Study on rural domestic sewage treatment scheme

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Abstract. Under the background of building a beautiful China, rural domestic sewage treatment has attracted much attention. At present, the backward status of rural domestic sewage treatment has become an important factor hindering the sustainable development of agriculture, destroying the rural ecological environment and threatening the health of the masses. In order to promote the construction of ecological civilization, rural domestic sewage treatment needs to be improved. Based on the current situation of rural domestic sewage in China, aiming at the prominent problems existing in the sewage treatment process, this paper explores the treatment scheme, hoping to provide some theoretical support for the related work.

Key words: sewage treatment; rural domestic sewage; treatment.

1. Introduction

Under the strong national planning for the construction of ecological civilization, our living environment has undergone tremendous changes, and the concept of green sustainable development is deeply rooted in the hearts of the people. In the process of ecological environment becoming beautiful, rural sewage treatment still has some problems and deficiencies. The main target of rural sewage treatment is domestic sewage. In recent years, China's rural domestic sewage discharge has increased significantly, and domestic sewage flows into rivers through pipelines and groundwater. This phenomenon has caused a serious threat to the rural ecological environment. The characteristic of rural domestic sewage is that the amount of water is much smaller than that of urban water, but the distribution of rural sewage is extremely scattered and random, which increases considerable difficulty for the staff in rural sewage treatment. Therefore, it is of great practical significance to explore the rural domestic sewage treatment.

2. Existing problems of rural sewage treatment

Rural domestic sewage is the waste water produced by people in rural areas, which mainly includes kitchen sewage, toilet sewage and washing sewage, which are called "Rural three water". It is characterized by wide dispersion, multiple sources, strong randomness, large daily and seasonal variation, complex sewage composition, low pollutant concentration and difficult to control. China is a big agricultural country. By 2019, the rural population in China accounts for 40.4%[1]. Due to the late start of rural ecological environment governance, the lack of unified standards, the high cost of investment and the lack of obvious effect, the governance of rural ecological environment has become a key factor restricting the overall improvement of environmental quality in China. At present, the low efficiency of rural sewage treatment not only causes hidden dangers to rural domestic water, but also
causes great consumption of fresh water resources. Therefore, rural sewage treatment can not be guaranteed, which also restricts farmland irrigation, and seriously affects the quality of life of rural residents. The rural domestic sewage is discharged randomly without treatment, which leads to the black and smelling of the surrounding ditches, rivers and water systems, pollutes the environment, affects the living environment and threatens the health of residents, and may lead to serious environmental pollution and social contradictions [2-3]. And then through the analysis of the characteristics of rural domestic sewage and explore solutions.

2.1. Residents' awareness of environmental protection is weak
In rural sewage treatment work, residents' weak awareness of rural sewage treatment work is an important factor affecting the efficiency of rural sewage treatment work. Rural residents and environmental workers in rural areas have a weak awareness of sewage treatment, usually through the direct discharge of sewage. This behavior not only causes serious damage to the ecological environment around the rural areas, but also causes serious damage to the rural areas because of the large amount of chemicals and a considerable number of bacteria in the sewage the life of residents has caused security risks. Therefore, for the rural areas of our country, we should first improve the villagers' overall awareness of sewage disposal. Only by constantly improving the villagers' awareness and making them understand the importance of environmental protection, can we quickly reduce the phenomenon of random discharge of domestic sewage.

2.2. The level of treatment technology is limited
Due to the relatively small amount of investment in sewage treatment, the actual situation in rural areas is also more complex, resulting in higher difficulty in rural domestic sewage treatment. Although some rural areas have built corresponding sewage treatment facilities, due to the unscientific design scheme and farmers' lack of in-depth understanding, the treatment capacity is weak, the treatment level is not high, the qualified rate of treatment is low, and the effect of sewage treatment is poor. At present, the vast majority of rural washing and kitchen wastewater is mostly used for courtyard dust suppression or greening. At the same time, due to the strong seasonality in the north and the cold climate in winter, the sewage discharge process is easy to freeze. Farmers do not master enough of the operation and maintenance technology of sewage treatment, resulting in the normal operation of treatment facilities. For rural areas adopting decentralized small-scale sewage treatment technology, winter directly affects the treatment effect and cost.

