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Analysis of rural domestic sewage treatment in Guizhou

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Abstract: Based on the data statistics and field investigation of domestic sewage treatment in 1414 township-level units and 17664 administrative villages in Guizhou Province, this paper summarizes and analyzes the coverage of administrative villages of sewage treatment facilities in Guizhou Province and the current treatment technology model. About 13.24% of the domestic sewage in administrative villages in the whole province has been centralized or partially centralized, and the degree of sewage treatment is relatively low. Among them, Zunyi and Guiyang are relatively high, with the coverage rates of 30.7% and 27.4% respectively. However, Bijie is the lowest with the largest rural population, which is 7.4%. In addition, through the investigation of rural sewage treatment technology mode in Guizhou Province, it can be concluded that in areas with relatively concentrated villages, centralized treatment technologies for rural domestic sewage are commonly adopted, including constructed wetlands and integrated sewage treatment equipment, and a decentralized sewage treatment system is often adopted for single households. In the selection of rural domestic sewage treatment technology scheme, the principles of simple process, low infrastructure cost, easy maintenance, and pollution-free and good removal effect of rural domestic sewage are taken as far as possible.

1. Introduction

In recent years, with the continuous improvement of rural living standards and the continuous advancement of urbanization, the rural infrastructure and living environment have been greatly improved. At the same time, the discharge of rural domestic sewage has increased year by year^[1]. At present, there are no complete drainage and sewage treatment system in most rural areas, domestic sewage is discharged at will, most of them directly into the river, which poses a huge threat to the water environment health^[2]. Therefore, it is of great significance for rural water environment protection to find out the current situation of rural domestic sewage treatment.

Guizhou Province is located in the karst area, one of the three fragile environmental zones in China. The topography and landform are fragmented, and its ecological environment is more serious than other regions^[3]. In addition, the population of Guizhou is scattered, and the agricultural population is large, the domestic sewage is discharged in disorder and difficult to collect^[4]. At present, the rural

water environment in Guizhou has become one of the hot issues to be solved urgently, and a number of rural sanitation projects have been implemented simultaneously. However, there has been no research on the status of rural domestic sewage treatment in Guizhou. Based on the basic situation of rural areas in Guizhou Province, this paper summarizes the domestic sewage treatment in various areas of the province to understand the administrative village coverage of rural sewage treatment in Guizhou Province. In addition, this paper also systematically summarizes the current situation and main technical models of rural domestic sewage treatment projects in Guizhou Province.

2. Basic situation of rural areas in Guizhou

Guizhou Province consists of six cities, namely, Guiyang, Anshun, Tongren, Liupanshui, Zunyi and Bijie. Three states, namely, Buyi and Miao Autonomous Prefecture of QianNan, Southwest Guizhou Autonomous Prefecture and Qiandongnan Miao and Dong Autonomous Prefecture, and The New Area between Guiyang and Anshun, involving 88 counties (districts and cities). Statistics of permanent residents in Guizhou province at the end of each year from 1978 is shown in Fig. 1. It can be concluded from the graph that the total population of our province is basically on the rise year by year. From 2004 to 2010, there was a slight decline. By 2016, the population of the whole province increased to 35.55 million. The proportion of rural population is relatively high. By the end of 2016, the number of permanent residents in rural areas totaled 19,850,000, accounting for 55.9% of the total population of the province. The residents number showed the following trend during 1978~2016. From 1978 to 1990, it tended to balance, fell sharply in 1991, and tended to balance again from 1991 to 1999. After 1999, it rose year by year.

In addition, the proportion of the rural population in the total of Guizhou Province in each city and state are shown in Fig.2. It shows that the proportion of rural population in various cities and counties is relatively prominent. Bijie is the area with the largest rural population in our province, accounting for 21.4% of the total. The rural population in Guiyang accounts for only 5.4% of the total of the province.

