**ORGANIC POLLUTANTS REMOVAL FROM WASTEWATER BY LIQUID MEMBRANE TECHNIQUES**

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**Abstract**

Water our nation’s most important natural resource. The world’s supply of fresh water is finite and is threatened by pollution. Rising demands for water to supply agriculture, industry and cities are leading to competition over the allocation of limited fresh water resources. Most of the different industries used water for different operations and then discharge it back into the environment. As the global population grows and many developing countries modernize, the importance of water supply and wastewater treatment becomes a much greater factor in the welfare of nations. Clearly, in today’s world the competition for water resources coupled with the unfortunate commingling of wastewater discharges with freshwater supplies creates additional pressure on treatment systems. Recently, researchers focus on wastewater treatment by difference methods with minimal cost and maximum efficiency. The chapter illustrated removal of organic pollutants in industrial wastewater treated by membrane techniques for water recycle and reuse in many industries. Water recycles and reuses produce by membrane technique to give substantial environmental benefits, arising from reductions in water diversions, and reductions in the impacts of wastewater discharges on environmental water quality. The chapter also describes the economic and environmental benefits identified in recent integrated membrane technique.

**Keywords**: Industries; Reuse; Fresh water; operations; Resources; Membrane techniques

**1. Introduction**

 Water is an important essence for every living creature throughout the world. We hardly separate our daily life with the water. Water pollution is one of the most serious and important issues in water quality. The natural water resources were often polluted by dyes discharge of a many industries like textile, printing, carpet and paper, etc., that leading to increase in toxicity and COD (chemical oxygen demand) and interferes with the transmission of sunlight into the watercourse and therefore reduces photosynthetic process (Ravindra and Sunil, 2009).The use of synthetic chemical dyes in various industrial processes, including paper and pulp manufacturing, plastics, dyeing of cloth, leather treatment and printing has increased considerably over the last few years, resulting in the release of dye-containing industrial effluents into the soil and aquatic ecosystems (Singh and Srivastava, 2001; Aksu, 2005).Textile industries utilize substantial volumes of water and chemicals for wet-processing of textiles. There are more than 8,000 chemical products associated with the dyeing process listed in the Colour Index, including several structural varieties of dyes, such as acidic, reactive, basic, disperse, azo, diazo, anthraquinonebased and metal-complex dyes (Banat et al., 1996).

 Due to their chemical structures, dyes are resistant to fading on exposure to light, water and many chemicals and, therefore, are difficult to be decolourised once released into the aquatic environment (Poots, et al., 1976). Many of the organic dyes are hazardous and may affect aquatic life and even the food chain (Banat et al., 1996). Exposure to the dye has been known to cause an allergic reaction (and possibly anaphylactic shock). Dyes are more difficult to treat because their synthetic origin is mainly complex aromatic molecular structures. This renders them more stable and less amenable to biodegradation. The removal of dyes from industrial waste before they are discharged into the water bodies is therefore very important from health and hygiene point of view and for environmental protection (Khan and Husain, 2007). Over the last decades, the tightening of water quality regulations and the increased attention given to trace contaminants in surface water and drinking water has been urging of alternative treatment technologies in order to improve conventional water treatment processes (Hassan et. al., 2013).

 Many treatment processes have been applied for the removal of dyes from wastewater such as: Photocatalytic decolorization (Hussein, 2010), electrochemical degradation, integrated chemical–biological degradation, Fenton and photo-Fenton oxidations, electroflocculation, combined photo catalytic and ozonation processes, coagulation, precipitation, ion exchange, chemical oxidation, and adsorption (Stephenson and Sheldon, 1996; Chiou and Chuang, 2006; Salem and El-maazawi, 2000). However, these methods are not very successful due to several restrictions, because these physical and chemical methods are either costly, or produce concentrated sludge, or may not capable of treating large volumes of effluent without the risk of clogging.

 In order to serve the purpose, liquid membrane technology has become an alternative since it can provide clean water and rejecting all threats during the treatment process. Liquid membrane is one of the most important separation processes. In the purification-separation of dyes from wastewater liquid membranes play a vital role.

**2. General description**

**2.1. Water consumption in textile industry**

 The textile dyeing and finishing industry has created a huge pollution problem as it is one of the most chemically intensive industries on earth. The industry is using more than 8000 chemicals in various processes of textile manufacture including dyeing and printing. Many of these chemicals are poisonous and damaging to human health directly or indirectly. Large quantities of water are required for textile processing, dyeing and printing. Water is also required for washing the dyed and printed fabric and yarn to achieve washing fastness and bright backgrounds. This removes the surplus color and paste from the substrate. Water is also needed for cleaning the printing machines to remove loose color paste from printing blankets, printing screens and dyeing vessels (Wasif and Kone, 1996; Vijaraghavan, 1999).

