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Application Research of Rotating Cross-flow Ultrafiltration Water Purifier in Rural Decentralized Water Supply Project

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Abstract: Aiming at remote and economically backward rural areas, the rotary cross-flow ultra-filtration purifier developed has solved the problem of rural users' difficulty in safe drinking water and provided technical support for rural dispersed water supply engineering equipment. The experimental results show that the equipment can remove turbidity, microorganism and bacteria well, all indexes are in line with China's national standard of drinking water, and can provide stable effluent during operation, ensuring sufficient drinking water for users.

1. Introduction

China's rural drinking water is developing in the direction of centralized water supply. Only a small part of the economically developed rural drinking water has been treated centrally. The drinking water that meets the standard is sent to the farmer's home through the pipe network, but some remote rural areas are scattered due to users. Due to the small size of the village and the small amount of water supply, the centralized water supply currently used is difficult to achieve. It still needs to adopt a decentralized water supply method, that is, the dispersed households directly draw water from the water source, without any facilities or water supply methods with simple facilities. Rural drinking water sources generally use rivers, lakes, reservoirs, well water and rainwater collection. These water sources are generally less affected by industrial pollution, but turbidity, organic pollutants, and microbial exceeding standards are common. Some of the organic matter is carcinogen. In addition, most farmers use water storage equipment to ensure normal water using. After the drinking water is stored, the water quality will change to some extent. Therefore, it is difficult for water quality to meet the national sanitary standards for drinking water^[1-2].

The ultrafiltration water purification process is an advanced treatment process following the conventional water treatment process. Ultrafiltration not only effectively removes turbidity, but also removes organic and inorganic contaminants from water without any additives. It does not have any water treatment by-products and is highly safe. The ultrafiltration membrane device has a small footprint, a small filtration volume, and is easy to operate and easy to manage. At present, the film equipment on the market is often equipped with the front filter element, resulting in high energy consumption and low efficiency, and has certain requirements on the quality of raw water. It is not suitable for remote areas in rural areas and areas with poor water quality requirements^[3-4].

The author uses the MXU001/0.12 drinking water ultrafiltration purification equipment produced by Suzhou Membrane Separation Technology Co., Ltd. to conduct practical research, analyse and



evaluate the application effect of the water purifier in the rural decentralized water supply project, and solve the rural decentralized water supply project. The lack of water purification facilities and equipment provides technical support.

2. Device

2.1. Equipment composition

The equipment adopts rotary cross-flow ultrafiltration (RCM) technology, which consists of ultrafiltration membrane water chamber and UV sterilizer. The ultrafiltration membrane water chamber uses RCM membrane module and drive motor. The equipment adopts imported polyether sulfone (PES) ultrafiltration membrane with an average pore diameter of $0.04\mu\text{m}$ and an ultrafiltration membrane area of 2m^2 . The ultrafiltration membrane is rotated by a driving motor to realize the dynamic membrane operation process.

2.2. Working principle

The immersed programmable rotary operation of the integrated dynamic membrane module achieves ideal cross-flow operation and elimination of concentration polarization. The shear stress, centrifugal force and filtrate turbulence generated on the surface of the flat ultrafiltration membrane can achieve flushing and renewal of the membrane surface, obtain stable membrane flux and operating pressure, significantly improve anti-blocking and anti-pollution ability, and avoid aeration operation. Amplitude reduces energy consumption^[5]. The raw water enters the ultrafiltration membrane water chamber through the water inlet for ultrafiltration, and uses the ultrafiltration membrane to physically intercept the suspended particles, colloids, natural macromolecules, microorganisms and germs, the ultrafiltration water is then sterilized by the water pump through the UV sterilizer to ensure that the water quality meets the national drinking water hygiene standards. The whole process flow of the device is shown in Figure 1.

