

# Application of Anti-clogging Ecological Soil Sewage Treatment Process in Rural Domestic Sewage Treatment and Prospects

Xingyu QI<sup>1\*</sup>, Qiuxia TAN<sup>2</sup>

1. Wuhan Jiangcheng Zeyuan Ecological Engineering Technology Co., Ltd., Wuhan 430000, China; 2. Wuhan Kunjian Eco-Environmental Planning & Design Co., Ltd., Wuhan 430000, China

**Abstract** [Objectives] By reasonable water distribution and air supply to soil, soil water permeability is maintained, and the nutrient conditions of degrading bacteria in soil are improved to effectively prevent soil clogging. [Methods] Through the innovation and improvement of traditional soil sewage treatment technology, the physical, chemical and biological characteristics of soil for sewage purification are utilized to enhance the pollutant decomposition ability of soil microorganisms and maintain soil water permeability. [Results] It has no secondary pollution, and can effectively remove pollutants such as COD<sub>Cr</sub>, TN, TP, NH<sub>3</sub>-N, *etc.* in sewage. [Conclusions] The operation and maintenance cost is low, and the land can be reused, while water and nutrients can be restored to the land.

**Key words** Anti-clogging; Ecological soil sewage treatment; Pollutants

Improving rural living conditions and building a beautiful and livable countryside is an important task to implement the rural revitalization strategy, and concerns the building of a moderately prosperous society in all respects, the fundamental well-being of farmers, and the civilization and harmony of rural society. At present, the living environment in rural areas is unbalanced, and the problem of squalor and mess is still prominent in some areas, which is still a prominent weak link in economic and social development. With the improvement of residents' awareness of environmental protection, the ecological environment has also been greatly improved, but there are still some problems in rural treatment facilities in some areas. For rural sewage treatment projects, due to scattered population in villages, a small amount of sewage, and many points, the operation and supervision are difficult, and the economic affordability is poor; there is a lack of professional environmental protection technology and management personnel<sup>[1]</sup>. As a result, there are many problems in the operation and maintenance of facilities in the later stage, and the facilities cannot operate normally, eventually losing sewage treatment capacity.

Anti-clogging ecological soil sewage treatment process has the advantages of low operation and maintenance cost, simple operation, stable effluent quality, basically no need for daily maintenance and management, and no noise, odor, flies, mosquitoes and other secondary pollution. It can effectively remove pollutants such as COD<sub>Cr</sub>, TN, TP, NH<sub>3</sub>-N, *etc.* in sewage, and restore the water of sewage and plant nutrients to the land while treating sewage, which has the effect of maintaining a virtuous cycle of natural ecology. After the completion of the treatment facility, crops can be planted on the surface of the soil without affecting the original function and ecological and economic value of the land, so it is an

effective way to solve the subsequent operation and maintenance problems and has almost no secondary pollution.

## Mechanism of treating rural domestic sewage by anti-clogging ecological soil sewage treatment process

Through the innovation and improvement of traditional soil sewage treatment technology, the physical, chemical and biological characteristics of soil for sewage purification are utilized, and the decomposition ability of soil microorganisms is fully exerted. By reasonable water distribution and air supply to soil, the stability of soil aggregate structure is effectively maintained, and soil water permeability is maintained; the nutrient conditions of degrading bacteria in soil are improved, and the degradation activity of soil microorganisms on various pollution components of sewage is strengthened, so as to effectively prevent soil clogging. In addition, plants planted on ecological soil treatment facilities can continuously absorb water and nutrients in sewage to achieve long-term, stable and efficient purification effect<sup>[2]</sup>. Ecological soil sewage treatment process can purify domestic sewage mainly through the following ways.

### Enhancing microbial activity in sewage treatment facilities

Through the electronic control air supply equipment, gas supply pipelines and gas supply effect inspection pipes, the oxygen required by microorganisms is supplied to them in a unique way, and the oxygen required for purifying domestic sewage is provided for the microorganisms in the multi-media ecological soil filler in the treatment process and the microorganisms in the biological filler in the soil distribution tank. In the case of ensuring the oxygen supply in the facility, through the multi-media filtration layer with different permeation rates, soil distribution flume and other technical measures, the overall water intake and water distribution of the facility are more uniform and scientific, so as to prevent soil blockage, strengthen the pollutant decomposition capacity of soil

Received: May 13, 2023 Accepted: June 13, 2023

Xingyu QI (1993 –), male, P. R. China, devoted to research about sewage treatment projects.

\* Corresponding author.

microorganisms, and also better maintain the soil aggregate structure and maintain good soil ventilation and permeability.

Physical and chemical action of soil

Pollutants TN and TP in domestic sewage mainly exist in the form of  $\text{NH}_4^+$ ,  $\text{H}_2\text{PO}_4^-$ ,  $\text{HPO}_4^{2-}$ ,  $\text{PO}_4^{3-}$ ,  $\text{NO}_3^-$ , etc. Some of them react with metal ions such as  $\text{Mg}^{2+}$ ,  $\text{Ca}^{2+}$ ,  $\text{Fe}^{2+}$  and  $\text{Fe}^{3+}$  in natural soil to form compounds that are insoluble in water, so as to absorb and fix the pollutants in the soil<sup>[3]</sup>.

