Progress in Treatment of Oily Wastewater by Inorganic Porous Ceramic Membrane

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Abstract : The composition and complexity of oily wastewater contains many solid particles, free oil, emulsified oil and so on.It brought about a series of environmental pollution problems when oily wastewater was directly discharged into rivers, lakes and other water bodies. Therefore, researchers are committed to study how to deal with oily wastewater to deal with oily wastewater to apply it to meet the requirements of water injection.Inorganic porous ceramic membrane has excellent properties among many filtering methods. For example, high temperature and high pressure resistance, resistance to acid and alkali, low energy consumption, no pollution to the environment and has a good prospect in the field of oily wastewater treatment, which has attracted the attention of many scholars not only at home but also on abroad. This article describes the present situation of the research on the treatment of oily wastewater by ceramic membrane in recent years, and expounded the significance of the treatment of oily wastewater to people's lives and makes an expectation for the development of inorganic porous ceramic membrane in the future.

0 Introduction

Porous ceramic membrane is a kind of ideal filter material. In recent years, many scholars at home and abroad have paid more attention to it in recent years. .Porous ceramic membrane has been being studied for more than 20 years in China. Both the production process and technical level have been greatly improved, which did a great favor to expand the scale of production. And the ceramic membrane undoubtedly takes an important part in the filters nowadays.

In the 50s of last century, China began to study ion exchange membrane and an experimental study on desalination of seawater by electrodialysis was carried out. In 1980s,inorganic membrane was developed rapidly and played an important role in membrane separation technology. After then, the application of porous ceramic membrane in gas-solid separation come into scholars' sight. The application of inorganic ceramic membrane have been used in China, in the removal of the bacteria, the fermentation liquid and in the collection of small molecular substances. Since 21st century, the ceramic membrane has been widely used in the oily wastewater, emulsion wastewater treatment, printing and dyeing, papermaking wastewater treatment, brine refining and so on. Sang H Hyun[1]used the self-made composite membrane to separate the emulsion, and the removal rate could

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reach 100%.Lin[2]used the polymer membrane to treat the wastewater containing vegetable oil, when the operating pressure was 2.1MPA,operating temperature is 313K,membrane surface velocity is 220L/h,the membrane flux is about 26.8 L/（m^2·h）.Thus, membrane filtration turns out to be a trend in the future.

For oily wastewater, the traditional separation technologies contained flotation expanded graphite adsorption, ultrafiltration, Electric-Fenton method[3].In order to avoid the shortcomings of traditional separation technology, people turn to research the ceramic membrane separation technology. Organic ceramic membrane technology is relatively mature while it has many disadvantages such as poor stability, poor acid and alkali corrosion resistance, non renewable, easy to occur two pollution, etc. Inorganic membrane[4]has been studied and used by scholars owing to its high temperature resistance, chemical corrosion resistance, good mechanical strength, strong anti microbial ability, high permeate flux and long service life. Therefore, the inorganic film is absolutely the key research direction in the ceramic membrane.

In this paper, we have made an introduction that the treatment of oily wastewater by inorganic ceramic membrane. The treatment of oily wastewater by inorganic ceramic membrane takes an important in people's life and environment, and provides a better research direction for the researchers who hammers at a more mature technology.

1 The traditional treatment of oily wastewater

Biochemical process is one of the treatment of oily wastewater in Daqing Oilfield:

Sedimentation + microorganism + membrane technology. But this method is used of organic film, which have some shortcomings like poor acid and alkali corrosion resistance, poor stability, easy to produce secondary pollution. Flocculation method also has a wide range of applications in recent years. The flocculant was added to the oily wastewater which then was hydrolyzed into colloid, and flocculation occurred after a series of physical and chemical actions. The chemical reagents were added to make the surface of the water charge neutralization reaction, and the oil droplets were gathered. The polymer material was added to carry out flocculation through the bridge. Finally the oil droplets are removed by sedimentation or air floatation. This method has a removal rate for the removal of oil droplets, but the addition of reagents will produce secondary pollution, which will have a lot of adverse effects on the treatment system. Biofilm method made aerobic microorganism attached to the surface of the solid filler, which can form the biological membrane to adsorb the oil and dissolved oxygen in the wastewater. Biofilm was also undergoing metabolic processes and could be recycled.

