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Ceramic Membrane Supports for Water Treatment Using Low Cost Materials: Elaboration and Characterization

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ABSTRACT

Porous ceramic membranes exhibit more remarkable advantages than their polymeric counterparts due to their excellent properties such as high mechanical strength, good chemical corrosion resistance, high separation efficiency, long lifetime, and easy clean regeneration. This type of membranes is mainly based on the use of raw materials and manufacturing processes typical of traditional ceramic materials. As a result, they are increasingly being applied in a number of industries, especially for water purification. The objective of this work is to study the feasibility of clay as a ceramic material for low cost microfiltration supports prepared using combined phase inversion/sintering technique. The physical properties of the fabricated ceramic membrane support were investigated and evaluated through morphologies, mechanical strength, dope suspension viscosity and pure water permeation. The resulting support has an average porosity of 40.5 ± 2.1% and pore size of about 8-0,5 μm, which are within microfiltration range. Preliminary study shows that the clay ceramic support in this work is potential to water purification application at lower cost.

Keywords: Ceramic, Membrane, Clay, Characterization.

1 Introduction

Ceramic membranes are more favorable than polymeric mem-branes, especially in gas application, due to its high thermalstability, good chemical compatibility and exceptional mechanicalstrength [1,2]. By having such characteristics that require no main-tenance, the production of ceramic supports has gained attention widely among the researchers. Maintenance is including replacement of membranes, electricity consumption, cleaning productsand labor prices. Previously, various ceramic membrane materi-als have been reported, such as alumina [3], nickel [4] and zeolite[5]. These materials are grouped into expensive materials used forceramic support. Therefore, to reduce the cost, recent investigation on the fabrication of ceramic support is focused toward the utilizationof cheaper raw materials, such as apatite powder [6], fly ash [7],natural raw clay [8,9], dolomite and kaolin [10,11].

2 Experimental

Ceramic suspension was prepared from clay and other mixtures (Despersant and Binder) and the prepared suspension was transferred into stainless steel syringes. The ceramic suspension was then extruded through the spinneret at a constant flow rate at room temperature while the bore fluid flow rate was fixed and delivered by a syringe pump into coagulant bath. Tap water was used as both bore fluid and coagulant bath for phase inversion. The precursor fiber was cut to a length of 15 cm and dried at an ambient temperature , which after that will be sintered at the high temperature. The preparation of porous ceramic supports for membranes requires a programmable furnace at different final temperature. In accordance with this idea, we have used two temperature plates.

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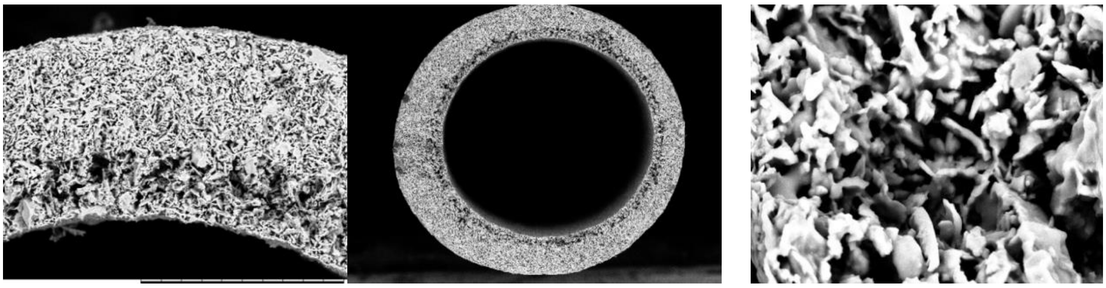
Table.1 presents the chemical composition of used clay measured via X-ray fluorescence (XRF) analysis. Based on table, clay consists of major silica (SiO_2 = 51.52 wt.%) and alumina (Al_2O_3 = 36.9 wt.%).

