

# Present Situation of Treatment and Utilization of Rural Sewage Constructed Wetland in Loess Plateau

Yulu Wei

Institute of Land Engineering and Technology, Shaanxi Provincial Land Engineering Construction Group Co., Ltd., Xi'an Shaanxi, 710075, China

## Abstract

With the improvement of living standards, the output of rural domestic sewage is also increasing. How to treat sewage and effectively use sewage has become the main technical bottleneck restricting the social and economic development of the Loess Plateau. The construction cost of constructed wetland is low, the construction form is flexible, and the landscape greening of courtyards and villages can be organically combined with the sewage treatment, which is in line with the guiding direction of local sewage consumption in rural areas. The existing problems of rural sewage treatment are analyzed, and the development status and prospect of constructed wetland are discussed.

## Keywords

Rural Sewage; Constructed Wetland; Sewage Treatment.

## 1. Introduction

With the implementation of rural revitalization strategy and the rapid development of rural economy, the sewage discharge in rural areas is increasing year by year. As of 2017, the discharge of rural sewage in China has reached  $2.14 \times 10^{11}$  t [1]. However, in the vast rural areas, drainage facilities are very imperfect; The survey results of the World Health Organization (WHO) and the World Water Supply Sanitation Association (WSSCC) show that in developing countries, the coverage rate of rural sanitation equipment only accounts for 18% of the total population, far lower than 75% in urban areas, and the large amount of domestic sewage and random discharge have caused serious water pollution. According to statistics, the pollution contribution of sewage discharge in rural areas in China to conventional indicators in water bodies is close to the sum of urban sewage and industrial wastewater [2]. Especially in the Loess Plateau area, which is dominated by agriculture, the contribution of rural sewage to regional water environment quality is higher.

## 2. Existing Problems of Rural Sewage Treatment

The residents in rural areas are widely distributed and dispersed, and the quality and quantity of domestic sewage fluctuate greatly. At the same time, the level of science and technology in rural areas of our country is relatively backward, and professional and technical personnel are lacking. This makes the majority of rural areas have not yet built supporting sewage treatment facilities. Even in the core areas of towns and villages with sewage treatment facilities, most sewage stations are in a state of "semi-paralysis" or "sunshine" all year round due to many problems that do not match the actual situation in the selection, design, construction, operation and management of sewage treatment processes, and the treated water is difficult to meet the requirements of discharge or reuse [3]. How to effectively use rainwater, sewage and other non-traditional water resources has become a major technical bottleneck restricting the social and economic development of the Loess Plateau, restricting the smooth implementation of the rural revitalization strategy.

In terms of process selection and design, the existing sewage treatment in villages and towns is mostly directly applied to the sewage treatment experience in large cities, which has great limitations. For example, A/AO technology is the mainstream urban sewage treatment process at home and abroad, which can not only remove organic components in domestic sewage, but also has a good synchronous nitrogen and phosphorus removal effect [4]. However, this technology is only applicable to large sewage treatment plants, and the operation effect is not ideal for small sewage situations such as villages and towns. However, in the actual visit, we found that this technology still occupies a considerable proportion in rural courtyard sewage treatment. As a commonly used distributed sewage treatment technology, the purification tank has a wide range of applications and good purification effect in areas with higher economic level. However, in the practical application of this technology in the Loess Plateau region, after the purification tank is installed in the household, due to the need for power consumption, even if the process itself is no problem, the farmer will take the initiative to disconnect the power supply, resulting in the loss of purification function of the purification tank.

Therefore, how to combine the climate and socio-economic development characteristics of the Loess Plateau and adopt the decentralized sewage treatment and in-situ reuse technology according to local conditions with less investment, less energy consumption/operating costs, convenient maintenance and management, and strong impact load resistance is the key to improve the water environment quality in the Loess Plateau. The constructed wetland makes use of the physical, chemical and biological synergies in the wetland system to achieve the purification treatment of sewage through the adsorption and retention of matrix, the absorption and utilization of plant itself and the action of plant root microorganisms. The technology can organically combine the landscape greening of courtyards and villages with sewage treatment, without large-scale pipe network laying, especially suitable for domestic sewage treatment in vast rural areas, and has been widely promoted and applied at home and abroad.

