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COMPARATTIVE EVALUATION OF OIL-IN-WATER EMULSION SEPARATION WITH ALUMINIUM OXIDE & ZINC OXIDE NANOPARTICLES CERAMIC MEMBRANE

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ABSTRACT

This research aims at comparing two nanoparticles (Aluminium oxide and zinc oxide) coated ceramic membrane with self-cleaning ability for the effectively separation of low concentration (<250mg/L) Oil-in-Water O/W Emulsion. Preliminary experimentals have been done to determine the morphology and pure water flux of unmodified commercial ceramic membrane using Scanning Electron Microscope(SEM) and in-house installed rig separator respectively. An uneven pore size with a densely packed image from SEM indicates an increase in flux. Steady pure water permeate flux shows possibility of anti-fouling in ceramic membrane.

Keywords: Oil-in-water emulsion, Nanoparticles, Ceramic membrane, Separation

INTRODUCTION

This research proposes the preparation and camparison of two nanoparticles coated ceramic membrane for real world industrial application to separate low concentrations of (O/W) emulsions before discharge into the environment. The mixture of oil with water from industrial activities creates an emulsion which is now termed as O/W emulsion (1) must beet regulatory limit (10mg/L) before discharge into the environment. Several chemical and physical methods have been successfully used for the separation of O/W emulsions; however, the trace amounts of oil (<250mg/L) remains unfiltered in the separated water (2) . Membrane technology has been used to separate low concentration of O/W emulsion yet this comes with a challenge of fouling in the membrane pores, hindering this technology from industrial use. Ceramic membranes were carefully chosen as a technique for review in separation of O/W emulsion due to their numerous advantage which include mechanical stability, chemical inertness, thermal stability, ability to be regenerated, high flux, and compactness in design (3). This study focuses on the modification and comparison of two nanoparticles coated ceramic membrane (Aluminium oxide and Zinc oxide) with self cleaning ability for the separation of <250mg/L O/W emulsion. The objectives includes:

- The assembling and installation of Rig (separator) for separation of O/W emulsion.
- Characterization and pure water flux separation is evaluated on unmodified commercial ceramic membrane to serve as a reference.
- Dip coating method is used for the modification of nanoparticles on ceramic membrane. Characterization of the modified ceramic membranes to determine pore size, porosity, contact angle, morphology using Quantachrome Analyzer, Mathematical model, ThetaLite Contact angle meter and Field Emission Scanning Electron Microscope respectively.
- Preparation and characterization of O/W emulsion parameters. Determination of flux, % oil rejection and anti-fouling in modified ceramic membrane is evaluated.
- Quantitative and qualitative analysis of permeate from modified ceramic membrane using UV-Visible Spectrophotometer is measured.

MATERIALS AND METHODS

The morphology unmodified commercial ceramic membrane was determined by of the membrane was determined by the use Zeiss EVO LS10 scanning electron Microscope (SEM). An in-house rig set was installed and used for the pure water flux evaluation of the unmodified commercial ceramic membrane. Both outcomes of the experiments serves as reference for the characterization and separation using modified nanoparticles ceramic membrane.

Characterization

Scanning electron microscopy (SEM) is used to characterize the surface of samples by identifying the morphology. The electron beam from SEM focuses on a sample and generates high resolution images of the sample. The SEM was used to examine support ceramic membrane to detect surface smoothness, cracks, structures, irregularities, and thickness. Support ceramic membrane samples were placed firmly on a stub and transferred to the sample carousel of the SEM for analysis. The SEM generated images of both outer and inner areas of the unmodified commercial ceramic membrane at 500X, 1000X and 3000X magnifications is represented in fig 1a.

Separation

Using the in-house rig installed (fig 1b), pure water flux was measured in the unmodified commercial ceramic membrane to obtain a steady flow with the following specifications: pressure (1bar), room temperature (20^0C), time (120min), feed flow (50L/h). the following equation 1, was used to calculate the permeate flux of the pure water where Qp (permeate volume - L), A (Membrane Area - m^2), t (filtration time – h), Jw (permeate flux – L/m^2 h). The perfume flux for pure water is over 120min is illustrated in fig 1c below.