2 Treatment of oily wastewater by inorganic ceramic membrane

2.1 Hydrophilic alumina ceramics

Alumina ceramic membrane is the direction of most scholars, Chun Lei Ren proposed that the porous alumina membrane was used to treat the oily wastewater, and the α-Al_2O_3 with average particle size of 0.78μm was prepared by phase inversion casting sintering technology. In the treatment of oily wastewater, the water permeability and oil permeability test should be carried out, the results show that the flat membrane meets the requirement of treating oily wastewater. The specific practice of this experiment is to mix the octane and water in the proportion of 30:70 to the formation of oily wastewater and oil red and methyl blue staining to make the experimental results more obvious. As shown in Figure 1.The flat membrane is fixed on the glass tube at the bottom, and then put the oil-water mixture to the glass tube, we can see that the flow of water with methyl blue is linear through the flat film, and the oil droplets with oil red are all trapped above the flat membrane. The results show that the alumina ceramic membrane has the properties of hydrophilic and oil repellent, and has good effect on oil and water separation.

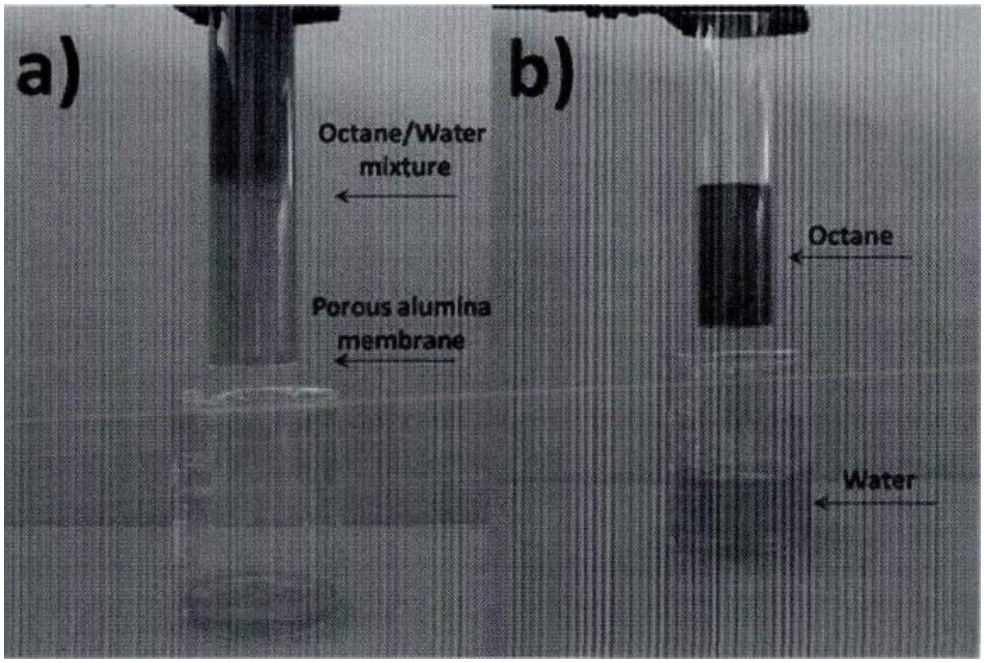

Figure 1. Oil-water separation of porous alumina membrane

2.2 Hydrophilic zirconia ceramic membrane

Chun Mei Wang studied the effects of various factors on the membrane flux in the treatment of oily waste water with a pore size of 0.2μm investigated, including the operating pressure, the film surface flow rate, the operating temperature, and so on. Fig. 2 flow chart of experiment.

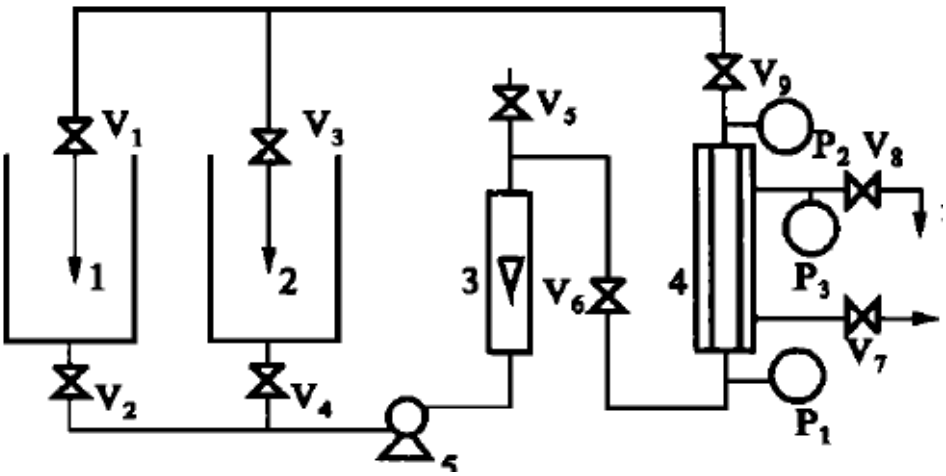

Figure 2. Flow chart of experiment. 1. storage tank; 2. cleaning tank; 3. rotor flow meter; 4. membrane components; 5. centrifugal pump; V1-V9 valve

Oily wastewater after being deal with the 0.2μm zirconia ceramic membrane, the operating differential pressure is 0.1MPA, the membrane surface velocity is 5.05 m/s, the operating temperature is 308k, the stability of the membrane flux can reach 250 L/(m^2/h),after treatment, the oil content of

waste water is less than 10mg / L,which can meet the requirements of treatment, and the operation and process of the equipment are relatively simple. It is an effective process for treating oil-containing wastewater.

