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Ultra filtration of Waste Water Containing a Mixture of Yeast and Bentonite by Organic Hollow Fiber Membrane

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Abstract

In this study is presented some important aspects regarding modern processes of ultrafiltration of waste water, through an organic hollow fibers membrane from polyacrylonitrile. Wastewater produced daily from industries contains a variety of organic and inorganic compounds that harm the environment if they are not removed from the water. In this study, the efficiency of retention of two compounds such as yeast and bentonite will be highlighted, from a solution that mixes these substances. The aim is to monitor the final volume of the permeate, the operating lifecycle of membrane without deteriorating over time, the influence of the operating parameters of the ultrafiltration process, etc. It is very important to investigate the impact that water with polluting compounds can have on the environment if the waste water will be discharged into the natural water resources, without removing these pollutants. The results of the study showed that food yeast mixed with bentonite can have a satisfactory retention rate of over 20% at a transmembrane pressure of 0.8 bars and at a temperature that oscillates around 26-27 ° C.

Keywords: *Bentonite, PAN membrane, Ultrafiltration, Ultrafiltration efficiency, Yeast.*

I. INTRODUCTION

Membrane technology is increasingly sought after due to the many advantages it has over the separation processes of the different substances that can be subsequently used, such as ease of use, acquisition costs and maintenance. At the same time, the retention performance of substances has been shown to be high due to the physical and chemical properties that confer high resistance in ultrafiltration processes [1],[2]. Extending the use of membranes was necessary not only to protect the environment but also to recover some compounds that can be used in other industrial processes, such as medicine, the food industry, etc. [3].

A number of studies have shown that, through membrane technology, many organic and inorganic chemical compounds have been retained in a fairly large percentage, with high enough values to encourage the use of membranes in the future, not just where there is a necessity but also to prevent pollution of natural water sources [4],[5],[6].

However, despite the advantages of having a membrane, during the ultrafiltration process, the phenomenon of dirt or fouling occurs, which implies both the increase of costs and the shorter life of the membrane used in the process [7].

As solutions to prevent the pollution of ultrafiltration membranes have been found methods to modify the inner structure of the membrane by mixing polymers as well as mixing chemicals to obtain a corresponding hydrophobia or hydrophilia [8],[9],[10],[11],[12],[13] .

A study on improving the structure and the lifetime of the membrane showed that the addition of metal nanoparticles contributes to the improvement of the membrane structure but also to

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the elimination of environmental pollution from an ecological point of view, improving its specific surface area, increasing its hydrophilicity, and finally increasing the separation performance [14].

The use of metal nanoparticles also increases the ease of use, ease of manufacture and other commercial benefits [15],[16],[17].

Another method of delaying the phenomenon of fouling of ultrafiltration membranes is the countercurrent washing [18].

Laurentiu T. et al. have shown in a study the increase of the performance of the ultrafiltration membrane by using ultrasonic vibrations in order to reduce the layer of accumulated matter on the working surface of the membrane [19],[20].

II. EXPERIMENTAL DETAILS

2.1.Materials and Procedures

In this paper, mainly used yeast, purchased from SC Lesaffre Romania SRL, and bentonite, both substances in different concentrations. For the ultrafiltration experiment, an organic membrane made of PAN with hollow fibers was used, having a molecular weight of 13 kDa, an inner diameter of the fibers of 0.8 mm and the outer diameter of 1.4 mm, with a pore thickness of 0, 3 µm. Separate, clean containers were required for the collection of permeate samples and for the analysis of the samples the equipment from the University research laboratory was used.

Figure 1. The membrane module from PAN.

The organic membrane from PAN was incorporated in a plexiglass module that ensured the protection of the membrane from the component of the MP 90 ultrafiltration pilot system (fig. 1). Distilled water was used to wash the containers and parts of the apparatus and the water from the tap was used to mix the substances.