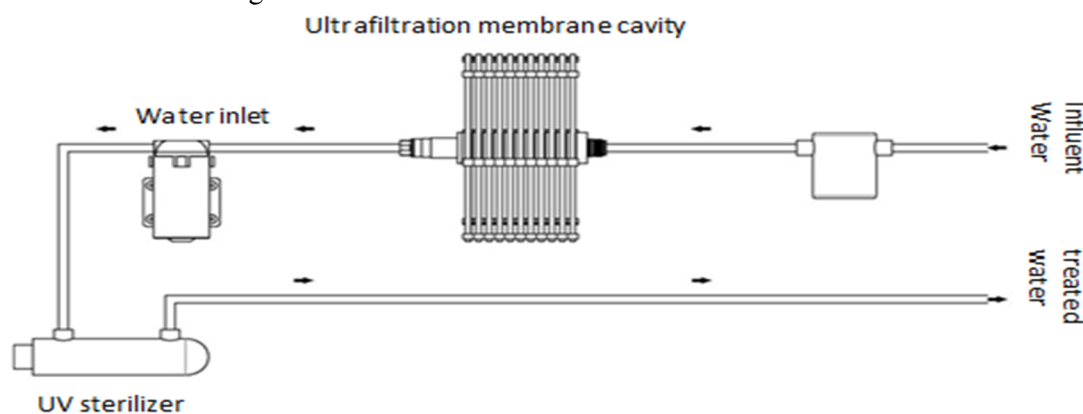


Fig.1. Process flow chart of ultrafiltration membrane water purification equipment

2.3. Experimental method

The Suzhou Taihu Lake and the tributary river water of the Xuguan Canal are used as water sources for simulating rural decentralized water supply. When the raw water is detected, there are problems such as excessive turbidity. During the experiment, the equipment was continuously operated for 8 hours per day (uninterrupted) and continuously operated for 14 days. The turbidity, membrane flux, transmembrane pressure difference and electrical conductivity of the effluent of the equipment were observed and recorded.

3. Results and analysis

3.1. Water quality testing method

Water quality testing was carried out in accordance with China's Standard Test Method for Drinking Water (GB/T 5750 – 2006). According to the “Sanitary Standard for Drinking Water” (GB/T 5749 – 2006), the water quality assessment is carried out. Some water quality indicators are evaluated according to the water quality indicators and limits of rural decentralized water supply in Table 4 of the “Sanitary Standards for Drinking Water”. If one of the test indicators exceeds the standard limit, the water sample is judged as unqualified.

3.2. Test results and analysis

During the operation of the equipment, the raw water and the effluent are sent to the local disease prevention and control center for testing. The test results are shown in Table 1. According to the test results, the rotary cross-flow ultrafiltration water purifier can effectively remove suspended solids, biological macromolecules, algae, etc. The diseased microorganisms have a turbidity of less than 2NTU, and the total coliform and heat-resistant coliforms are equal to zero. There is no visible matter after the membrane is discharged, and the effluent quality meets or exceeds the national sanitary standard for drinking water in China.

Table.1. Comparison of inlet and outlet water quality of rotary staggered water purifier

Test items	Drinking water limit	Xuguan Canal tributary river		Taihu Lake	
		Influent	Outlet	Influent	Outlet
Chroma (°)	≤ 20	20~100	< 5	< 5	< 5
Turbidity (NTU)	≤ 3	15.24	0.27	11.79	0.71
Stinky	Null	Weak	Null	Null	Null
Visible to the naked eye	Null	Suspended solids	Null	Very little sediment	Null
Total coliform (MPN/100mL)	Not checked out	—	Not detected	—	Not detected
Heat-resistant coliform (MPN/100mL)	Not checked out	—	Not detected	—	Not detected
Total number of colonies (CFU/mL)	500	—	Not detected	—	Not detected

Annotate: “—” Indicates that it is not detected or less

3.3. Membrane flux and membrane pressure difference

The variation of membrane flux and transmembrane pressure difference under two different water sources during the experiment is shown in Figure 2 below.

It can be seen from Fig. 2 that under different water sources, the equipment can maintain a high membrane flux. Under the same water source condition, the membrane flux of the equipment can maintain a stable change trend, and as the treatment time increases, the membrane pores suspend in the water. The interception and adsorption of substances or macromolecular solute, there is a certain resistance on the surface of the membrane, resulting in a gradual decrease in membrane flux. The device uses cross-flow filtration to automatically clean the equipment while it is running, which can effectively keep the equipment running longer and with higher membrane flux.

It can be seen from Fig. 2 that under different water sources, the change trend of transmembrane pressure difference is different, but both are less than 80kPa. Under the same water source condition, there is basically no difference in transmembrane pressure difference. The reason is that the pollution layer is generated when the ultrafiltration membrane is trapped, and the influent pollution load of

different water source belts is different. As the operation time of the equipment increases, the transmembrane pressure difference will become larger.

