Chapter-2 Scope and Objectives

Ultrafiltration (UF) membranes are widely used in recent years for drinking water purification for the removal of bacteria, viruses, and natural organic matter, and for water reclamation. They are also employed for concentration, purification and fractionation of various products in diverse fields such as food, medical, biotechnology. Ultrafiltration membranes are usually made according to phase inversion process from polysulfone (PSF), polyethersulfone (PES), polyvinylidene fluoride (PVDF), polypropylene (PP) and polyacrylonitrile (PAN) owing to their excellent chemical resistance, thermal stability and mechanical properties. However, these (PSF, PES, PVDF, PP, PAN) polymeric membranes are highly hydrophobic and have the tendency for rapid fouling during the ultrafiltration of aqueous solutions. Membranes with hydrophilic surface are known to be less susceptible for fouling by feed solutes. Another major problem confronting the use of membrane based separation processes in a wide range of applications is the lack of membranes with high flux and high selectivity. There has been a trade off between selectivity and permeability; high selectivity tends to exhibits less permeability and vice versa. Therefore, the development of membranes with higher thermal and chemical resistance as well as anti-fouling properties is critically important in the quest for improvements in membrane technology for water purification and other separation applications.

In the preparation of PAN, a certain amount (4-10%) of acidic comonomers like methacrylic acid (MAA), acrylic acid (AA) or itaconic acid (IA) is generally incorporated into PAN during polymerization for enhancing the solubility, spinnability, hydrophilicity and drawability, and especially for promoting the thermo-oxidative stability of the fibres.\(^{115-118}\)

The present investigation is related to the preparation, characterization and performance evaluation of poly(acrylonitrile–co–methacrylic acid) (PANMA) asymmetric ultrafiltration membranes, PANMA-poly(piperazine-trimesamide) thin film composite
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ultrafiltration (TFC UF) membranes and PANMA-poly(methacrylate) composite ultrafiltration (SM UF) membranes. Poly(acrylonitrile-co-methacrylic acid) ultrafiltration membranes are expected to possess good mechanical stability owing to polyacrylonitrile chain, while the presence of carboxylic acid functionality provides fouling resistance property.

The objectives of this study are stated as following:

i) Preparation of poly(acrylonitrile-co-methacrylic acid) based integrally skinned asymmetric ultrafiltration membranes under different conditions using semi-automated membrane casting machine to reduce the error of manual casting and also to enable the casting to be carried out under optimum condition. The variables in the preparation of the membranes include: a) concentration of PANMA and b) molecular weight and concentration of polyvinylpyrrolidone in the membrane casting dope.

ii) Preparation of PANMA-polyamide thin film composite ultrafiltration (TFC UF) membranes by in situ interfacial polymerization of piperazine (PIP) in water with trimesoyl chloride (TMC) in hexane on the PANMA support. The variables in the preparation of the TFC UF membranes are: a) TMC concentration and b) curing temperature.

iii) Preparation of PANMA-poly(methacrylate) surface modified ultrafiltration (SM UF) membranes by in situ free radical redox polymerization of methacrylate monomers like sulfopropylmethacrylate (SPMA) on the PANMA support. The variables in the preparation of these membranes include: a) concentration of SPMA, crosslinking monomer (methylene-bis-acrylamide) and initiator ($K_2S_2O_8 + K_2S_2O_5$).

iv) To characterize the PANMA UF membranes by scanning electron microscopy (SEM) for surface and cross-sectional morphology
v) To characterize the TFC UF membranes by IR for surface chemical nature and AFM for surface roughness

vi) To study the effects of casting dope composition i.e., polymer concentration, additive (polyvinylpyrrolidone, PVP) concentration and solvent (DMF and DMF + THF mixture) composition on membrane characteristics and performance i.e., pure water flux, permeate flux and molecular weight cut off (MWCO) values.

vii) To study the effects of polyamide active layer preparation conditions on the characteristics and performance of the PANMA-polyamide composite membranes.

viii) To study the effect of operating pressure on membrane performance such as pure water flux, permeate flux and rejections of water soluble polymers like polyethyleneglycols (PEG), polyethyleneoxide (PEO) and dextran.

ix) To study the effect of feed solute molecular weight on permeate flux and rejection.

x) To evaluate the fouling tendency of the PANMA UF, TFC and SM UF membranes by continuous permeation of PEO solution for several hours and by determining their flux recovery ratio values at the end of the experiment.

xi) To study the polymer-assisted separation of dye by PANMA UF, TFC UF and SM UF membranes and evaluating their fouling tendency by determining their flux recovery ratio values at the end of the experiment.