2.2. Working procedure

To carry out the ultrafiltration experiment a solution of 3 g / L yeast concentration was prepared. In the feed tank 30 liters of water were introduced, with a total content of 90 g yeast and 60 grams of bentonite, in finally having a concentration of 2 g / L, at a speed of 300 rpm at a time of 25 minutes. The tap water passed through two filters, one of carbon active and the other of organic material **(fig. 2),** in order to pre-purify the water.

Figure 2. Pre-treatment filters.

3. RESULTS AND DISCUSSIONS

3.1. The influence of temperature on the ultrafiltration process

Throughout the entire experiment, the temperature increased significantly by 3 degrees over the course of 240 minutes, which means that the speed of movement of the liquid through the installation and the cumulative pressure in the mode lead to the heating of the water flow over time (fig. 3).

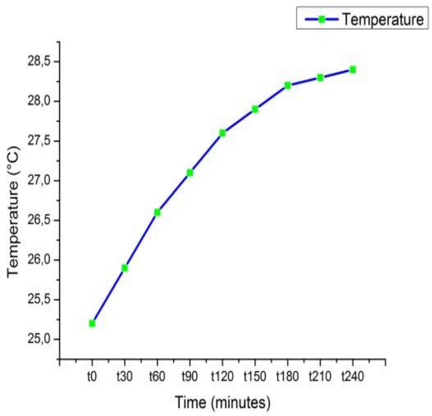

Figure 3. Temperature variation over time.

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The temperature also influences the other process parameters such as pressure, water viscosity, water permeability through the membrane, etc. The transmembrane operating pressure in the experiment was 0.8 bar.

After the yeast and bentonite were completely dissolved, the homogenized liquid was recirculated for 10 minutes in order not to rush the membrane fouling from the first hours of the process.

The working procedure consisted of conducting an experiment by mixing some substances to finally see if the mixture between them had an influence on the final product obtained, respectively on the permeate.

The experiment was performed for 240 minutes because during this time it was necessary to monitor the influence between the important parameters of the installation, the strength of the membrane and the quality of the permeate for each sample. Samples were collected after every 30 minutes and analyzed immediately after sampling so that room temperature did not influence the quality of the fresh liquid. The data recorded throughout the experiment were subsequently processed and validated in order to establish the efficiency of ultrafiltration of the organic membrane from PAN.

3.2. The volume of permeate obtained, depending on the input flow

Figure 4 shows the decrease in the flow rate of the fluid entering the mode and this leads to the decrease of the final product. This is due to the occurrence of the phenomenon of fouling of the membrane surface.

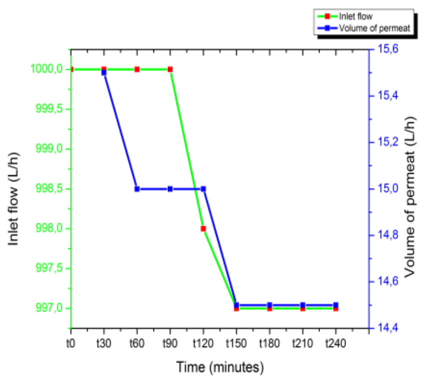

Figure 4. The volume of permeate obtained over time.

3.3. Variation of dissolved oxygen for each sample taken

Increased oxygen concentration in the permeate samples indicates that the yeast and bentonite particles remain on the membrane surface (Fig. 5), respectively the quality of the permeate shows a slight increase over time

