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Waste Water treatment in textile industry using membrane technology: An Overview

Pratima Singh
Department of Physics, DAV College, Kanpur
E- mail: asgpratima@gmail.com

ABSTRACT

All aspects of life need water. Good quality of water is needed to support healthy ecosystems. Safe and good quality of water is necessary for maintaining public health, irrigation in agriculture and various industrial production processes. Water is short in supply and heavily polluted by various industrial, human and commercial activities. The fresh water available is being polluted because of these activities by various types of pollutants and thereafter needs resource recovery alternatives. Textile industry also needs this precious resource for the various productions processes but pollutes it heavily. Thus, textile industry needs technologies to recycle the waste water and make it free from various pollutants. Waste water from textile industry needs dye recovery, size composition recovery, salt and dye separation, reclamation and waste water recycle. For this purpose various technologies are available .Among them membrane technology is preferred. Variety of membrane technologies i.e. micro filtration, ultra filtration, Nano filtration , reverse osmosis etc. are available and further research is going on to improve the quality and capacity of membrane technology.

Keywords: *Pollutants, Membrane technology, Reclamation, Nano filtration.*

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INTRODUCTION

Water is one of the most important components which are essential for life-line. Water is required for production of electricity, thermal energy, nuclear energy and growing bio-fuels. Irrigation in agriculture sector needs large quantity of water. Industries need water for different manufacturing processes. Fresh and safe water is needed for maintaining healthy life and healthy environmental conditions. But fresh water on the earth is decreasing very fast. Pressure is increasing on fresh water because of increasing population, urbanisation and industrialisation. So reuse and recycling of water has become necessary. Government of different countries has become alert for this problem and are making strict environmental norms and ensuring compliance to save the situation. Investments and research in water sector are growing. As a result many technologies for the water preservation and purification have been emerged. There are various technologies for recycling and preservation of the water i.e. Physico-chemical Treatment, Coagulation-flocculation, Granular activated carbon, Fixed bio film reactor, electrosorption and membrane technology. Membrane technology is one of the most advanced technologies for this purpose.

Textile industry consumes high amount of water for different production processes. Released water from industry is finally loaded with different pollutants, dyes, acids, bases, salt, surfactants, heavy metals and suspended solids. Production in Textile industry needs mixture of dyes, various additives, solvents, antifoaming, whitening agents and pH conditioners for different processes. Water released from textile industry is either used for irrigation purposes or it runs off into natural sources of water.Basic and reactive dyes are gently used in the textile industry because of their bright colours, being water soluble, easy to apply fabric and being economic [1]. Fast colours make effluent more harmful. Effluent water contains about 15% of the dyes used in textile industry [2]. About 40-65 litres of effluent are generated per kilogram of cloth produced in Textile industry[3]. Various salts and chemicals used in textile industry are the major sources of heavy metals released in water. Sediments, suspended solids and dissolved solids and dyes causes rapid depletion of dissolved oxygen [4]. Chemical Pollutants in effluent from textile industry affect health of public in different ways [5]. Total suspended solids (TSS), total dissolved solids (TDS) have high concentration in textile effluent. Biological oxygen demand (BOD), Chemical oxygen demand (COD), Chloride, Sulphate, Phosphate, Lead, Nickel, Zinc, Chromium, Copper and oil-grease have higher concentration than permissible limits. High value of pH in effluents harms humans, aquatic animals and disturbs the biological activities of stream if released untreated. Total alkalinity and hardness of effluent affect the quality of water released. So it is recommended that the disposal of effluent from the textile industry without proper treatment should be avoided to keep our land and water resources safe.

DEVELOPMENT OF MEMBRANE TECHNOLOGY

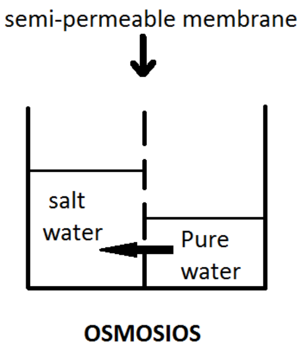
Cellulose Acetate films for desalination were firstly investigated by Charles E. Reid in 1955. Loeb and Sourirajan developed a method for making Cellulose Acetate membranes i.e. practical RO separation of matter. Development of spiral wound membrane elements and thin film composite membrane polymers took place in early 1960's and 1970's respectively. New generation membrane can tolerate pH ranges, higher temperatures, harsh chemical environments, highly improved flux and solute separation characteristics. RO membranes are being used in sea water desalination process, brackish water treatment, waste water treatment, water softening and many other processes. Reverse osmosis process does not need any energy-intensive phase changes as it is a pressure driven process. Ultrafiltration membranes and Nano filtration membranes are related to reverse osmosis process. Because of water scarcity and pollution control issues, there has been a tremendous development in the membrane technology. There are various membrane technologies. Some of them are given below:

Microfiltration: The latest microfiltration use "cross-flow" design which produce two streams. One stream is passed through membrane and gets purified and second one is used to carry contaminants and rejected.