### **3. Progress of Wastewater Treatment in Constructed Wetlands at Home and Abroad**

Constructed wetland wastewater treatment technology originated in Germany. In 1953, Seidel study found that reed can remove a large number of organic and inorganic substances, and further studies showed that bacteria in sewage disappeared when passing through the reed bed, and reed and other large plants can absorb heavy metals and organic matter from the water. Then, Kiehuth proposed the "root zone method", since then constructed wetlands as a typical distributed sewage treatment technology has attracted wide attention in the world, and has been rapidly developed in the past decades. At present, thousands of constructed wetlands have been put into operation in Europe, which are widely used in the purification and treatment of urban domestic sewage, industrial wastewater and water sources. In 2002, the US Congress and the Environmental Protection Agency (USEPA) published an Application Manual for decentralized wastewater treatment technologies. As of 2014, there are nearly 20,000 constructed wetlands in North America, and more and more are being used in Latin and England. Since 1977, Japan has implemented the rural domestic sewage decentralized treatment plan, conducted in-depth research on different forms of small integrated sewage decentralized treatment facilities, and in April 2001, promulgated relevant laws to ensure the purification of domestic sewage in rural areas.

Compared with developed countries, constructed wetland started late in China, but it has become the second largest research country of constructed wetland technology. In 1990, China built the first productive constructed wetland for sewage treatment in Bainikeng, Shenzhen, and based on this, carried out research on biodegradation dynamics and hydraulics inside the

wetland [5]. Since 2000, with the implementation of major projects on water pollution control and treatment, the research and application of constructed wetland in China have been developing rapidly. It mainly solved the theoretical and technical problems of how to improve the overall removal efficiency of nitrogen, phosphorus and organic components in constructed wetlands, the microbial structure and function of the root zone of constructed wetlands, and the construction of constructed wetland models. In particular, since 2010, the promulgation of relevant technical specifications for constructed wetlands has further resulted in the organic integration of water treatment functions and ecological landscape environmental protection functions of constructed wetlands, indicating the maturing of this technology in our country [5-8].

Zhang et al. investigated the removal characteristics of diclofenic acid and caffeine in scallions of wetland plants through hydroponics experiments, and found that diclofenic acid was mainly removed by photolysis, while caffeine was heavily absorbed by plants and mainly distributed in the stems and leaves of scallions. This makes the applicant realize that for new pollutants, in addition to the metabolism of microorganisms in the wetland substrate and the adsorption of substrate materials, the contribution of wetland vegetation absorption and utilization as well as volatilization and photolysis of organic components can not be ignored. If the adsorption of the substrate is the main factor, the replacement of the substrate and secondary pollution after long-term operation of the wetland should be considered. If plant absorption is the main factor, attention should be paid to its ecological accumulation. If it is mainly metabolic decomposition, it is necessary to clarify its degradation pathway to prevent the formation of highly toxic products. Therefore, to clarify the removal mechanism of emerging pollution components such as drugs and personal care products in constructed wetlands is the key to efficient treatment and safe reuse of rural sewage.

#### 4. The Prospect of Constructed Wetland in Loess Plateau

The Loess Plateau region is located in the middle and upper reaches of the Yellow River basin, which is dry early and rarely rains all the year round. With the implementation of the national rural revitalization strategy, "courtyard economy" is very common in the Loess Plateau area. Villagers can be largely self-sufficient by growing seasonal vegetables and crops in their courtyards. In practical application, most rural areas irrigate garden crops by collecting and storing rainwater. However, due to the constraints of dry and early weather conditions, the stormwater storage can not meet the needs of garden crop irrigation and greening water. Therefore, effectively solving the problem of rural sewage treatment and reuse in the Loess Plateau area has become the key to solve the problem of local water pollution and water resources shortage.

Constructed wetland technology has the advantages of low investment and operation cost, simple management and high treatment efficiency, and is suitable for decentralized treatment of rural domestic sewage. However, in the Loess Plateau region, due to the low penetration rate of water flushing toilets, the organic matter content of domestic sewage is significantly lower than that of urban sewage, and the organic pollution components are mainly detergents, drugs and personal care products introduced in the process of washing vegetables, laundry, and bathing. In addition, the low temperature weather in winter will inhibit the activity of wetland vegetation and microorganisms, and the purification performance of constructed wetland will be greatly affected. According to the unique water quality characteristics (low carbon, high nitrogen and phosphorus) and the purification requirements of characteristic pollution components in this area, it is necessary to develop the wastewater treatment process of cold-resistant constructed wetland, and use the purified effluent as water for garden irrigation and

greening, which has important strategic significance for improving the living environment of villages and towns.

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