ABSTRACT

Ultrafiltration (UF) designates a membrane separation process, driven by pressure gradient, in which the membrane fractionates the components of a liquid as a function of their solvated size and structure. The membrane configuration is generally cross-flow and dead end. UF membranes have a pore sizes in the range of 0.001 to 0.1 micron. Ultrafiltration separation processes is considered to be the superior separation processes, due to its low energy requirement than the other conventional processes (Ilias et al 1995).

UF involves no phase change, relatively non-destructive to the easily denaturable proteins, may be operated at low hydrostatic pressure and can be performed at ambient or relatively low temperatures which are useful to avoid denaturation of proteins (Medda et al 1981). Hence, ultrafiltration is now widely employed in the biotechnology industry for separating proteins and peptide drugs from fermentation broths (Johnson and Tragardh 1990) compared to other separation processes.

The development of polyethersulfone membranes of asymmetric structure has found wide range of applications in many separation industries due to their high tolerance towards chemicals, extreme pH environments respectively and it is thermally stable. However, it is more susceptible to fouling due to its hydrophobic character. This fragility of the membrane material results in loss of flux over a period of time. Even the membrane life

is reduced due to fouling and the choice of cleaning agents is extremely limited (Brousse et al 1976).

Polyetherimides are well known for their photo resistant property and they are highly stable to photo chemical radiations (Van der Bruggen 2009). Polyimides are important, both scientifically and commercially, because of their combination of outstanding key properties, including thermal, thermo-oxidative stability, high mechanical strength, high modulus and excellent electrical properties. Polyimides are widely used as membrane material, matrix resins, adhesives, coatings, printed circuit board and insulators for high performance applications in the aerospace, automotive, electrical, electronics and packing industries.

In the present investigation, keeping all the above points in mind, Flat sheet ultfrafiltration blend membranes based on polyethersulfone, polyethersulfone /polyetherimide with a thickness of 0.20 ± 0.02mm were prepared by solution blending and phase inversion technique. The polymer compositions were varied from 100/0, 90/10, 80/20 and 70/30 wt% PES/PEI system and the total polymer composition was optimized and maintained at 17.5 wt%. Beyond 70/30 wt% of PES/PEI, phase separation was observed, indicating the incompatibility between the polymer components. To improve the anti fouling property of the membrane, the prepared membranes were grafted with monomers such as Acrylic acid and N-Vinyl Pyrrolidone individually by photochemical reaction with use of UV lamp at different time intervals since, photochemical grafting of membranes was found to show low fouling properties. Modified membranes are expressed as AA-g-PES/PEI, NVP-g-PES/PEI. The monomers concentration were optimized to 5 wt % inorder to avoid chain cleavage during UV-grafting.

Molecular Weight Cut off (MWCO) of all the membranes were also determined by permeation of proteins (trypsin, pepsin, Egg Albumin (EA) and Bovine Serum Albumin (BSA)) of varied molar masses of 20, 35, 45 and 69 kDa. In PES/PEI system, the molecular weight cut-off of all membranes was greater that 69 KDa. For AA-g-PES/PEI, the least molecular weight was found for 6 min irradiated samples and all NVP-g-PES/PEI was found to have very low MWCO of 20 KDa irrespective of irradiation time. Morphology of all the membranes was investigated by SEM. The top surfaces and cross section of the PES, PES/PEI, AA-g-PES/PEI and NVP-g-PES/PEI blend membranes were studied. The presence of monomers was confirmed by FT-IR and TGA analysis.

The protein separation (trypsin, pepsin, EA and BSA) in terms of permeate flux and percent rejection has been investigated at dilute concentrations, BSA was found to have the highest separation with lowest product rate of all membranes respectively, while trypsin showed least separation and highest flux. This variation has been accounted in view of the size of the molecules.

Further, fouling behavior of all membranes were studied using BSA as a model. NVP-g-PES/PEI membranes found to have high resistance towards fouling. Flux recovery of NVP-g-PES/PEI membrane was high, on the other hand the irreversible fouling values were found to be very low, indicating the better performance in view of fouling. Next to NVP-g-PES/PEI ,AA-g-PES/PEI shows acceptable values on fouling. The enhanced performance of AA-g-PES/PEI, NVP-g-PES/PEI is due to the attachment of hydrophilic monomers on the surface.

FT- IR and TGA studies were not limited to the confirmation of functional groups, but the application is extended to know the mechanism of blending as well as mechanism of photografting.

Filtration protocols and fouling parameters reveal the antifouling property of all the membranes. It was found from all the characterizations that, PES/PEI membranes have good flux values, whereas the rejection and fouling behaviors are not up to the level of high performance. However AA-g-PES/PEI, NVP-g-PES/PEI membranes have better rejection values in addition to their high anti fouling properties with a marginal flux decline .