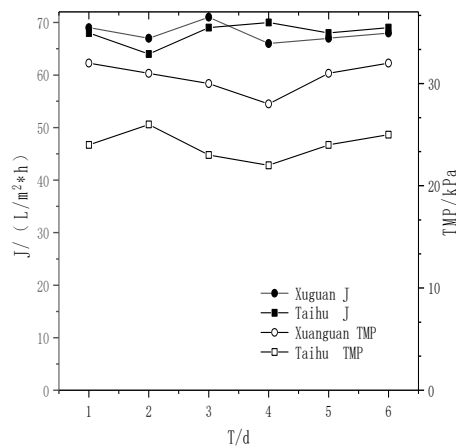


Fig.2. Variation of membrane pass and transmembrane pressure difference under different water sources

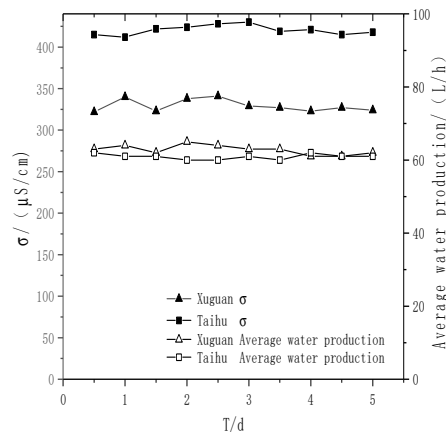


Fig.3. Changes in average water yield and conductivity under different water sources

3.4. Average water production and conductivity

The variation of average water production and water conductivity under two different water sources during the experiment is shown in Figure 3 below.

It can be seen from Fig. 3 that under different water sources, the average water production is basically maintained at 60 L/h, maintaining stable water production and meeting the drinking water consumption of residents. Under the same water source conditions, the daily water production of the equipment is basically the same (after discharging concentrated water).

It can be seen from Fig. 3 that under different water conditions, the conductivity of Taihu Lake effluent is maintained at 412-430 $\mu\text{S}/\text{cm}$, and the conductivity of the effluent from the Xuguan Canal is maintained at 322-341 $\mu\text{S}/\text{cm}$, due to the presence of mineral components, ions, etc. in different water sources. Under the same water source condition, the conductivity of the effluent is maintained within the above range, and there is basically no change.

4. Conclusions

Through the analysis of the experimental results, it shows that the rotary cross-flow ultrafiltration water purification process membrane separation technology and UV disinfection technology can maintain a stable effluent and effluent quality when dealing with drinking water sources with poor water quality. Both of them can meet or exceed the Chinese National Standard for Drinking Water Hygiene (GB/T 5749 – 2006) to meet the water demand of farmers.

The rotary cross-flow ultrafiltration water purification process does not require pre-treatment. The 0.04 μm flat PES ultrafiltration membrane loaded by the equipment can efficiently intercept suspended solids, colloidal particles, natural macromolecules, cryptosporidium and pathogenic microorganisms, and can directly purifies the natural surface water and shallow groundwater with large changes in turbidity, which meets the requirements of farmers for easy operation, hygienic and reliable equipment.

Rotary cross-flow ultrafiltration water purification equipment covers a small area, less than 0.6 m^2 , simple maintenance, easy operation and easy management, long-term no-clean, long service life, low energy consumption, and efficient and safe water demand. The rotary cross-flow ultrafiltration water purifier can be widely used in rural areas, providing technical support for the equipment and facilities

of the rural decentralized water supply project, making up for the gap in the water purifier that can't handle the poor water quality requirements in the market. Promote the rapid development of rural decentralized water supply projects.

References:

- [1] Kun Wang, AnChao Geng, Dexiang Liao, Lingyi Qian. Application of Active Cross-flow Ultrafiltration-Ultraviolet Integrated Equipment in Rural Distributed Water Supply [J], Water Treatment Technology, 2015 (7): 80-82.
- [2] GB 5749—2006 Drinking water sanitary standard [S].
- [3] J M Arnal, B Garcia-Fayos, G Verdu, et al. Ultrafiltration as an alternative membrane technology to obtain safe drinking water from surface water: 10 years of experience on the scope of the AQUAPOT project[J].Desalination,2009,2481:34-41.
- [4] Panyue Li. Application of ultrafiltration membrane in rural drinking water safety project [J]. China water conservancy, 2009 (5).
- [5] Anchao Geng, Rui Wang, Dexiang Liao, etc. Development of active cross-flow membrane separation equipment [J].Water Treatment Technology, 2013, 39(10):122 - 124.