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A Short Review on Polymeric Membrane Used for Treating Waste Water

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Abstract

The potable reuse of water has become an important factor due to ever increasing population worldwide. The waste water can be reused in the field of agriculture, industry and also for drinking purpose where there is acute scarcity of water. The polymeric membranes in this regard play a crucial role for the purification of waste water. But the use of polymeric membranes is limited due to the fouling of membranes, permeation of the pollutants through the pores of the membranes, consumption of energy, high cost of pretreatment membrane integrity etc. There are various methods available for the fabrication of the polymeric membrane. The method of fabrication can improve the shelf life by lowering its fouling. These fabrication processes also vary its pore size distribution.

Keywords: Waste water; Polymeric membrane; Nano composite; Fouling

Introduction

The potable reuse of water has become an important factor due to ever increasing population worldwide. The waste water can be reused in the field of agriculture, industry and also for drinking purpose where there is acute scarcity of water. The polymeric membranes in this regard play a crucial role for the purification of waste water. But the use of polymeric membranes is limited due to the fouling of membranes, permeation of the pollutants through the pores of the membranes, consumption of energy, high cost of pretreatment, membrane integrity etc. [1].

Membrane technologies

The secondary and tertiary treated waste water contains several impurities as suspended solids even after various treatment methods

- Suspended solids, colloids, nitrogen, metals, phosphorous etc.
- Oxy-halides
- Pesticides, insecticides, plasticizers etc.

The main principle behind the separation of contaminants by the use of membranes is mainly based on the different sizes of the pores of the membrane material. Day-by-day the use of potable water has become more common and hence removal of contaminants has become more necessary and also challenging too [2]. The removal of contaminants from the solution by the use of polymeric membranes significantly varies and can be controlled by changing the physicochemical properties, type of the membranes and so on [3]. The purification by membrane can be divided into various categories depending on the configuration of the membranes, type of membrane materials, driving force, mechanism of separation and the size of contaminants excluded/eluted. With decrease in the size of pore, more pressure will be needed and thus membranes can be classified as:

- Ultra Filtration (UF), Micro Filtration (MF)
- Nano Filtration (NF), Reverse Osmosis (RO) [4-6].

Microfiltration and ultra filtration

Microfiltration and ultra-filtration are the main classes of filtration by using low pressure. The microfiltration separates the impurities by the process of sieving and large pore size of the membrane limits its separation efficiency to the suspended solids or particles, bacteria and very less amount of organic colloids. The ultra-filtration technique also separates the impurities by the process of sieving but it has a wider range of separation than that of microfiltration and depending on the size of the pore, it has the ability to remove particles, pathogens, viruses and colloids. The elution of the impurities by microfiltration and ultra-filtration depends on the properties of the membrane as well as the hydrodynamic conditions. For the potable use Microfiltration (MF) is commonly employed for the removal of suspended solids. The pore size of MF membranes ranges from 0.1 micrometer to 1.0 micrometer (diameter) which can do limited removal of viruses. The ultra-filtration membranes has the capability to reject all suspended solids, organic impurities, BOD (Biological Oxygen Demand) by an efficiency of 95 % and also can reduce the turbidity of solutions. But the main disadvantages of purification of waste water by the use of membranes are as follows:

- Surface defects
- Deterioration due to fouling
- Imperfect packing

Ultra filtration can also remove phosphorous, nitrogen and total organic compounds but to achieve greater efficiency chemical coagulants are needed to be added. MF and UF cannot remove dissolved contaminants. Fouling prevention should be regularly done but the polymeric UF and MF membranes are less tolerant towards the chemical washing.

Nano-filtration and reverse osmosis

For the effective removal of chemical constituents such as salts, near about similar processes Nano Filtration (NF) and Reverse Osmosis (RO) are employed. Both the processes operate on high pressure and are of same/almost same materials of membrane. RO is more efficient than NF for the removal of solutes but the NF is mostly used due to its higher energy requirement. NF allows greater water permeability and hence requires much less operating pressure than that required for RO and are much more energy efficient. The efficiency of removal of divalent ions by NF is about ~95% whereas monovalent

ion removal ranges from 20%-80%. RO membrane constitute of a homogenous polymeric layer. For driving the solvent through the membrane pressure is applied and most of the solute retain on the feed site. Here the applied pressure exceeds the osmotic pressure. RO membranes can reject NaCl up to an efficiency of 99%. RO can also act as a barrier to pathogens. RO can also remove organic compounds having high molecular weight. BOD and COD can be removed to up to 98% and 96% respectively. Different configurations of RO membranes have been engineered to minimize the cost of energy.

Membranes

The development of new membranes is an avenue for the research in the field of academics, industries and laboratories. The main challenge is to obtain membrane with low fouling, high permeability, and higher shelf life. The contaminants can range from micro-organisms, viruses and bacteria.

Polymeric membrane

The polymeric membranes are made of various types of polymers such as PVA, PP, PS etc. The polymeric membranes are more prone towards fouling and thus have lower shelf life. To avoid the fouling regular washing should be done. But the polymeric membranes are not tolerant towards chemical washing.

Conclusion

Membrane fabrication

There are various methods available for the fabrication of the polymeric membrane. The method of fabrication can improve the shelf life by lowering its fouling. These fabrication processes also vary its pore size distribution. Other techniques used in membrane fabrication or modifications include *in-situ* polymerization, film casting, ion assisted deposition, aerosol deposition, ion exchange, dip coating, hydrothermal synthesis, sputtering and etching, surface adsorption, layer-by-layer deposition and spray coating and also some chemical methods are there.

Nano composite membrane

Incorporation of nanoparticles imparts interesting properties to the polymeric membranes including its mechanical strength, pore size distribution and fouling behavior.

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