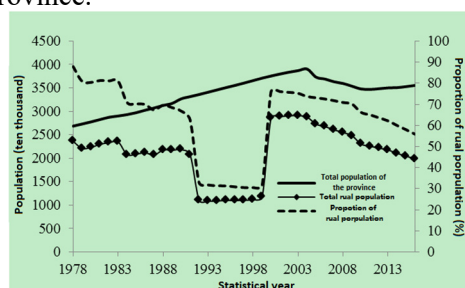


Fig.1 Statistics and comparison of permanent resident population in Guizhou province at the end of last year

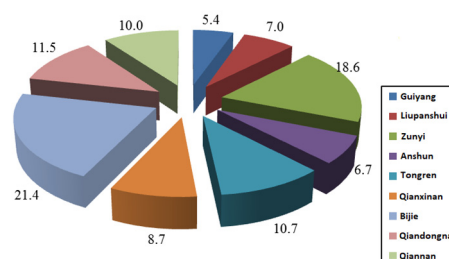


Fig.2 The proportion of agricultural population in each city and Prefecture in Guizhou province accounts for the total population of the province

3. Present situation of rural domestic sewage treatment in Guizhou

The data of this study mainly come from the field survey data of 1414 township-level units and 17664 administrative villages (including 15114 administrative villages, 2550 agricultural-related residential committees) in Guizhou. The distribution of rural sewage treatment facilities in Guizhou is shown in Figure 3. It can be seen that the coverage rate of rural sewage treatment facilities in different regions of our province is quite different. Among them, Zunyi and Guiyang are relatively high, with the coverage rates of 30.7% and 27.4% respectively. However, Bijie is the lowest with the largest rural population, which is 7.4%. In summary, about 13.24% domestic sewage of the administrative in the whole province has been centralized or partially centralized (It refers to there are facilities in the village for centralized treatment of sewage, even there are no facilities, the sewage need to be collected uniformly also by other units). Sewage treatment level is relatively low.

At the same time, this paper also summarizes the rural environmental renovation projects in recent

5 years (from 2013). It shows that 1632 rural environmental renovation projects have been implemented in the past 5 years in our province. 992 of them are related to the construction of sewage treatment facilities, with a total investment of 1 billion 649 million yuan, including 852 million yuan of central environmental protection funds, 340 million yuan of provincial and 121 million yuan of local. These domestic sewage treatment projects are mainly constructed wetlands and integrated sewage treatment technology. And the capacity of these sewage treatment plants is almost under 300m³/d, which accounts for about 97.6% of the total items.

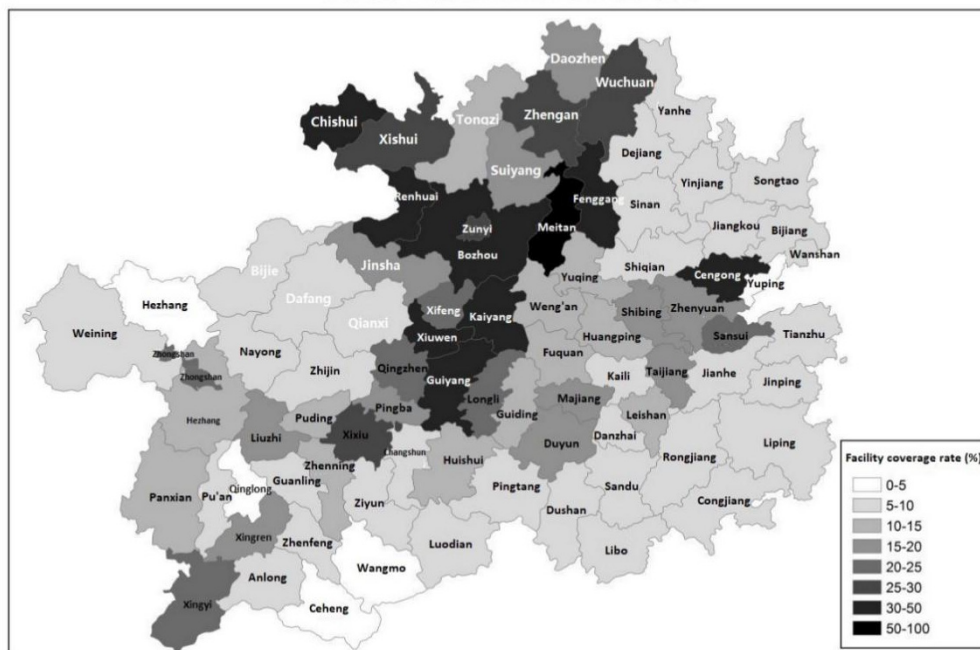


Fig.3 Coverage of sewage treatment in administrative villages in Guizhou (%)