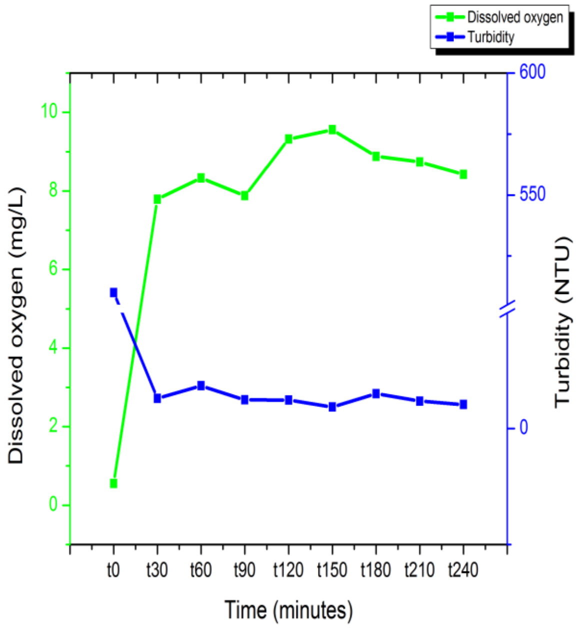

Fig. 5. Dissolved oxygen fluctuations in relation to turbidity.

The increase in the retention performance of bentonite and yeast is also due to the decrease of turbidity, which means the decrease of the concentration of the particles in each sample collected after 30 minutes (fig. 5).

3.4. Retention rate in relation to the concentration of substances in feed water

The retention rate of the particles in the present study is given by the conductivity determined for each sample collected and calculated subsequently. Figure 6 shows that the retention rate is constant because the conductivity did not show large fluctuations in any sample. It can be said that the membrane worked in a normal regime, without disturbances, under constant working conditions. During the experiment, it was not necessary to replace the membrane or to replace some component parts of the ultrafiltration system.

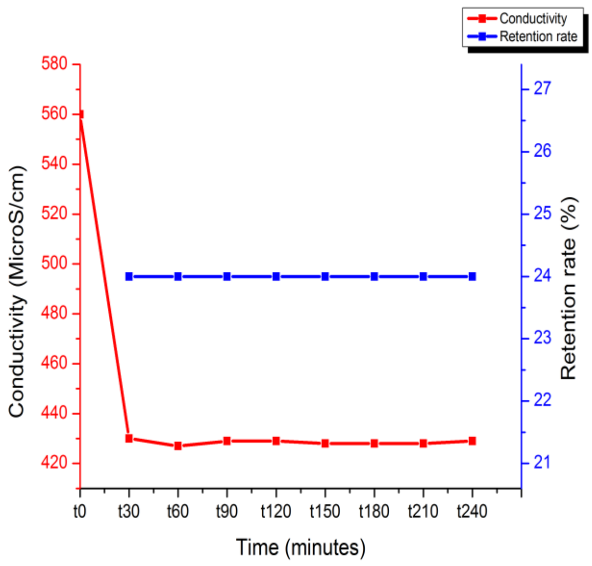

Fig. 6. Retention rate of substances for permeate samples.

Following the findings in figure 6 it can be said that the organic membrane from PAN provides a good resistance in time, in the ultrafiltration processes, regardless of the type of substance used in the study. On the other hand, during 4 hours of work, the membrane fouling was by no means pronounced even though substances with particles of different sizes and properties were mixed.

It can be said that the value of 24% is a satisfactory percentage in terms of the retention of two substances that are found in industrial wastewater and the use of membranes in branches in fields such as the food, pharmaceutical, etc. is a pretty good solution for wastewater purification. , a solution that can prevent pollution but also combat it.

CONCLUSIONS

The experiment that aimed to retain bentonite and food yeast was performed in good conditions, with acceptable values of the working parameters and the quality of the permeate obtained.

The organic membrane from PAN finally showed a satisfactory performance regarding the retention of the substances used in the study.

The decrease of the permeate volume was insignificant and its quality proved to be constant.

As a result of the aspects presented in the paper, it can be said that the hollow fiber organic membranes of PAN can be applied in industrial branches where the waters generated daily have in their concentration substances such as yeast and bentonite.

The quality of the permeate samples was acceptable and the determination of the chemical indicators from each sample collected recorded good values, avoiding measurement errors during the experiment.

The chosen time duration of the experiment was appropriate because the time variations of the physical parameters of the ultrafiltration installation could be represented.

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