Absorption mechanism of plants

Plants can absorb and utilize  $\text{NH}_4^+$ ,  $\text{H}_2\text{PO}_4^-$ ,  $\text{HPO}_4^{2-}$ ,  $\text{PO}_4^{3-}$  and  $\text{NO}_3^-$  in domestic sewage as their nutrients, and purify various pollutants such as phosphorus and ammonia nitrogen in sewage.

Application of anti-clogging ecological soil sewage treatment process in rural domestic sewage treatment

According to the rural population, sewage quality and surrounding environment, the treatment scale and pretreatment process used in different areas are slightly different. In the landscape area, *Zoysia matrella* (L.) Merr., *Rhododendron simsii* Planch. and other shallow root flowers and shrubs can be planted on the surface of the sewage treatment facility, thereby beautifying

the surrounding environment, increasing the green area, and maintaining a good ecological environment around.

For village A, Wuwei Town, Nanning City, Guangxi, the designed effluent standard is grade A standard in the *Discharge Standard of Pollutants for Municipal Wastewater Treatment Plant* (GB 18918-2002), and the process flow is "pretreatment tank + anti-clogging ecological soil sewage treatment process" (Fig. 1). The final effluent results could reach the original design standard stably. The removal rate of COD, ammonia nitrogen, total nitrogen and total phosphorus could be up to above 90%, 92.2%, 90.3% and 90.5%, respectively. The treated domestic sewage could be used for field irrigation and landscape water supply, which realizes the recycling of water resources (Table 1)<sup>[4]</sup>.

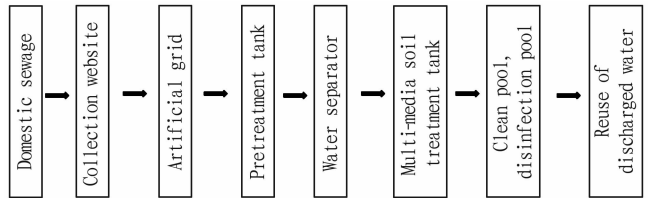


Fig. 1 Technological flow diagram of anti-clogging ecological soil sewage treatment facilities

Table 1 Quality of inlet and outlet water from some anti-clogging ecological soil sewage treatment facilities mg/L

| Village                  | Water        | COD | NH <sub>3</sub> -N | TN    | TP   |
|--------------------------|--------------|-----|--------------------|-------|------|
| Village A in Guangxi     | Inlet water  | 244 | 44.60              | 65.00 | 3.14 |
|                          | Outlet water | 25  | 3.46               | 6.31  | 0.31 |
| Village B in Guangxi     | Inlet water  | 87  | 53.30              | 58.40 | 2.92 |
|                          | Outlet water | 12  | 0.63               | 3.98  | 0.09 |
| Village A in Yunnan      | Inlet water  | 732 | 23.60              | 31.40 | 4.78 |
|                          | Outlet water | 10  | 0.40               | 0.67  | 0.05 |
| Scenic spot A in Guangxi | Outlet water | 13  | 3.12               | –     | 0.29 |
| Village A in Chongqing   | Outlet water | 11  | 0.34               | –     | 0.09 |

Discussion

At present, anti-clogging ecological soil sewage treatment process has been used in some villages and scenic spots in Guangxi, Guangdong, Yunnan, Hubei and other places. Compared with the traditional distributed sewage treatment process, the treatment process has the following advantages. For instance, operation and maintenance cost is low, and the degree of equipment automation is high; it has basically no personnel on duty, and the operating cost of a ton of water is only 0.1–0.2 yuan/t. After the installation of soil treatment facilities, the land can be reused, which can bring landscape and economic benefits. The effluent water is good in quality, has strong adaptability to external environment changes and impact load is strong, and can reach the standard stably. It solves the blockage problem of traditional soil treatment process, and can be used for a long time (20 years) after one investment<sup>[5–6]</sup>. Therefore, considering the purification capacity, follow-up operation management, comprehensive utilization value and landscaping, the process will play a huge role in domestic sewage treatment in rural areas and scenic spots.

References

[1] LIANG YQ, HUANG LJ, HAN B, et al. Discussion on the application of ecological treatment technology in rural domestic sewage in Guangxi[J]. Cities and Towns Construction in Guangxi, 2021(2): 33–36. (in Chinese).

[2] WU DY. Application of sewage treatment technology in eco-environmental protection[J]. Contemporary Modern Chemical Research, 2021(11): 109–110. (in Chinese).

[3] NIE FH, LI T. Application and prospect of clay minerals in wastewater treatment[J]. Journal of East China Jiaotong University, 2006, 23(4): 22–26. (in Chinese).

[4] ZHU Q. Research on eco-environmental sewage treatment technology[J]. Leather Manufacture and Environmental Technology, 2022(12): 20–21, 27. (in Chinese).

[5] LIU QQ. Study on optimal evaluation system of rural sewage treatment scheme in Yantai City[D]. Yantai: Yantai University, 2022. (in Chinese).

[6] LIU M, SUN H, WU YS. Technology and application prospect of "treatment of domestic sewage by anti-plugging soil method"[J]. Shandong Environment, 2000(7): 73. (in Chinese).