Experiences from wastewater treatment in the hilly areas in Sichuan

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Abstract. In recent years, measures have been taken against rural environmental problems, and remarkable achievements have been made in the construction of sewage treatment facilities, but there are still some problems. This paper takes three small sewage treatment facilities in the hilly areas of Sichuan as the research object, through field research and data collection, statistical analysis and analysis of various facilities, combined with actual use, the corresponding optimization development proposals are summed up to optimize the utilization efficiency of the facilities and improve the living environment in the rural areas. The results show that the combination of A2O+MBBR is more suitable for the economy and performance at Sichuan hilly areas, but other options can be selected according to different situations to achieve the best results. At the same time, this paper points out some problems and provides reasonable corresponding suggestions for rural small-scale sewage treatment facilities from the aspects of technical mode selection, planning and design, construction and operation, etc., and provides a more practical and feasible optimization plan and reference for the region to control rural water pollution.

1. Introduction
Through the unremitting efforts of experts, scholars and government departments, great progress has been made in terms of China's small sewage treatment facilities. With the implementation of China's rural revitalization strategy, the living standards of rural residents have increased rapidly, and at the meanwhile the discharge of rural domestic sewage has also increased. However, most villages lack perfect drainage channels and sewage treatment systems, as a result the domestic sewage is freely discharged causing serious pollution to the rural ecological environment, which not only poses a serious threat to groundwater, but also causes eutrophication of lake nitrogen and phosphorus, and may even lead to the production of black and odorous water. As the economic condition in rural areas is poor, the pollution sources of sewage are scattered, the scale is small, the infrastructure facilities are imperfect, and the technical strength of operation and maintenance is weak. Due to the above multiple factors, the rural sewage treatment system is quite different from the conventional urban sewage treatment \cite{1}. The integrated sewage treatment device concentrates pretreatment, biological treatment, sedimentation and disinfection on one device. Due to the small size of the device and small area needed for the device, it can be built nearby so that the investment in pipelines can be saved. Besides, it can also be installed in advance and installed once it arrives at the destination. It is convenient and fast, and the device can work stably and be easily managed. It is also possible to flexibly combine the
processing units to meet the requirements for wastewater treatment in most areas. In recent years, with the promulgation of the three-year remediation action plan for rural human settlements, the protection of rural ecological environment has also risen to the height of national policies. Therefore, with integrated sewage treatment facilities and ecological treatment technologies, not only can funds be saved, but also environment protected. In terms of processing technology, according to its process categories and characteristics, it can be divided into: eco-technical, bio-technical, biological and ecological combined technology and materialized technology. With the deepening of research, scholars' research has begun to focus on the exploration of new technologies and the research of ecological processing technologies, such as screw pyrolysis technology [2], to adopt sludge treatment using reed beds [3], rural sewage lagoon system combined with underground filtration technology [4], Integrated algae bacterial system for wheat bran biotransformation and rural domestic sewage treatment [5]; However, in recent years, the measurement and analysis of specific components of pollutants has not only been limited to traditional pollutant indicators, but also taken environmental impact of other pollutant components in sewage treatment into consideration, such as measuring per capita organic pollutant flux in on-site sewage treatment facilities [6] greenhouse gas emissions from different sewage sludge treatment methods [7]. Determination of the attenuation of drug, nutrient and toxicity in sewage [4], structural characterization and evaluation of sewage and sludge [8], etc. Some scholars are not limited to the optimization of the facility itself and the improvement of technology, but make active attempts to plan making and optimization of decision-making of the small sewage treatment. At this time, the experience of urban cases can still be used for reference in rural areas, such as optimization of life cycle assessment indicators for urban sewage treatment [9], formulation of a sustainable development strategy for sewage treatment [10], use of decision support tools to select the best sewage treatment research [11] and non-target screening, prioritization and removal of pollutants in sewage treatment plants and etc.