**2.2. Hazards of Water Pollution**

 The waste water that flows in the drains corrodes and incrustates the sewerage pipes. If allowed to flow in drains and rivers it effects the quality of drinking water in hand pumps making it unfit for human consumption. Such polluted water can be a breeding ground for bacteria and viruses. Impurities in water affect the textile processing in many ways. In scouring and bleaching they impart a yellow tinge to white fabric. In dyeing stage metallic ions present in water sometimes combine with the dyes causing dullness in shades.

 Textile effluent is a cause of significant amount of environmental degradation and human illnesses. All the organic materials present in the wastewater from a textile industry are of great concern in water treatment because they react with many disinfectants especially chlorine. Chemicals evaporate into the air we breathe or are absorbed through our skin and show up as allergic reactions and may cause harm to children even before birth (Kant, 2012). Thus, the removal of dyes from industrial effluents has become one of the major environmental concerns.

**2.3. Treatment of effluent from textile industry**

 Effluent treatment methods can be classified into physical, chemical and biological methods. Exclusive treatment by one of these three methods has proved to be insufficient in removing color and other effluent from textile industry wastewater. While some dyes are difficult to biodegrade few, particularly the hydrolyzed reactive and certain acidic dyes are not readily absorbed by active sludge.

The resulting effluent is usually high in color. A complimentary treatment process is needed to remove color and if possible residual impurities. The textile industry has been condemned to be the world’s worst environment polluters. It requires large amounts of Chemicals and Water at every step of the textile manufacturing and finishing process. Water is needed to convey the chemicals into the fabric and to wash it at the beginning and end of every step. It becomes full of chemical additives and is then expelled as wastewater; which in turn pollutes the environment. Considering the adverse effect on environment and health of people due to the effluent being thrown out of the Textile Dye Industry we need to wake up to the serious problem and make every effort to reduce pollution and construct effluent treatment plants at the sites churning out billions of liters of waste water.

 Liquid membranes (LM) have received much attention over the last decades: liquid membrane applications having different configurations and have recently become of substantial practical consequentiality in separation technology, macromolecular chemistry and membrane technology.

 Liquid membranes first invented by Li (1968) remove the equilibrium limitations of solvent extraction by combining extraction and stripping in a single operation. In the past years, the use of liquid membranes has gained a general interest in the treatment of effluents where solute concentrations are low and large volumes of solutions could be processed. A liquid membrane (LM) is literally a membrane made of liquid. It consists of a liquid phase existing either in supported or unsupported form that serves as a membrane barrier between two phases of dye aqueous solutions or gas mixtures. One of the benefits of using a liquid membrane is that LMs are highly selective, and, with the use of carriers for the transport mechanism, specificmolecularrecognition can be achieved.

**3. Types and transport of liquid membrane**

 LMs are relatively high in efficiency, and as such, are being looked into for industrial applications. There are three basic forms of liquid membrane processes: emulsion liquid membrane (ELM), Bulk liquid membrane and supported liquid membranes (SLM). Liquid membrane (LM) process in which two aqueous phases named as feed and stripping phases are separated by an immiscible organic phase. LM has advantages such as low operation costs, high efficiency and potential usage of environmental friendly materials as diluent or carrier. Based on the mechanism of solute transport from the feed phase through the liquid membrane into the stripping phase, LM technique can be divided into four major types:

a) Simple transport: in this case the solute solubility is the main reason for solute to move through the organic phase (Mulder, 1996; Nath, 2008).

b) Facilitated transport in which a carrier mediated organic phase accelerates the solute diffusion through the liquid membrane (Alguacil et al., 2005; Teng et al., 2014).

c) Coupled counter transport (co-transport) is a specific type of facilitatedtransportin which feed and stripping phases acidity play the major role in solute-carrier complexation, decomplexation and couple transport of protons (Khaoya and Pancharoen,2012; Talebi et al., 2015).

d) Active transport which is based on oxidation-reduction and biochemical conversions in feed-membrane and membrane-strip phase interfaces (Paugam and Smith, 1993; Shinbo, 1977).

Figures of liquid membrane shown in Fig. 1,2 and 3. The most common and conventional solute transport mechanism in LM is the facilitated type and many researchers have investigated the effect of various carriers, diluents, solutes and LM modules to find the best and most effective solvent extraction condition.


**Fig. 1:** Simple transports of Species (S) from Feed phase (F), through LM (M) to Stripping phase (S)



 **Fig. 2:** Facilitated transport of species S through LM



**Fig. 3:** Active transport of species S through LM

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