2.3. Insufficient investment in capital cost
The amount of investment in rural domestic sewage treatment is large, and the financial affordability of local governments is limited. It is difficult for grass-roots financial operation and maintenance, resulting in insufficient environmental infrastructure construction. Most of the village collective financial difficulties, resulting in most of the treatment facilities unable to operate, unable to ensure the effluent quality standards and long-term effective operation and maintenance of treatment facilities. A large amount of money needs to be invested for timely maintenance during the operation of the facilities. It is difficult to collect sewage, and the operation and maintenance cost is high. The normal operation and maintenance cost of a sewage treatment station is about 30000 yuan per year, mainly including the electricity cost, equipment maintenance and repair cost, and the salary of operation and maintenance personnel. Some sewage treatment stations need to replace expensive treatment consumables due to the particularity of sewage treatment process, and the operation and maintenance cost is as high as 10000 yuan. About 100000 yuan per year. At present, the rural domestic sewage treatment fund security system is not ideal, there are still many gaps and deficiencies, it is difficult to meet the actual needs of the comprehensive treatment of rural domestic sewage, and then have a huge impact.
3. Rural domestic sewage treatment mode and process

3.1. Rural domestic sewage treatment mode

The rural sewage treatment mode is mainly divided into relatively centralized treatment mode and decentralized treatment mode, considering the village nature, village physical and geographical conditions, layout form and scale, difficulty of pipe network laying, infrastructure construction, environmental improvement demand, economic and social development and other factors [4].

(1) Relative centralized treatment mode: for the villages with large population and ecological sensitive areas, and the villages with concentrated population and landform meet the requirements of sewage pipe network laying conditions, it is suggested to build a supporting pipe network collection system to collect the sewage generated by farmers, and build unified sewage treatment facilities to treat the domestic sewage of villages. This mode has the characteristics of simple construction, cost saving and easy maintenance.

(2) Decentralized treatment mode: for villages in non ecologically sensitive areas with scattered farmers and small population, or villages whose elevation and topography are not suitable for laying conditions of sewage pipe network, farmers' sewage is collected by joint or single households and then treated separately. This mode has the characteristics of flexible layout, saving pipe network cost and simple construction.

3.2. Rural domestic sewage treatment process

At present, the common rural domestic sewage treatment processes in China can be roughly divided into activated sludge process, ecological treatment process and integrated bioreactor. The advantages and disadvantages of each process are shown in Table 1.

| Classification                                      | Advantages                         | Disadvantages                                      |
|-----------------------------------------------------|------------------------------------|----------------------------------------------------|
| Sewage treatment technology with activated sludge   | Mature technology and good treatment effect | The process is complex and needs professional management |
| Bio ecological combined decontamination method      | Low energy consumption and low operation and management cost | The pollutant removal load is low, the floor area is large, and the effluent quality is greatly affected by the environment |
| MBR integrated facility decontamination method      | Small area, stable operation and good effect | High energy consumption, must be managed by professionals, high operating costs |

3.2.1. Sewage treatment technology with activated sludge. Activated sludge is a way to use the aerobic bacteria and their original organisms to absorb, degrade and oxidize the organic matter in sewage, and finally decompose the organic matter into carbon dioxide and water (Table 2). The process is realized by physicochemical and biochemical actions. Physicochemical effect is to achieve the purpose of sewage purification by using activated sludge for organic matter adsorption, and the adsorption capacity is very strong and rapid. The biochemical process needs to be carried out under aerobic conditions. In this process, the bacteria will use the energy and nutrients obtained from the decomposition of organic matter to form new protoplasm. Therefore, the bacteria will gradually grow and divide, the bacteria will be cultivated, and the number of activated sludge will also increase.

| Treatment comparison | Chemical oxygen Demand (mg/L) | Phosphorus content (mg/L) | Ammonia nitrogen content (mg/L) | nitrogen content (mg/L) | Content of suspended solids (mg/L) |
|----------------------|-------------------------------|----------------------------|-------------------------------|------------------------|----------------------------------|
| Before               | 26.8                          | 8.3                        | 58.3                          | 41.6                   | 48.7                             |
| After                | 19.6                          | 1.25                       | 7.9                           | 13.6                   | 14.3                             |
3.2.2. **Bio ecological combined decontamination method.** Rural sewage has different characteristics from other sewage. Rural sewage generally has the characteristics of less discharge, relatively high concentration of organic matter, large coefficient of daily variation and intermittent discharge. In addition, due to the influence of agricultural production structure, farmers’ planting and breeding habits, village distribution, geographical and ecological characteristics, and the level of social and economic development, rural sewage also has the characteristics of decentralization, high degree of local pollution, uncertainty and unpredictability. Therefore, according to the resources and environmental conditions in rural areas, it is necessary to develop and popularize feasible and low-cost sewage treatment technology [5]. The process flow of sewage treatment is shown in Figure 1.