In general, domestic and foreign scholars' research on small-scale sewage treatment facilities in rural areas tends to be refined, strategic and innovative, and the technology is generally ecological. However, there are still some areas to be further explored: the analysis of specific components of wastewater and the exploration of technological innovation. However, the reality is often limited by many factors, which leads to the failure to implement new technologies and cannot be applied to the construction of small-scale sewage treatment facilities in rural areas. Therefore, the author tries to understand the status of sewage treatment facilities in the hilly areas of Sichuan Province, China through the combination of field research and data analysis.

2. Materials and methods

2.1. Overview of the study area

The research site is located in Chongwang Town, Guang'an District, Guang'an City, Sichuan Province, Zaoziao Town, Nanbu County, Nanchong City, and Caoba Village, Taiping Town, Shawan District, Leshan City. They are mainly distributed in the hilly areas of the Sichuan Basin to the east of Longquan Mountain. Sichuan hilly areas includes all of Nanchong, Suining, Guang'an, Ziyang, Neijiang and Zigong, as well as Bazhong, Dazhou, Yibin and the hilly counties of Luzhou whose administrative centers are all located in the hilly areas, and also includes Mianyang, Deyang, Meishan and the counties in the eastern hilly areas of Leshan all of whose administrative centers are situated in the plain areas. In the administrative divisions, they involve 14 prefecture-level cities in Sichuan, which are all densely populated and economically concentrated areas in Sichuan (figure 1).

The hilly areas of Sichuan are also known as the hills in the basin. It is located where the Longquan Mountain Range is in the west, the Huaying Mountain in the east, the Daba Mountain in the north, and the south of the Yangtze River in the south. The area is about 84,000 square kilometers. The hilly areas and the creeks are the most prominent geographical features of the area. It is the most stable part of the eastern Sichuan platform. In most areas, the rock formation is flat or dip, with an altitude of about 250-600 meters, and the valley height difference is 50-100 meters. There are many shallow hills
in the south and many deep hills in the north. Soil and water loss in the hilly areas of Sichuan is serious, and the vegetation in the whole area is sparse, which is region with the lowest forest cover rate in Sichuan. Another feature is that there are more than enough heat and insufficient precipitation. The annual average temperature of this area is 16-18°C. It is featured by the warm winter and early spring and is a region with high heat in Sichuan. The annual precipitation is only 900-1000 mm, and it is also known as a place where the winter is dry and spring is droughty.

![Survey location map](image)

**Figure 1.** Survey location map.

2.2. *Research method*

In this study, a small-scale sewage treatment facility located in the hilly area of Sichuan Province with a treatment scale of less than 1000 m$^3$/d was selected, which made the monitoring data of different research sites comparable, and can analyze the strength and weakness of different sewage treatment facilities more specifically. The research method includes three parts: collecting research data and survey, as well as analysis the data and get the conclusion. The contents of the survey include the project overview, the technical route of the main process, the test results of actual water quality, and the advantages of project implementation. As the research sites are all in the country, the indicators of the pollution treatment on the three research sites are the same, and the sewage treatment technology adopted is similar and comparable. Therefore, the three facilities are named as Case 1, Case 2 and Case 3 according to the research order. The water quality monitoring includes the following six indicators: CODcr, BOD5, SS, TN, TP, NH3-N. The detection methods for different indicators are shown in the following table (table 1).

| Indicator | Detection Method |
|-----------|------------------|
| CODcr     | Method 1         |
| BOD5      | Method 2         |
| SS        | Method 3         |
| TN        | Method 4         |
| TP        | Method 5         |
| NH3-N     | Method 6         |

The survey is conducted on May 2018. There are two sources of data: interviews with relevant departments for data collection and on-site data monitoring; In the process of data sampling and composition determination, the peak time of sewage treatment in one day is selected with the same sampling time of the three facilities, which is 18:00, to ensure the representativeness of the data, and
the data from different treatment facilities measured is comparable. However, due to the lack of continuous testing data provided by government departments, only the sample results, there is only one sample data obtained from each facility.