Table1: Chemical composition of clay used in this investigation

Oxide	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3
Composition (wt.%)	51.52	36.9	0.96	0.58	0.08	0.22

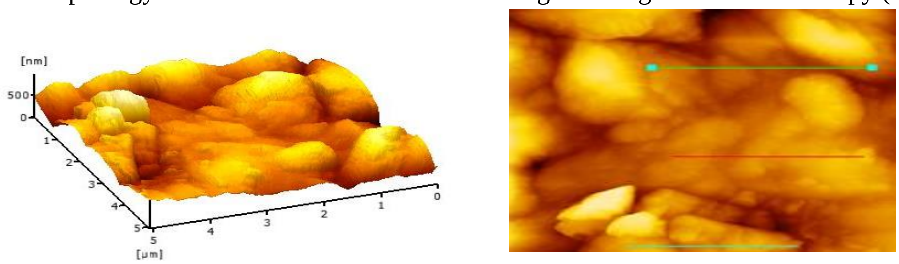
3 Results and Discussion

The Tha obtained results showed that the precursor hollow fibre membranes were well-shaped with a fully circular structure for both outer and inner contours (figure 1). The SEM images represent the successfully fabricated support through phase inversion/sintering technique, under studied conditions.



a. Overall view **b.** Cross section **c.** Porous structure

Figure1: Morphology of natural ceramic membranes using scanning electron microscopy (SEM) analysis



a. 3D surface Roughness **b.**2D surface Roughness

Figure 2: Atomic Force Microscopy (AFM) analysis

As can be seen, ceramic Membrane support with 37,5 wt.% clay content consists of an asymmetric structure of long finger-like voids originating from the inner Hollow Fiber Membrane surface and occupying up to 40% of the Hollow Fiber Membrane thickness, with the remaining of 70% Hollow Fiber Membrane region occupied by a sponge-like layer. AFM analysis revealed that small value of surface roughness (less than $1\mu m$) was obtained at this study.

4 Conclusions

The elaboration of ceramic membrane supports via phase inversion and sintering method received widely attention due to offer asymmetric membrane structure consisting finger-like and sponge-like structure. Hollow fibre configuration is a precious property offered by phase inversion and sintering technique towards fabrication of ceramic membranes, which its particularity is the high surface area.

References

[1] B.F.K. Kingsbury and K. Li, A morphological study of ceramic hollow fibre membranes. Journal of Membrane Science, 328, 134–140, 2009.

[2] B. Wang and Z. Lai, Finger-like voids induced by viscous fingering during phase inversion of alumina/PES/NMP suspensions. Journal of Membrane Science, 405–406, 275–283, 2012.

[3] Z. Shi, Y. Zhang, C. Cai, C. Zhang and X. Gu, The preparation and characterizations of the diatomite-kaolin composite support layer for microfiltration. Journal of the Ceramic society of Japan. 41, 1333–1339, 2015.

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[4] Y.-L.E. Fung and H. Wang, Nickel aluminate spinel reinforced ceramic hollow fibre membrane. Journale of Membrane Science, 450, 418–424, 2014.

[5] Z. Zhan, J. Shao, Y. Peng, Z. Wang and Y. Yan, High performance zeolite NaA membranes synthesized on the inner surface of zeolite/PES–PI blend composite hollow fibers. Journal of Membrane Science, 471, 299–307, 2014.

[6] S. Masmoudi, A. Larbot, H.E. Feki and R.B. Amar, Elaboration and characterisation of apatite based mineral supports for microfiltration and ultrafiltration membranes. Ceramic International, 33, 337–344, 2007.

[7] J. Fang, G. Qin, W. Wei and X. Zhao, Preparation and characterization of tubular supported ceramic microfiltration membranes from fly ash. Separation and Purification Technology, 80, 585–591, 2011.

[8] N. Saffaj, M. Persin, S.A. Younssi, A. Albizane, M. Bouhria, H. Loukili, H. Dach andA. Larbot, Elaboration and characterization of microfiltration and ultrafiltration membranes deposited on raw support prepared from natural Moroccan clay: application to filtration of solution containing dyes and salts. Separation and Purification Technology, 47, 36–42, 2005.

[9] N. Saffaj, M. Persin, S.A. Younsi, A. Albizane, M. Cretin and A. Larbot, Elaboration and characterization of microfiltration and ultrafiltration membranes deposited on raw support prepared from natural Moroccan clay: application to filtration of solution containing dyes and salts. *Applied Clay Science*, 31, 110–119, 2006.

[10] M.C. Almandoz, J. Marchese, P. Prádanos, L. Palacio and A. Hernández, Preparation and characterization of non-supported microfiltration membranes from aluminosilicates. Journal of Membrane Science, 241, 95–103, 2004.

[11] F. Bouzerara, A. Harabi, S. Achour and A. Larbot Porous Ceramic Supports for Membranes Prepared from Kaolin and Doloma Mixtures. Journal of the European Ceramic Society, 26,1663–1671, 2006.

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