2.1. Scope of the work

Human beings need tremendous amount of water for survival. Water is not only essential for the drinking purpose for our biological needs but it is also necessary to prepare many foods that we depend upon and fundamental for basic hygiene which helps us to be healthy. An average person needs minimum 7.5 liters/day of water to maintain health and to survive. Due to growth in population the demand for clean water is increasing. Though supply of clean water is reducing day by day due to increasing water pollution.

Thus membrane technology has become most effective separation and purification technology now days since it can remove biological contaminants, organic and inorganic impurities in large volumes. Although, high energy filtration systems have been used in membrane technology for the removal of impurity, there is a crucial requirement of membranes which can give higher rejection and higher pure water flux at lower operating pressure thus reducing the cost of the membranes. The aim of the present study is to fabricate a new type of nanoporous mixed matrix membranes with functionalized multiwalled carbon nanotubes used as filler and to study the role of f-MWCNT in the membranes towards the pure water flux, heavy metal rejection, ternary wastewater treatment and protein fouling. The carbon nanotubes have been selected as fillers due to ease of frictionless transport of water through its hydrophobic walls [254] which could improve the pure water flux tremendously.

"The motivation behind the thesis is to fabricate the mixed matrix membrane incorporated with modified nanotubes which can offer low pressure separations of unwanted contaminants present in water."

2.2. Objectives of the study

Even though the RO membranes have been commercialized effectively and have widely used in the field of separation and purification of contaminated water, yet these membrane are having limitations such as requirement of higher applied

pressure and the resultant high energy consumption etc. Thus the fabrication of new generation of membranes is an important issue which can overcome the limitations of these commercialized membranes.

This work is based on the fabrication of functionalized multiwalled carbon nanotubes (f-MWCNT) incorporated polyether sulfone (PES) and sulfonated PES based mixed matrix membranes and investigation of these membranes in terms of morphology (using small angle neutron scattering), rejection performance.

The explicit objectives of the study are:

1. To functionalize the multiwalled carbon nanotubes with carboxylic, amide and azide functionality and their characterization to ensure the functionalization.
2. Fabrication of pristine polyethersulfone membrane (18 wt%) as well as mixed matrix membranes with f-MWCNT as filler and PES as polymer matrix. The concentration of f-MWCNT should be varied (0.03 wt%, 0.05 wt%, 0.07 wt%, 0.1 wt% and 1 wt%) and its effect on the morphology would be observed using different techniques including small angle neutron scattering.
3. To study all the fabricated membranes for the heavy metal removal experiment, ternary waste water treatment, and antifouling performance of the membranes.
4. To sulfonate PES in order to get the enhanced rejection performance of the modified membranes and functionalization of PES would be confirmed by NMR.
5. To fabricate pristine sulfonated polyethersulfone membrane (SPES) as well as mixed matrix membranes with f-MWCNT as filler and SPES as polymer matrix. With varying concentration of f-MWCNT (0.05 wt%, 0.1

wt% and 1.0 wt%) and to observe its effect on the morphology using different techniques including small angle neutron scattering.

6. To study all the fabricated membranes for the heavy metal removal experiment, ternary waste water treatment, and antifouling performance of the membranes.
7. To use Click reaction for modifying the 1 wt% azide f-MWCNT membrane using 1-pentyne and its characterization to ensure the modification. The modified membrane would be analyzed in terms of heavy metal removal experiment, ternary waste water treatment, and antifouling performance of the membranes.