**Table 1.** Classification, concentration-determining methods and standards of water pollutants.

| Pollutant Items | Methods | Standards          |
|-----------------|---------|--------------------|
| CODcr           | Dichromate Method | GB 11914          |
| BOD5            | Microbial Sensor Rapid Assay | HJ/T 86    |
| SS              | All-glass Microporous Membrane filter for Gravimetric Measuring Method | GB 11901 |
| TN              | Alkaline Potassium Persulfate Digestion Ultraviolet Spectrophotometry | HJ 636   |
| TP              | Ammonium Molybdate Spectrophotometry | GB 11893 |
| NH3-N           | Salicylic Acid Spectrophotometry | HJ 536   |

Three representative projects had been selected as the survey sites which were all located in the rural area. The spatial relationship between the three sites was not concentrated, and the actual effects of the facilities under different topographical and climate conditions were examined to ensure the objectivity of sample selection. Finally, the statistical analysis of the collected data was conducted and the conclusion of the study drawn. A subsubsection. The paragraph text follows on from the subsubsection heading but should not be in italic.

3. Results and analysis

3.1. Analyses of field research and typical case

3.1.1. Sewage treatment station in Chongwang Town, Guang'an District, Guang'an City (Case 1). The sewage treatment station of Chongwang Town, Guang'an District is located in Group 10, Chongwang Village, Chongwang Township, Guang'an District, Guang'an City. The planned land area of the project is 1100 square meters and the design scale is 400 m$^3$/d. The AOAS box-type integrated treatment process (modified A2O process) is adopted with 1438 meters pipe network as the supporting and a total investment of 600.93 million yuan, serving a population of 5,000 people around the town and surrounding areas. The project started the construction in January 2015 and was put into operation in July 2016. The designed water output index reached Grade A of GB18918-2002, “The National Urban Sewage Treatment Plant Pollutant Discharge Standard”, effectively improving the water environment around the town. The figure below shows the process flow diagram (figure 2).

**Figure 2.** Process flow chart of sewage treatment station in Chongwang Town, Guang'an District, Guang'an City.

The sewage treatment station is currently operating well and the effluent water quality is stable. The sewage treatment station accommodates the water body of the nearby river, adopts an integrated sewage treatment device, and finally performs deep purification through the constructed wetland. The test table for the effluent water quality is shown in table 2.
Table 2. Influent and effluent water quality of sewage treatment station in Chongwang Town, Guang'an District.

| Water quality index (mg/L) | Designed Standard Content for Effluent Water (mg/L) | Actual Content for Effluent Water (mg/L) |
|---------------------------|--------------------------------------------------|----------------------------------------|
| CODcr (mg/L)              | 50                                               | 30                                     |
| BOD5 (mg/L)               | 10                                               | <10                                    |
| SS (mg/L)                 | 10                                               | <10                                    |
| TN (mg/L)                 | 15                                               | 5.52                                   |
| TP (mg/L)                 | 0.5                                              | 0.24                                   |
| NH3-N (mg/L)              | 5                                                | 0.51                                   |

The on-site investigation shows that the project has the following advantages in the management of contiguous small towns: the effluent effect is good, the process is simple, the integrated sewage treatment equipment can be unattended, and the operating cost is low; the modular construction and construction itself is simple and not restricted by the terrain. The technology is applicable to domestic sewage treatment in rural areas and small towns with developed or more developed economy, especially for storage water bodies with high requirements for N and P.

3.1.2. Sewage treatment station in Zaojiao Town, Nanbu County, Nanchong City (Case 2). The sewage treatment station is located in Zaojiao Town, Nanbu County, Nanchong City (figure 1). The design scale is 240 m³/d, and the actual processing capacity is 200 m³/d. Combined with the technical characteristics of A2O and MBBR, the high-efficiency integrated sewage treatment device is adopted. The service covers an area of Zaojiao Town and its nearby towns. The designed water output index meets the Grade A standard of GB18918-2002 “The National Urban Wastewater Treatment Plant Pollutant Discharge Standard”. The figure below is the process flow diagram (figure 3).

