INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

Name of the Student	:	**Vinoth Kumar R**
Roll Number	:	**136107022**
Programme of Study	:	Ph.D.

Thesis Title: **Novel Low Cost Ceramic and Zeolite-Ceramic Composite Tubular Membranes for Liquid Phase Separation Applications**

Name of Thesis Supervisor(s)	:	Prof. G. Pugazhenthi
Thesis Submitted to the Department/Center	:	Chemical Engineering
Date of completion of Thesis Viva-Voce Exam:		27.09.2016
Key words for description of Thesis Work	:	Low cost tubular membrane, Zeolite membranes, Oily wastewater, Dairy wastewater, Chromium removal, BSA separation

SHORT ABSTRACT

In this work, a novel tubular configured ceramic membrane was developed using locally available inexpensive raw materials by extrusion technique. The raw materials and the fabricated membrane were characterized by particle size distribution (PSD), scanning electron microscopy (SEM), energy dispersive X-ray spectroscopy (EDX), X-ray diffraction (XRD), thermogravimetric (TG) and field emission scanning electron microscopy (FESEM). The prepared membrane ($0.5/membrane or 69 $/m^2) possessed the porosity of 53%, water permeability of 5.93×10^{-7} m^3/m^{2}s kPa, an average pore size of 0.309 µm and mechanical strength of 12 MPa with very good corrosion resistance. In order to explore the potential application of the membrane, it was utilized for the treatment of oily and dairy wastewaters. Various process conditions such as effect of applied pressure, feed concentration and crossflow rate on the treatment process were investigated. Diverse pore blocking models (complete, standard, intermediate pore blocking and cake filtration model) were employed to analyze the fouling mechanism associated with the treatment process. The applied pressure of 69 kPa offered the highest rejection of oily wastewater (99.98%) with permeate flux of 3.16×10^{-5} m^3/m^{2}s. The membrane achieved a maximum reduction in COD up to 91% in the permeate stream with a flux of 2.59×10^{-6} m^3/m^{2}s in dairy wastewater. It was anticipated that the elaborated low cost membrane could be used as a support for the fabrication of zeolite ceramic composite membranes. Hence, FAU and MFI type zeolite composite membranes were prepared on the ceramic support by hydrothermal treatment. The synthesized zeolites as well as membranes were characterized by XRD, PSD, Fourier transform infrared spectroscopy (FTIR), TGA, zeta potential measurements, FESEM, porosity, pore size and water permeability measurements. The porosity, pore size and water permeability values of the support was reduced and weight of the membranes was increased due to the incorporation of the zeolite layers on the support. The separation efficiency of zeolite membranes was evaluated for the chromium removal from an aqueous solution. A maximum chromium removal of 82% and 78% was obtained with FAU and MFI membrane, respectively at an applied pressure of 345 kPa and the initial feed concentration of 1000 ppm with natural pH of the solution. The performance comparison analysis with other membranes reported in the literature clearly indicated that the prepared membranes have better potential in the removal of chromium with offering 1 to 6 order higher fluxes. In addition, the application of zeolite membranes for the separation of BSA protein from its solution and optimization of critical parameters of the microfiltration system was also studied. Three operating parameters such as, BSA concentration, pH and applied pressure were optimized for the better separation efficiency of the membranes using response surface methodology (RSM) followed by bi-objective genetic algorithm (GA). The

appropriate optimum conditions were obtained as BSA concentration of 100 ppm, solution pH of 2 and applied pressure of 276 kPa. These predicted conditions were experimentally validated and a higher permeate flux and rejection of BSA are obtained as 2.66×10^{-5} m^3/m^2s & 88% for FAU membrane and 4.63×10^{-5} m^3/m^2s & 82% for MFI membrane, respectively. Besides, despite the use of simple fabrication method, lower sintering temperature and inexpensive raw materials, the excellent properties of the novel low cost tubular membrane substantiated that it could be effectively used as an alternative for high cost commercial membranes as well as the development of composite membranes. It is also found that the FAU membrane is a better candidate for chromium removal and BSA separation application as compared to MFI membrane due to higher separation efficiency, lower synthesize temperature in fabrication, and no calcination step required in the development of FAU zeolite membrane.