4. Rural domestic sewage treatment technology in common use

Previous studies^[5~7] have shown that the quality of rural domestic sewage is relatively stable and there will be no toxic substances. The main pollution factors are nitrogen, phosphorus, organic matter, bacteria and parasitic eggs. At present, for the treatment of rural domestic sewage, there are many research and application at home and abroad, such as constructed wetland treatment technology, anaerobic biological treatment technology, underground soil infiltration purification system, and combined process treatment technology and small-scale integrated sewage treatment equipment. After the investigation of rural domestic sewage treatment technology mode in Guizhou, some conclusions can be concluded as follows: in areas with relatively concentrated villages, centralized treatment technologies for rural domestic sewage are commonly adopted, including constructed wetlands and integrated sewage treatment equipment, and a decentralized sewage treatment system is often adopted for single households.

4.1 Constructed wetland

Constructed wetland is a semi biological sewage treatment system which is designed and reconstructed artificially. It is mainly composed of three parts: soil matrix, aquatic plant and microorganism. Because of its advantages such as small investment, extensive management, strong shock resistance and good effluent quality, it is suitable for application in rural areas where capital is scarce and land area is relatively rich. At the same time, it can beautify the environment and save water resources. According to the internal water level of the constructed wetland, it is divided into surface flow wetland and subsurface flow wetland. At present, in the application of rural domestic sewage treatment in our province, constructed wetland is often used as the main treatment technology

or advanced treatment technology of village centralized sewage treatment. Subsurface flow wetlands (divided into horizontal and vertical subsurface flow wetlands according to flow direction) are commonly used wetland treatment models. In addition, the combined wetland treatment system composed of several constructed wetland pools of the same type or different types is also widely used in our province. The following figure shows a sketch of the technological process of the constructed wetland sewage treatment system in Yuquan Street Xinshi Village, Meitan County. The design capacity of the project is 65m³/d and the project investment is 910,000 yuan. The sewage treatment scope includes 91 farmer households, 3 farmhouses, and 1 village hotel. Through monitoring, the treated water can reach the first class and level B discharge standard of Discharge standard of pollutants for municipal wastewater treatment plant (GB18918-2002) .

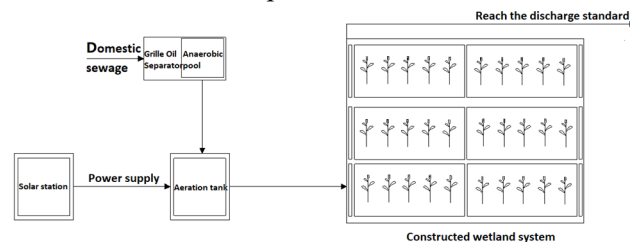


Fig.4 Layout plan of a constructed wetland sewage treatment system in Meitan County of Zunyi

4.2 Integrated sewage treatment technology

Integrated sewage treatment equipment is a combination of pretreatment, biochemistry, sedimentation, disinfection, sludge reflux and other units based on biochemical reactions. There are three structural modes including integrated oxidation ditch, integrated membrane bioreactor and integrated A/O or A2/O equipment. Investigation shows that MBR and AO or A2/O equipment are widely used in our province.

The technological process of AO-MBR used in Chetian sewage treatment plant in The New Area between Guiyang and Anshun is shown in the following graph. Among them, the pretreatment process consists of coarse grille, fine grille, and aerated grit chamber and membrane grille. The two stage treatment process is AO2-MBR integrated equipment. Ozone oxidation process for advanced treatment, Chlorine dioxide for disinfection, and the treated sewage will be recycled. The project has been completed and put into operation since 2014, March. The sewage treatment plant is located at the village. The scale of the first stage sewage treatment is 400m³/d, the service target is 830 people in Chetian Village, with an area of about 362 square kilometers.

