[897] Eco-friendly ceramic membranes for water reuse in a membrane bioreactor (MBR)

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Short Introduction

In recent years, water scarcity is becoming a growing problem that has made that water reclamation and reuse becomes a solution of great interest. In this regard, membrane bioreactors (MBR) represent one of the major treatment solutions for wastewater treatment. MBRs present the advantage of being a compact system, which allow high concentrations of mixed liquor suspended solids (MLSS), low production of excess sludge and high quality of treated water. The limitation they have is membrane fouling, that decreases permeability, requires cleaning procedures and eventual membrane replacement. Traditionally, MBRs are operated with polymeric membranes, but ceramic membranes can offer a more robust and long-term alternative, for both microfiltration and ultrafiltration processes. The main advantage of ceramic membranes is that they have better chemical, thermal and mechanical properties, which make possible to operate them under severe conditions and also to apply harsh cleaning procedures (high temperature, strong cleaning reagents).

In contrast, conventional ceramic membranes are more expensive, mainly due to the materials required for their manufacture. The main objective of this study is to develop and validate ceramic membranes at lower cost than the commercial ones, by including agricultural and industrial wastes in the composition, together with raw materials typically used in the ceramic tile industry.

Material and Methods

The ceramic membranes developed in this project are based on raw materials normally used in the ceramic tile industry (basically clay), mixed with agro-industrial wastes in high proportions (higher than 40 wt% in the support). Recycled low-cost ceramic supports have been manufactured by extrusion in an industrial extruder. After extrusion, the supports were dried at room temperature for 48 h, and oven-dried at 110°C to a constant weight. Next, the supports were sintered in a pilot electric kiln.

Active layer deposition was done by dip-coating on the sintered industrial supports. The composition of the precursor suspensions used to obtain the layer is based on clay and industrial wastes: marble powder (from quarrying and processing of marble) and chamotte (from fired tile scrap). After immersion, layers were dried at room temperature for 24 h and oven-dried at 110°C. Finally, the ceramic membranes were sintered again in a pilot electric kiln at 1000°C. Different layers were obtained by modifying the composition of the layer and the immersion time. Five different membranes have been compared, one without active layer and the others with different active layer composition and immersion time. Membranes 2, 3 and 5 had lower clay content in the precursor solution (60% wt), while membrane 4 had 70% wt clay content. Solids content of the precursor suspension was 15% wt in all layers.

Finally, the membranes were characterized by determining water permeability and pore size (by bubble point method). The microstructure was observed by Scanning Electron Microscopy.

Results and Discussion

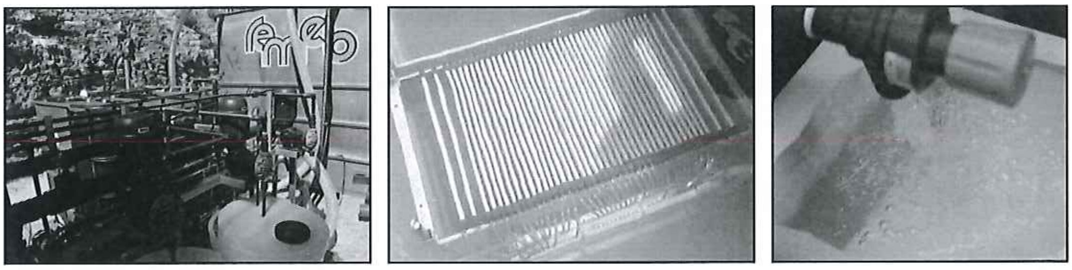
Table 1 shows that the different properties of the membranes manufactured. It can be seen that the ceramic membrane without active layer has higher pore size, and so higher permeability. Regarding the different active layer compositions, it was selected the composition of the membrane 5 to carry out the experiments with activated sludge in Aledo WWTP (Spain), with a solids concentration between 8-10 g/L.

Table 1. Characterization of the membranes: pore size and water permeability.

Membrane	Immersion time layer (sec)	d_{50} (μm)	K ($L/m^2 \cdot h \cdot bar$)
1	—	4.4	1700
2	10	1.5*	420
3	15	1.3*	394
4	15	0.4*	240
5	15	0.7*	467

* Mean value of the series.

Figure 1. MBR pilot plant designed to validate the REMEB low-cost ceramic membranes developed in the study.



Conclusions

The membrane with higher water permeability and lower pore size has been selected to perform the trials in the WWTP (Fig. 1), achieving more than 95% COD removal, suspended solids lower than 5 mg/L and removal of *Escherichia coli* and *Clostridium perfringens*.

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