![Flowchart of sewage treatment station in Zaojiao Town, Nanbu County, Nanchong City](image)

Figure 3. Flowchart of sewage treatment station in Zaojiao Town, Nanbu County, Nanchong City.

The integrated sewage treatment plant adopts the A2O-MBBR process, which is a high-efficiency sewage treatment process combining A2O and MBBR. The designs of modified biosuspension filler, ring water and energy-saving reflow are adopted by setting pre-denitration, anaerobic, anoxic and aerobic functional zones to enhance the removal effects of nitrogen and phosphorus for the treatment system, and has the characteristics of intensive structure and stable operation. The sewage treatment device forms a standardized products with a daily processing capacity of 50 m³/d, 100 m³/d, 200 m³/d, and 300 m³/d. The corresponding equipment can be selected according to different environments, different types, and different treatment water amounts, and the construction is convenient. The test form of the effluent water quality provided by the staff is shown in table 3.

The survey shows that the project has the following advantages in sewage treatment in small towns: the process is simple. The use of integrated sewage treatment equipment can basically achieve unattended operation, relatively low operating costs; good effluent effect; modular construction. The construction is simple, and is not limited by the terrain, and can be modularized in stages to facilitate capacity expansion. The technology is applicable to domestic sewage treatment in economically
developed or more developed rural and small towns, especially for water bodies with high requirements for N and P treatment.

Table 3. Influent and effluent water quality of sewage treatment station in Zaojiao Town, Nanxian County, Nanchong City.

| Water quality index (mg/L) | Designed standard content for effluent water (mg/L) | Actual content for effluent water (mg/L) |
|---------------------------|-----------------------------------------------|----------------------------------------|
| CODcr (mg/L)              | 50                                             | 36.3                                   |
| BOD5 (mg/L)               | 10                                            | <10                                    |
| SS (mg/L)                 | 10                                            | <10                                    |
| TN (mg/L)                 | 15                                            | 0.052                                  |
| TP (mg/L)                 | 0.5                                           | 0.112                                  |
| NH3-N (mg/L)              | 5                                             | 0.061                                  |

3.1.3. Sewage treatment plant in Mojiang Office, Leshan City (Case 3). The project is located in Caoba Village, Taiping Town, Shawan District, Leshan City. The design scale is 800 m³/d, and the actually treated water volume is 600 m³/d. It adopts integrated sewage treatment equipment (Bass 200 high-efficiency biofilm reactor) with a total investment of about 8 million yuan and serving a population of 7,000 people. The project started construction in 2017 and was put into operation in February 2018. The designed water output reached the GB18918-2002-grade A standard of “The National Urban Wastewater Treatment Plant Pollutant Emission Standard”, which can effectively improve the water environment around the town.

The collecting process of the domestic sewage is conducted through the pipeline. First, the large suspended solids are removed through the grille, then the sewage flew to the regulating tank, then is pumped into the bass through the lifting pump in the regulating tank, and then is biochemically treated by sequentially flowing through the pre-denitrification tank, the anaerobic tank, the anoxic tank and the aerobic tank and the muddy water is separated in the sedimentation tank, and the effluent is finally sterilized by the ultraviolet sterilizer and discharged or reused. Wherein, the nitrifying liquid is stripped from the aerobic zone to the anoxic zone for denitrification, and part of the sludge in the sludge tank of the sedimentation tank is returned to the pre-denitrification tank to replenish the sludge, and the excess sludge is discharged into the sludge concentration tank. The concentrated and dried sludge can be transported into landfill or compost. The figure below is the process flow diagram (figure 4).