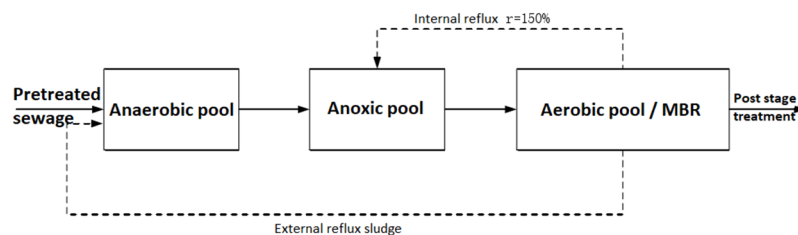


Fig.5 Schematic diagram of A2O-MBR membrane bioreactor

4.3 Decentralized sewage treatment system without power

Decentralized sewage treatment system without power is a decentralized domestic sewage treatment method commonly used in rural areas of Guizhou. Its technological process is shown in Fig.6. Single household sewage or multi household sewage will be collected, then the collecting sewage enter the sewage filter, floating matter and particulate matter will be removed there, and then the treated sewage enter the TQW system. Because of the advantages of modified fibers, such as porous, large surface area (more than 2000m²/g), high porosity, high adsorption capacity, abundant microspores and various functional groups, and various enzymes and bio flocculants produced by the adherent microorganisms

on the surface of biofilm, also the pollutants can be removed by biochemical methods such as adsorption interception, complex sedimentation, digestion and degradation. Then the sewage enter the secondary SWL bio filter system. The sewage treated by the two stages fully meets the discharge standard and can be discharged into irrigation canals or farmland. At the same time, the power-less decentralized sewage treatment system also has the advantages of no power, easy maintenance, low operating cost, standard discharge, less land occupation (no land acquisition), no large-scale pipeline network construction, 40%-50% less investment than the traditional sewage treatment method, and the treatment system can beautify the environment. It can be widely accepted by villagers. This kind of technology is widely used in the distributed sewage treatment in Dafang, Nayong, Hezhang, Cengong, Majiang, Zhenfeng, Qingzhen, Libo, Wudang and so on. Through monitoring, the treated water can also reach the first class and level B discharge standard of Discharge standard of pollutants for municipal wastewater treatment plant (GB18918-2002) .

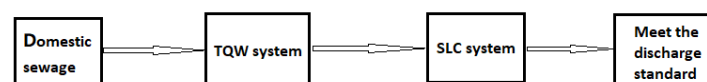


Fig.6 Process flow chart of decentralized sewage treatment system without power

5. Conclusion

This paper summarizes the investigation data of domestic sewage treatment in 1414 township-level units and 17664 administrative villages in Guizhou, and draws the following conclusions.

- The rural resident population in our province is relatively large, accounting for 55.9% of the total population of the province. By comparing the proportion of rural population in each city and proportion in the total province, we can see that Bijie is the region with the largest distribution of rural population, it accounts for 21.4% of the total rural population in the province. However, the rural population in Guiyang accounts for only 5.4%.
- About 13.24% of the domestic sewage in administrative villages in the whole province has been centralized or partially centralized, and the degree of sewage treatment is relatively low. Among them, Zunyi and Guiyang are relatively high, with the coverage rates of 30.7% and 27.4% respectively. However, Bijie is the lowest with the largest rural population, which is 7.4%.
- From the summary of rural environmental improvement projects in recent 5 years (from 2013), it can be concluded that: 1632 rural environmental renovation projects have been implemented in the past 5 years in our province. 992 of them are related to the construction of sewage treatment facilities, with a total investment of 1 billion 649 million yuan, including 852 million yuan of central environmental protection funds, 340 million yuan of provincial and 121 million yuan of local.

In addition, through the investigation of rural sewage treatment technology mode in Guizhou Province, it can be concluded that in areas with relatively concentrated villages, centralized treatment technologies for rural domestic sewage are commonly adopted, including constructed wetlands and integrated sewage treatment equipment, and a decentralized sewage treatment system is often adopted for single households.

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