Ultrafiltration: This process contains membrane and mostly effective for removal of micro-organism, colloidal material and dissolved organic solutes.

Nano filtration: It exhibits rejection of ionic species and monovalent salts mostly.

Reverse osmosis: Simultaneous separation and concentration of both inorganic and organic compounds are possible with reverse osmosis process. Osmosis is a process in which pure water flows from a dilute solution through a semi-permeable membrane into a high concentration solutionas in Figure1. This process stops when concentration in both solutions becomes same. The height of salt water column will increase until the pressure of column is so high that the force of this water column stops water flow. If a force is applied to this column of the salt water, the direction of water flow through membrane can be reversed i.e. reverse osmosis as in figure 2**.**



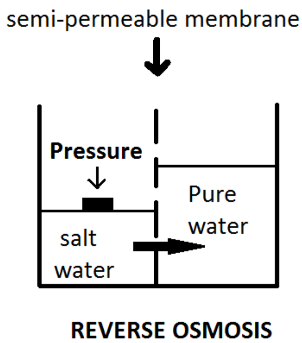


FIGURE 1: OSMOSIS FIGURE 2: REVERSE OSMOSIS

Electro-dialysis: It contains combination of permeable membrane and an electrode (cathode or anode). This process takes place with charged membrane which allows either cation or anion to pass through, with proper charge imposed by anode and cathode. Electro-dialysis is unaffected by Osmosis Pressure.

Polymeric membrane technology along with some filler such as carbon nanotubes, nanoclay and nanoparticles prepare different type of composite membranes.

Only ultrafiltration is not sufficient for water treatment in textile industry for its reuse for different purposes [6, 7]. Ultrafiltration with reverse osmosis[8] or with biological reactor [9] can give better results. Nano filtration membrane has satisfactory rejection against various dyes at most testing conditions. In addition rejected stream with NaCl and Na_2SO_4 have the potential to be reused for next dyeing process in textile industry[10].

Membrane bioreactor (MBR) also uses bio-membranes for filtration processes to treat waste water for recycling and re-use. Pre-treated, screened water enters the membrane bio-reactors and filtration takes place. Permeate from the membrane system contains treated effluent. The rejected water has concentration of solids and returns to the bio-reactor and is wasted from the bio-reactor or from the return line. MBR Plant has many advantages over conventional treatment methods and is attractive because of its easy operation. Disadvantages of this technology include frequent membrane monitoring, maintenance requirements and relatively high costs. These reactors have been used in treatment of a wide range of difficult waste waters [11-13].

APPLICATION OF MEMBRANE SEPARATION SYSTEMS FOR WASTE WATER

The application of membrane separation systems has wide range. This system is used for desalination of sea water or brackish water, waste water recovery, purification of drinking water and treatment of waste water from different industries. Performance and efficiency in any membrane separation system can be affected by several factors i.e. feed stream chemistry, membrane element design, membrane area, membrane polymer, temperature, applied pressure, recovery, flow conditions and membrane element array. Membrane element can be designed as tubular, capillary or hollow fibre, plate and frame and spiral wound type.In full scale membrane separation system raw effluent is collected, pre-treated and then passed through different stages of reverse osmosis membrane systems which results in a purified stream of water for reuse and rejected stream has high concentration. The concentrated rejected water is solidified before disposal.

CONCLUSION

Each membrane separation technology has strengths and weaknesses. There is always a probability of reject mismanagement as the membrane systems involve physical separation process. Combination of membrane technology and other technologies take advantages of a particular strength in a specific application. Prior use of membrane technology to Ion-Exchange dramatically reduces operating costs. Effluent from Textile industries inherently possess high level of "TDS" and promote only water recovery projects and leaving the reject back to natural environment. The Membrane Separation is widely accepted traditional, economical and less energy consumption technology.

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