$$Jw = \frac{Qp}{A \times t}$$

Result

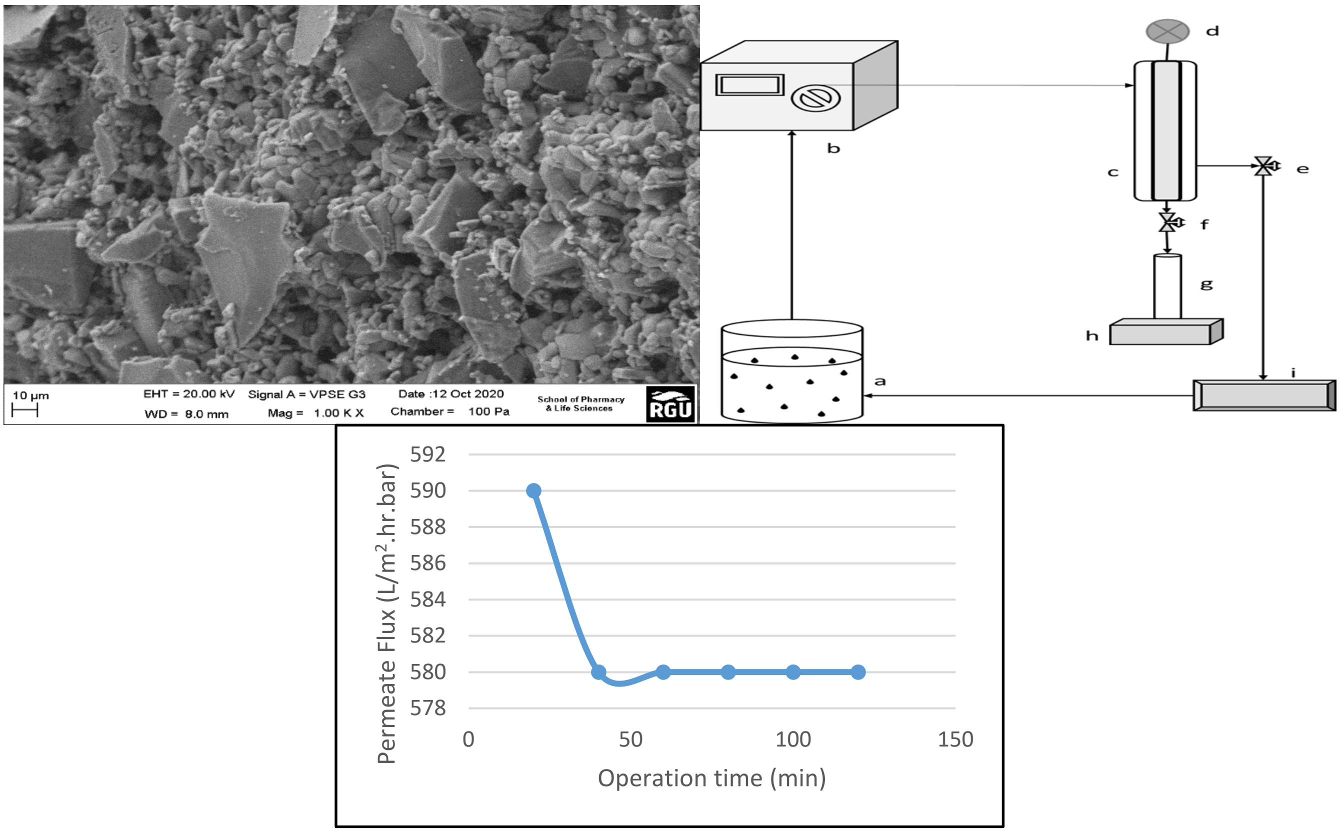

Fig. 1a: SEM image for unmodified commercial ceramic membrane; Fig. 1b: Schematic diagram of in-house rig set up(a-feed tank, b-peristaltic pump, c-membrane module housing ceramic membrane, d-pressure gauge, e & f-control valves, g-measuring cylinder, h-weighing balance, i-flowmeter) ; Fig. 1c: Permeate flux of pure water in unmodified commercial ceramic membrane.

CONCLUSIONS

A preliminary experiment to determine morphology and pure water flux of unmodified commercial ceramic membrane was evaluated as a reference for modified nanoparticle ceramic membrane. SEM results indicates a densely packed and rough structure with unevenly distributed pore size providing the possibility of increased flux. Indication of a steady permeate flux is shown from 45min implying the possibility of anti-fouling.

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