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Wastes from industrial processes introduced as chamottes in ceramic membranes

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Introduction

The treatment of wastewater by MBRs (membrane bioreactors) has been widely studied in recent years, due to the advantages that this system poses compared to traditional processes (Le-Clech 2010). Nevertheless, few MBRs use ceramic membranes, due to the high price of commercial membranes compared to polymeric ones.

In the present work, chamottes generated as subproducts by different industrial processes have been used to obtain low-cost ceramic membranes. The influence of the nature and particle size of these wastes on membrane properties has been evaluated. Chamottes have been widely used in the ceramic industry as they behave as an inert raw material during the firing cycle and therefore improve the processing by controlling the shrinkage and porosity of the final product (Lorente-Ayza et al. 2016).

Material and Methods

Wastes to be used as chamottes were collected from two different industries ceramic tiles and refractories. Ceramic tile industry provided two different types of wastes: fired tile scrap (consisting on pieces of fired tiles with dimensional or aesthetic defects) and ceramic powder waste (from processing of porcelain fired tiles). Refractory industry provided scrap from insulating, with high content of alumina and silica. After collecting the wastes, they were characterized and adapted to be used in the extrusion ceramic process. Ceramic membranes have been manufactured by extrusion as shown in Fig 1.

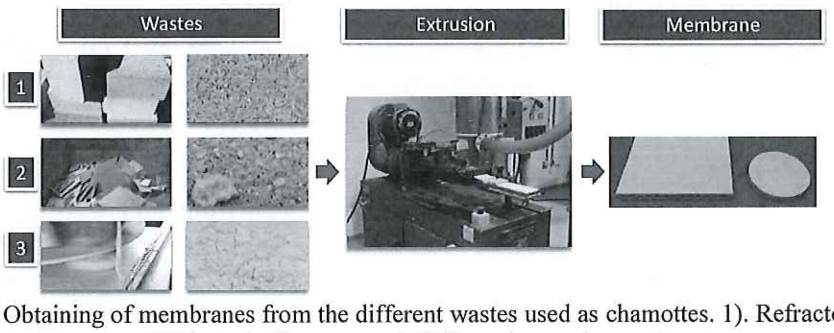

Figure 1. Obtaining of membranes from the different wastes used as chamottes. 1). Refractory scrap, 2) Ceramic tile scrap and 3) Ceramic powder waste.

After sintering, their properties were determined: bulk density, porosity, mechanical strength, microstructure, water permeability and pore size. Finally, the membranes characterization has been completed by determining their permeability and pore size and their testing in an experimental lab-scale set-up consisting of a bioreactor with 30 L working volume where membrane was submerged in. The membrane filtration was operated in a cyclic mode (9 min on, 30 sec off, 1 min of backwashing) at a constant permeate flux of 12 L/m^{2}h. For the sake of comparison, a standard composition was formulated with a commercial chamotte normally used in the ceramic sector.

Results and Discussion

Fig. 2 shows the different particle size distribution of the wastes used to manufacture the ceramic membranes, whose characteristics are summarized in Fig. 3.

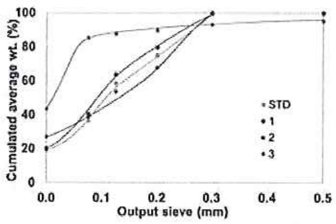

Figure 2. Particle size distribution of chamottes from different sources.

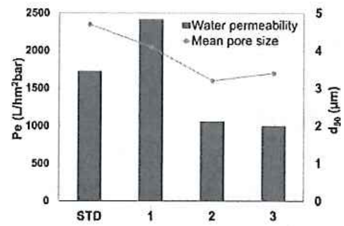

Figure 3. Characterization of membranes obtained with different chamottes.

Fig. 4 shows the evolution of overpressure (mbar) in two membranes over time. Both membranes operate similarly in the experimental lab-scale bioreactor (Fig. 5), obtaining COD removal efficiencies of 83-85%.

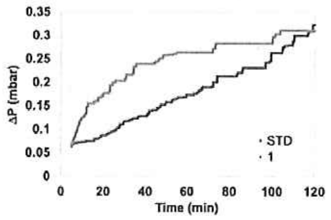

Figure 4. Overpressure of two membranes over time in the experimental bioreactor.

Figure 5. Experimental lab-scale bioreactor.

Conclusions

The results show the great influence of the nature and particle size of wastes used as chamottes in membrane's properties, particularly in the water permeability and the performance in the lab MBR.

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References

Le-Clech P., *Membrane bioreactors and their uses in wastewater treatments*, Appl. Microbiol. Biotechnol. 88 (2010), 1253-1260.

Lorente-Ayza M-M., Orts M.J., Gozalbo A., Mestre S. *Preparation of chamottes as raw material for low-cost ceramic membranes*, Int. J. Appl. Ceram. Tech. 13[6] (2016) 1149-1158.