## Preface

Ever increasing stress on the water bodies due to their excess abstraction and untreated discharged enhanced environmental pollution levels have led researchers to look for cost effective treatment technologies without compromising the efficiency. Ultrafiltration is preferred over other membrane technology like Ion exchange membrane, Reverse Osmosis, Nanofiltration commonly used for water treatment since it is cost effective, small pressure gradient required which add additional benefit to it also the cleaning technique is simpler in case of Ultrafiltration compared to other mentioned techniques. Therefore it has started attracting the interest of researchers for this purpose due to its efficiency over other techniques. The nanocomposite membrane comprising of green synthesized nanoparticle incorporated in polymer matrix are attracting increasing attention due to their economic viability and environmentally benign nature. Out of various polymer, PVDF is widely used for ultrafiltration due to high mechanical and thermal stability but high hydrophobicity restrict its successful application. Use of nanoparticles could reduce the fouling tendency of membrane. Among different nanoparticles, $TiO_2$ NPs is being widely used because of simple preparation technique having a unique property of nanomaterial and when embedded within the polymer matrix enhanced the performance of membrane. The present work was planned to check the efficacy of green synthesized particle loading for membrane fabrication and to prove their potency at the industrial scale. The work conducted included synthesis of particle using *Cajanus Cajan* extract followed by synthesis of membrane by phase inversion technique and incorporating the particle in the polymer matrix during synthesis. The synthesized particles and membrane is characterized and is finally used to reject and reduce Cr(VI) from wastewater followed by optimization of various parameters

for obtaining maximum rejection and reduction. The details of experiments performed and results obtained are included in this thesis. The subject matter contained in this volume is organized in seven different chapters.

Chapter 1 presents an overview of the water demand and supply, different technology available to treat wastewater, introduction to membrane technology , advantages of membrane technology over conventional technology for wastewater treatment.

Chapter 2 Describe the current research status of $TiO_2$ nanoparticle using green route. Different types of extract and method used to increase the yield of $TiO_2$ nanoparticle. This chapter also emphasis on the application of particle as photocatalyst material to degrade different pollutant. Afterwards this chapters highlights the researchers carried out in the field of membrane and nanocomposite membrane, their preparation technique. A comparative analysis of various treatment technology and nanocomposite membrane is also presented. The review has revealed that inspite of substantial work done, there are several challenges associated with the Ultrafiltration membranes that need to be addressed to make them an economically available at large scale.

Experimental protocols for membrane fabrication starting from the particle synthesis, processing to membrane fabrication are given in Chapter 3. Various techniques have been employed to study their physico chemical characteristic. The chapter mainly emphasis the effect of particle loading on the membrane properties in terms of morphological changes, porosity, pore size etc.

Chapter 4 incorporates the effect of particle loading on antifouling property. The antifouling property was analysed qualitatively and quantitatively using XDLVO approach.

This approach relates the fouling mechanism in terms of interaction energies existing between membrane surface and foulants and how the different particle loading changes the total interaction energy thereby indirectly affecting or enhancing the antifouling properties of membrane.

Chapter 5 deals with antifouling behaviour study of membrane during Ultrafiltration. The chapter provides better understanding of membrane fouling to solve the problems encountered during its application. Hermia's model is used to quantify the properties of the membrane by fitting the experimental results for explaining the fouling mechanism in order to adapt the process for controlling the fouling.

Chapter 6 deals with the application of synthesized nano composite membrane to remove Cr (VI) from wastewater and the mechanism for the removal of Cr(VI) using nanocomposite membrane. It involves the optimization of parameter including particle loading, particle size, pH, Cr (VI) concentration and transmembrane pressure to achieve maximum rejection and reduction%. At optimized condition the membrane are used to treat real tannery wastewater in order to compare the efficiency of membrane with modeled Cr solution. Emphasis was also given on the reusability and stability of the membrane by conducting 5 runs of experiment and observing the morphological changes within the membrane using different characterization technique.

Lasttly Chapter 7 include summary and main conclusion drawn from the results of the present work together with some future directions to make nanocomposite membrane more useful without losing efficiency at industrial scale