![Process Flow Diagram](figure 4)

The integrated sewage treatment device (Bass 200 high-efficiency biofilm reactor) adopts A2O+MBBR process, the biochemical part residence time is 10.4 h, and the precipitation zone residence time is 3.6 h. It is featured by high degree of automation, more energy saving, and low failure rate. The MBBR is used as a filler to hang the film. The Bass 200 Efficient Biofilm Reactor forms a standardized product with a daily throughput of 15 m³/d, 30 m³/d, 60 m³/d, 75 m³/d, 100 m³/d, 150 m³/d, and 200 m³/d. Among them, the set of Bass 200 equipment is about 900,000 (including transportation costs), and the processing scale is 200 m³/d. The test form of the effluent water quality provided by the staff is shown in table 4.
Table 4. Detection of water quality indicators (water quality data is detected by Shawan environmental monitoring station).

| Water quality index (mg/L) | Designed standard content for effluent water (mg/L) | Actual content for effluent water (mg/L) |
|---------------------------|---------------------------------|-----------------------------------|
| CODcr (mg/L)              | 50                              | 29                                |
| BOD5 (mg/L)               | 10                              | <10                               |
| SS (mg/L)                 | 10                              | <10                               |
| TN (mg/L)                 | 15                              | 6.82                              |
| TP (mg/L)                 | 0.5                             | 1.64                              |
| NH3-N (mg/L)              | 5                               | 0.6                               |

Since the collecting area is substantially free of septic tanks, the sewage concentration is high, and there are many dirt and debris, resulting in frequent grid cleaning. The higher TP influent concentration leads to excessive water content. The survey shows that the project has the following advantages in sewage treatment in small towns: the process is simple. As the integrated sewage treatment equipment is adopted, the equipment is automatically operated and no need of attending; the water discharge effect is good. The effluent can reach the Grade A standard of urban sewage discharge, low noise, no odor, no impact on the surrounding environment; modular construction. The device covers a small area so it is convenient for site selection. It has a short construction period and is standardized in module configuration, which is convenient for capacity expansion; the investment in pipe network construction and operation management is low.

3.1.4. Summary. A comparison of the actual effluent quality of the small sewage treatment facilities at three typical research sites is shown in the following chart (figures 5 and 6).

The order of daily water treatment is: the case 3 (700 m³/d) > the case 1 (400 m³/d) > the case 2 (240 m³/d). Through the chart, we can draw the following conclusions: In the treatment effect of CODcr index, the third facility has the best reduction effect, and both BOD and SS have been completely eliminated. The order of reduction effect of TN, TP and NH3-N: the case 2 > the case 1 > the case 3. The reduction effect of the facilities in the case 2 is significantly better than the other two.

![Figure 5](image1.png)

**Figure 5.** Comparison of sewage treatment capacity of three types of equipment (COD, BOD, SS).
Figure 6. Comparison of sewage treatment capacity of three types of equipment (TN, TP, NH3-N).

Based on the data analysis obtained above, the optimal choice for Sichuan hilly region can be obtained: if the daily water demand is not high, then the solution adopted in the second case has important reference value and can be considered; if the daily water demand and the number of people who needs the service of water are high, then the third option can be considered. And if we consider the complexity of the process, we can find the order of complexity from high to low: case 1 > case 2 > case 3. In the case where the amount of water handled and the number of people served are not more than the case 3, the case 2 is selected as the optimal solution. However, when the daily water volume is higher than the case 2, we recommend a case 3. Although the case 3 has the highest total cost based on cost considerations, its equipment consists of multiple units of equipment, and the unit equipment has the lowest cost and flexible application, which can adapt to different situations. At this time, the schemes of the case 3 is most effective. The above is the preliminary analysis based on the surveyed data. The actual reasons may be multifaceted. We will continue to do some further discussion and analysis from a technical perspective and a practical operational perspective.

3.2. Comparative analysis of small sewage treatment facilities suitable for research scope

3.2.1. A2/O process of the secondary sewage treatment. The paragraph text follows on from the subsubsection heading but should not be in italic. The A2/O method is a commonly used secondary sewage treatment process, which can be used for secondary sewage treatment or tertiary sewage treatment. It has good nitrogen and phosphorus removal effects and is most widely used in small
sewage treatment facilities. The process began in the 1970s and evolved on the basis of the AO denitrification process. The process is the simplest process of simultaneous removal of nitrogen and phosphorus in the system; the three different environmental conditions of anaerobic, anoxic and aerobic and the organic combination of different kinds of microbial flora can simultaneously remove organic matter, denitrification and dephosphorization. The process is featured by the high efficiency of pollutants removal, stable operation, and resistance to shock load. Under the alternating operation conditions of anaerobic (anoxic) and aerobic, the filament expansion of the sludge is not easy to occur; the sludge sedimentation performance is good; The mud contains high phosphorus and has high fertilizer efficiency; it does not need to be administered during operation, and the running cost is low.