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\text{Lift pump} \\
\text{Rural domestic sewage} \quad \text{Grid channel} \quad \text{Regulating pool} \quad \text{Anoxic pool} \\
\text{Return sludge} \\
\text{Constructed wetland} \quad \text{Disinfection pool} \quad \text{Sedimentation pool} \quad \text{Aerobic pool} \\
\text{excess sludge} \\
\text{Reach discharge or irrigation} \quad \text{Sludge thickener} \quad \text{Farmers’ fertilizer} \\
\]

**Figure 1.** Bio ecological combined decontamination method

3.2.3. **MBR integrated facility decontamination method.** Rural domestic sewage is generally discharged in an extensive way, and the discharge and collection system is not perfect. The collection rate of village sewage in China is relatively low. Rural domestic sewage treatment facilities mainly include constructed wetland (subsurface flow and surface flow), ecological pond, biotrickling filter, integrated MBR equipment, etc. The constructed wetland is suitable for the southern region with abundant land resources and little temperature change. The integrated sewage treatment equipment has the advantages of small area, large treatment load, good dispersion and convenient construction. At present, the township sewage treatment is developing towards the integrated equipment. At present, the treatment effect of integrated MBR experiment for rural sewage is shown in Table 3.

**Table 3.** Effluent effect of MBR integrated facilities for rural domestic sewage treatment

| Treatment capacity (t d⁻¹) | CODₐ (mg L⁻¹) | BOD₅ (mg L⁻¹) | Ammonia nitrogen (mg L⁻¹) | Total nitrogen (mg L⁻¹) | Total phosphorus (mg L⁻¹) |
|---------------------------|---------------|---------------|--------------------------|------------------------|--------------------------|
| 4                         | 40            | 8             | 1.6                      | —                      | —                        |
| 10-20                     | 38            | —             | 2.82                     | 10.5                   | 0.39                     |
| 10                        | 46            | —             | 3.23                     | 7.12                   | —                        |
| 10                        | 19-31         | 5.1-7.8       | 1.9-3.1                  | —                      | —                        |
| 100                       | 50-60         | 15.4          | <8                       | —                      | 0.8                      |
| 50                        | 10-35         | —             | <1.5                     | —                      | <0.5                     |
4. Safeguard measures for rural domestic sewage treatment

4.1. Enhance residents' awareness of environmental protection

One of the key tasks of rural sewage treatment is to improve the residents' awareness of environmental protection, which is the basis and key to carry out all other work. At present, China's rural residents live in a wide range of areas, each region has its own unique way of life, especially in remote mountainous areas. The design of sewage treatment equipment must be reasonable. We should make rational use of propaganda means to let the masses know the impact of water pollution on their lives. At the same time, environmental education should also start from children. According to the actual situation, environmental education should be arranged regularly in primary schools in rural areas, and practical courses should be arranged to cultivate their awareness of sewage treatment.

4.2. Strengthen technical guidance

Without affecting farmers' daily busy work, grassroots organizations should strengthen the training and technical guidance for rural residents in sewage treatment facilities, and strengthen farmers' professional skills in sewage treatment. At the same time, some people should be trained systematically to arouse the enthusiasm of farmers in environmental protection and then make it drive others to learn the corresponding operation and maintenance skills. Relevant departments at the township and village levels can also regularly employ relevant experts to train cadres and farmers, and strengthen their technical level of domestic sewage treatment. Through the operation and management of professional team, the treatment process is adjusted in time according to the operation parameters and water quality changes, so as to achieve the long-term management of the construction, operation and maintenance of domestic sewage treatment facilities.

4.3. Optimize the capital channel of sewage treatment

While continuing to emphasize the protection of the rural environment, we should increase investment in rural areas. The government should timely provide policy subsidies for the improvement of rural water environment or the construction and operation of rural sewage treatment facilities, ensure the investment in the construction of environmental infrastructure, ensure the long-term stable operation of the built facilities, and normalize the rural environmental remediation work. By means of social capital participation, government purchase of services, self financing of villages and towns, we can raise funds for facility operation and maintenance, effectively achieve the expected goal of comprehensive environmental improvement, effectively improve the rural people's environment, and promote the effect of green agricultural development. At the same time, strengthen the training of grass-roots staff, so that grass-roots staff can better understand the rural sewage related work and technology. Priority should be given to the areas where rural domestic sewage has a serious impact on the ecological environment.

5. Conclusion

The conservation and utilization of water resources is an environmental protection task that any country attaches importance to. So far, due to the promotion of urban construction and the attention of relevant environmental protection departments, the treatment of sewage in urban water conservation projects has been gradually improved. At present, it is more important to improve and improve the sewage treatment work in grass-roots areas such as rural areas. Relevant departments should pay more attention to the rural sewage treatment, the structure analysis of rural sewage is carried out, the chemical properties of the sewage are studied, and a more perfect sewage treatment scheme is formulated. Combined with the successful case experience of rural sewage treatment, the most appropriate sewage treatment scheme is designed according to local conditions, so that the rural sewage treatment work can be improved and improved.
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