2.3 Hydrophilic silicon carbide ceramic membrane

There are few reports on silicon carbide ceramic membranes. Compared with alumina and zirconia ceramic membrane, it is more hydrophilic, acid and alkali corrosion resistance is stronger, and that is a kind of ideal filter material with the highest flux.

Shi Wei Ye used 0.1μm silicon carbide ceramic membrane to treat wastewater that oil content is 7.564mg/L-9.568mg/L and water temperature is about 20℃ and the suspended matter content is 35mg/L-45 mg/L and pH is 6,with the method of dead end filtration.The experiment shows that when the temperature is 20℃, suspended solids and oil removal rate can reach more than 98% and 88%, when the temperature is 40℃, suspended solids and oil removal rate can reach 97% and 87% respectively; when the temperature is low, the filtering effect will be better.

2.4Treatment of oily wastewater by other membrane materials

In addition to studying the treatment of oily wastewater with inorganic ceramic membranes, the scholars also studied the organic/inorganic composite ceramic membrane, considering the properties of the two kinds of film together, not only can improve the surface hydrophilicity of [5-6] and toughness, but also can fight pollution.Wang Shu had a ceramic base membrane of polyvinylidene fluoride (PVDF) ultrafiltration membrane surface modification, prepared with polyamide/PE pure organic/inorganic composite membrane.The ceramic film deal with GS-1 type high speed vacuum pump oil with an average particle size of 2.365μm under the operating pressure of 0.4MPA.The experimental results show that the water flux is 120 L/（m^2·h）,the oil concentration after treatment is 5mg/L. The test results are not satisfactory, and need to be further improved. Xue Dong Zhang used to treat the sand filtration water in the eight sewage treatment plant of Da Qing oil production plant, using the modified PVDF ultrafiltration membrane with inorganic nano particles. The results showed that the content of suspended matter of three kinds of modified ultrafiltration membrane effluent was below 0.4mg/L,the removal rate was above 95%, oil content decreased from 12.52mg/L-84.42mg/L down to 1.0mg/L, the removal rate was above 90%, COD in the water form the 450.17mg/L-1280.55mg/L down to 80mg/L-90mg/L, the removal rate was 80% -95%,The treatment effect is very good, and the treated liquid can be discharged directly to meet the experimental requirements. Jin Ming Wang used the alumina microfiltration membrane modified by nano ZrO_2 treatment of oily wastewater, the modified membrane flux can reach a maximum of 295 L/（m^2·h）, the oil removal rate was 99%, and the oil content that treatment was less than 10mg/L, reached the national emission standard.

3 Conclusions and prospects

In this paper, we have summarized the various experimental methods made by researchers in recent years that the inorganic ceramic membrane is used to treat the oily wastewater, such as ceramic ceramics, zirconia ceramic film, silicon carbide ceramic film and organic / inorganic composite ceramic membrane, the filtering effect has unpredictable good prospects in many areas. Table 1 summarizes the results of the treatment of oily wastewater by these 3 kinds of inorganic ceramic membrane.

Table 1. Effect of the treatment by three kinds of inorganic ceramic membrane

ceramic membrane	effect		
alumina ceramic membrane	Oil	water	separation

	efficiency was 96%
zirconia ceramic membrane	The oil content of the filtered water is less than 10mg/L, and the stable flux can reach 250 L/（m2·h）
SiC ceramic membrane	The removal rate of suspended solids and oil can be reached 97% and 87%

There are both advantages and disadvantages in the treatment of oily wastewater in each kind of inorganic ceramic membrane, and which has a very important impact on people's production and life. It is worth mentioning that in the treatment of oily wastewater should also ensure that no pollution to the environment, no waste of energy. But researchers also are faced with the problems that how to clean the oil droplets when the ceramic membrane pore blockage, to control membrane pollution degree, to guarantee the performance of the film does not have too big change after cleaning. How to control the pore size is whether suitable to be used for oil-water separation or not if the size of the oil droplets is too small? It could be seen that there is still a long way to explore in the treatment of oily wastewater by using inorganic ceramic membrane.

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