Process limitations: The denitrification effect is affected by the reflux ratio of the mixed solution, and the removal effect of the phosphorus is affected by the entrainment of DO and Nitrate oxygen in the reflux sludge, so the removal efficiency of the nitrogen and phosphorus is not high; Besides, it is difficult to increase the effect of removing phosphorus, and there are certain limits for sludge growth so it is difficult for it to improve; it is also difficult to further increase the denitrification effect; the treated water entering the sedimentation tank should maintain a certain concentration of dissolved oxygen, reduce the residence time, and prevent anaerobic conditions and the phenomenon of phosphorus release from sludge, but the concentration of the dissolved oxygen should not be too high to prevent the circulating mixture from interfering with the anoxic reactor.

3.2.2. Moving bed biofilm reactor (MBBR). The process of MBBR combines the advantages of both traditional fluidized bed and biological contact oxidation. It is a new and efficient method for sewage treatment. It relies on the promotion of aeration and water flow in the aeration tank to make the carrier in a fluidized state, in turn, it forms a suspension-grown activated sludge and an attached biofilm, which enables the entire reactor space to be used by the moving bed biofilm, giving full play to the superiority of both the attached and the suspended organism, so as to develop strengths and avoid weaknesses and complement each other. Unlike previous fillers, suspended fillers can be frequently contacted with sewage and are therefore referred to as “moving biofilms. The key to MBBR technology is the development of a bio-filler whose gravity is close to water and easy to move freely with water under slight agitation.

It has the characteristics of large effective surface area and suitable for microbial adsorption. It has strong applicability and wide application range. It can be used for both organic removal and nitrogen and phosphorus removal. It can both be used in the new sewage treatment plants and the process modification and upgrading of existing sewage treatment plants.

However, there are certain process limitations: higher investment; as suspended fillers are used in MBBR so if the effluent isolation is not done well, it is easy to produce filler loss or blockage; The material and form of suspended filler used by MBBR have great influence on the effect of hanging film; in order to ensure the suspension effect of suspended filler, aperture is generally used for aeration whose energy consumption is high, and the design requirements for gas distribution are high; for sewage environment with higher water temperature, the MBBR process does not significantly enhance the effect of conventional activated sludge process.

3.3. Problems with existing operating models
The main problems in operation: the lack of professional maintenance at the sewage plants or stations, which are generally managed by local residents; the lack of maintenance funds; most of the sewage treatment facilities are directly operated and maintained by the competent government departments, failing to exert the enthusiasm of supervision and assessment; The department in charge of the construction of sewage pipe network and that of sewage treatment facilities are two different departments, resulting in unsynchronized construction and the situation under which there is no sewage treatment. In some areas, the sewage pipe network is old and in some cases when sewage treatment facilities are under construction, the pipe network has not been well repaired or rebuilt due to funding problems. As a result, the amount of sewage treatment is usually less than the design value,
and the amount of water in the rainy days is greater than the design value.

There are still many villages and towns that are seriously lacking in pipe network facilities and weak in sewage collection capacity. Because the sewage plant and the pipe network belong to two responsible entities, so when the water quality exceeds the standard, it is easy to have unclear responsibility. Since there is no septic tank in the residential area, the domestic wastewater directly enters the pipe network, resulting in more debris and frequent grille cleaning. For example, the sewage treatment station of the Mojiang Office in Taiping Town, Leshan City needs to be cleaned almost every day, and the concentration of pollutants is higher than that of urban sewage treatment plants.

