena are more serious, the sludge is not only rich in organic matter, Moreover, it is also rich in nutrients required for the growth of some plants, such as N, P, K, etc. At the same time, it is also found that the sludge contains some bioactive substances and hormone substances, etc., the existence of which can affect the growth of green plants. Sludge agricultural use is a low-carbon development road in line with the national conditions, from the perspective of economic development, comprehensive utilization of resources and urban ecological environment. The agricultural use of municipal sludge will become an economical and sustainable sludge treatment and disposal method.

Acknowledgments

This study was supported by Jiangsu Innovation and entrepreneurship project of college students No. 202311049034Z and 2023 Jiangsu Province industry-university-research cooperation project No. Z412B23208.

References

[1] David, L, Lewis, David, K, et al. Peer Reviewed: Pathogen Risks From Applying Sewage Sludge to Land [J].Environmental Science & Technology, 2002, 36(13): 286A–293A.

[2] Tan Q L, Hu C X, Zhou H J. The forms of heavy metals in municipal sludge and their effects on enzyme activity of tidal soil [J]. Journal of Huazhong Agricultural University,2002, 1 :36-39.

[3] Song J Y. Agricultural application of municipal sewage sludge. Foreign Environmental Science and Technology, 1993, 3: 29-32.

[4] Zhao Y Q, Davis R D. Sludge disposal status and development overview in UK. China Water Supply and Drainage, 1998, 24(9): 28-29.

[5] Xue W Y. Treatment and disposal of municipal sewage sludge. China Water Supply and Drainage, 1992, 1 (8): 41-46.

[6] Cao L Y, Hou X S. Analysis of recycling disposal methods of residual sludge from municipal sewage treatment plants [J]. China Comprehensive Utilization of Resources, 2019, 38(9): 126-128.

[7] Dai X H. Comparison of sludge treatment technologies at home and abroad [J]. Water Industry Market, 2012, 4:15-17+11.

[8] Wang J, Lu Z W, Tian S, et al. Research status and progress of sludge at home and abroad [J]. Municipal Technology, 2006, 3: 140-142+195.

[9] Qiao X L, Luo Y M, Wu S C. Land use of sludge and its environmental impact [J]. Soil Science, 2000, 2: 79-85.