4. Conclusions and discussions

4.1. Measures and suggestions

It is suggested that the government plan and build pipe networks in a unified manner, and build sewage treatment facilities in batches according to actual needs. The investment in small-scale sewage treatment projects is relatively large which is a huge pressure on most local governments. Therefore, the selection of the processes for small-scale sewage treatment should follow three basic principles: a process with strong impact load resistance, with simple operation and maintenance and with low energy consumption can be selected; The layout of small sewage treatment facilities should be adapted to local conditions. In the alpine mountainous areas, hilly areas and scattered areas, when it is difficult to construct the sewage collection pipe network, it can be treated in situ according to the situation; Larger villages can be divided into several districts, each with a small centralized management approach; A large centralized management approach can be directly adopted in smaller villages. In the urban and rural overall planning and drainage special planning, basic conditions such as local economic level, population density, living habits, climatic characteristics, topographic and geological conditions and current drainage facilities should be analyzed according to local conditions, the drainage system should be determined reasonably, drainage divisions accurately defined, sewage treatment mode scientifically formulated and emission standards strictly implemented. Large and medium-sized centralized sewage treatment plants will continue to play an important role in controlling water pollution and improving water environment quality. With the acceleration of urban construction, sewage resource recycling has received extensive attention, and the layout of sewage treatment plants has been decentralized and miniaturized. Therefore, in the planning of sewage treatment plant layout, it is necessary to comprehensively consider various factors such as technical and economic indicators, environmental impact, comprehensive utilization of sewage resources, etc., and comprehensively analyze the current conditions of sewage pipeline system, river and lake water system planning, urban construction area layout, etc. so as to compare a variety of options and finally decide the one.

4.2. Conclusions and prospects

In terms of technical operability, although it is not easy to operate the processes of A2O and MBBR. But The interviews with relevant staff in this field survey indicated that it is easy to obtain integrated equipment and personnel technical training for small-scale sewage treatment facilities from relevant companies, the financial support is provided by the government, and the requirements for operational and management staff are relatively low under existing sewage discharge standards, so A2O and MBBR technologies can be applied in rural areas. The interviews also indicated that it is hoped that the discharge standards for small-scale sewage treatment facilities should be tailored to local conditions and treated differently, and the discharge standards can be appropriately relaxed.

Therefore, the discharge standards of small domestic sewage treatment facilities must take into account the current economic strength. The social development in most of China's small towns and rural areas is relatively backward and economic conditions poor. For these areas, sewage treatment projects are not only costly to build. The operation and maintenance costs after completion are also a
heavy economic burden. Without the financial support from the state and superior governments, sewage treatment projects in small towns and rural areas will be in a situation that they can neither be built nor afforded. Therefore, saving investment and reducing operating costs are important factors that must be carefully considered when determining small-scale domestic wastewater treatment targets.

In the hilly areas of Sichuan, the water quality is characterized by low water temperature, large fluctuations in water volume and quality, and incomplete shunting of rain and sewage. The SS content is high during heavy rain, which has a greater impact on ecological and materialized sewage treatment systems. Therefore, when determining the small domestic sewage treatment facilities in the hilly areas of Sichuan, a variety of most important factors need to be seriously considered. They are: saving investment, reducing operating costs, determining appropriate technologies based on water temperature and topography, handling capacity and redundancy of sewage water. In terms of effluent parameters, based on actual research and data acquisition, suspended solids (SS), chemical oxygen demand (CODcr), and total nitrogen (TN) are the most important detection parameters in the treatment of water.

Through this research, we have a preliminary understanding of the current situation of the planning and construction of sewage drainage systems in the hilly areas of Sichuan Province, the status and problems of sewage treatment, the use of small domestic sewage treatment facilities, and the status of investment, construction and operation modes of sewage treatment. Valuable experience gained and data collected on successful cases of small sewage treatment facilities can help provide experience and reference for the construction, operation and management of small sewage treatment facilities in the future. The biggest deficiency of this study is the shortage of sample size and sampling frequency. This is also due to the lack of continuous detection data provided by the local government, which may lead to errors in measurement results, and is also a problem to be solved in the future research.

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