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Recovery of cationic and anionic dyes from wastewater by supported membrane techniques

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Abstract
The current study enumerates the use of supported liquid membrane (SLM) technology to remove and recover the crystal violet dye from wastewaters. The management of textile industry waste effluents is one of the main concerns of environmental health experts due to having excessive concentrations of dyes and resistance to biodegradation. A lab-scale study on the application of supported liquid membranes (SLM) has been conducted for recovery and selective removal of Malachite Green dye from wastewater. Naturally occurring non-toxic vegetable oils have been used as membrane liquids. Polyvinylidene fluoride (PVDF) films have been used as supports for the liquid membrane. Various parameters affecting the dye permeation such as initial dye concentration, pH, stripping acid concentration, oil viscosity and membrane stability have been investigated. In this research liquid-liquid extraction and bulk liquid membrane methods are used to study on the removal and recovery of methylene blue dye from textile wastewater by using salicylic acid in benzene. First, the liquid-liquid extraction of mennyien methylene blue dye was investigated. The parameters examined in this research were the effect of diluents, effect of pH, effect of Extractant concentration, effect of dye concentration and the suitable stripping agent. Second, taking into consideration the obtained results, the transport of methylene blue dye across a bulk liquid membrane was studied. The present work describes the application of Supported Liquid Membrane (SLM) technology towards the removal and recovery of a cationic dye (Methylene Blue) from aqueous solutions. Natural and non-toxic vegetable oils have been impregnated on micro porous polymeric films of polyvinylidene fluoride (PVDF) to constitute a liquid membrane.
The supported liquid membrane technique has proven to be one of the promising methods for the separation and recovery of dyes from wastewater. The cationic dyes MB, MG and anionic dyes EY, TY were tested for removal and more than 89% of the dyes were removed and recovered. The SE/LLE method was used as a preliminary proceeded in determine the appropriate carrier and optimal conditions that were to be applied in BLM and SLM methods in this research work. The BLM technique has been used in compare the effectiveness of SL.M. When comparing BLM with SIM, although BLM removes more dyes than SIM, lots of chemicals required making the less environmentally friendly.
Compared to SK and BLM, SLM has proven to be a very simple, effective and cost effective separation method. Experiments have shown that SLM is a good alternative because of its advantages such as efficient separation, economy and high selectivity to separate the dyes. Also, the use of expensive chemicals in low consumption makes it economical and eco-friendly.

Keywords: MB-Methylene Blue, MG-Malachite Green, EY-Eosin Yellow, TY-Tartrazine Yellow, LLE-Liquid Liquid Extraction, BLM-Bulk Liquid Membrane and SLM-Supported Liquid Membrane

Introduction
Water, the blood of life and earth's key resource, plays a vital role in human civilization. As we are aware that, of the waters covering 70% of the earth's surface, only 3% is fresh and only 0.4% is available to us. The freshwater is spread all over the world in water bodies such as ponds, rivers, lakes, wells and underground bodies.

Due to the unrestricted use and covetous approach, the freshwater level has fatally decreased and is also contaminated. So, taking the total population into account, the availability of freshwater is not sufficient. Some researchers have opined that by 2030, an estimated 2/3 of the world's population will be forced to live in water-scarce areas. Billions of people are living without adequate access to safe and clean drinking water. Mekonnen and Hoekstra reported that four billion individuals are living in severe water insufficient circumstances. The UNICEF and World Health Organization have reported that 663 million people still lack better quality water. The World.

Economic Forum (WEF, 2015) [12] included in its Global Risk Report, water crises pose a serious threat to the world. The availability of clean water for drinking, cleaning and industrial use is one of the biggest challenges of the 21" century. Therefore, for the remaining water, people may have to fight and some scholars have even predicted that the third world war will be for freshwater. Hence, saving water to save the planet and humanity is the need of the hour.

The textile and leather industries produce large amounts of wastewater that contains a variety of dyes, and these coloured wastewater streams can have a serious negative impact on both the environment and human health. So, they must be treated or discoloured before water is discharged or recycled. Textile industries are one of the large level wastewaters producers that contains organic and inorganic compounds and of them, dyes are the most important ones. During the dyeing process in the textile industry, some of the dyes which are not fixed in the textiles will reach the wastewater stream. Textile wastewater stream may contain these left out dyes in high concentrations. At present, it is estimated that more than one lakh commercial dyes with a roughly estimated production of 7 x10° to 1 x10 tons per year are produced worldwide and 10 to 15% of used dyes enter into the environment [9]. Dyes generally have a synthetic origin and a complex aromatic molecular structure, which makes them more stable and more difficult for biological degradation.

Advantages of Liquid Membranes

LM an emerging removal technique finds enormous space in separation, removal and recovery processes. It is one of the most efficient methods of separation. Some of the advantages of LM are listed below.

The main advantages of this technology are as follows

- Unlike other technologies, LM can remove the toxic components selectively, leaving the non-hazardous components behind.
- It is a potential for retrieval or reuse of contaminants.
- A cost-effective alternative to other existing forms of membrane filtration technology.
- Required only low starting capital costs and operating costs.
- It can process various elements and compounds in a selected laboratory and industrial conditions at high speed and with a maximum degree of efficiency.
- It is environmentally friendly, in most cases; it does not produce sludge or other harmful by products that will require additional post-treatment before disposal.
- It can selectively obtain the target substances.
- They can recover metals, organic chemicals, and other elements and compounds in a concentration and purity that they can reuse.
- It has the feature of selectively removing multiple elements from a mixed process flow by sequentially switching in linear systems.
- It uses less power.
- Simple to use and easy to scale up.

Main advantages of SLM are as follows

- SLM technology theoretically is one of the most efficient membrane-based methods of separation. It does not use pressure or voltage but is based on the difference in chemical energy as a driving factor of the process.
- Coupled co- or counter-ion transport allows to get an active transport of the targeted species from diluted solutions into more concentrated and to collect toxic or precious species in a small volume of the acceptor solution.
- Small volumes of Extractant solutions and the possibility to conduct continuous processes make the SLM more attractive than classical ion exchange and solvent extraction technologies.

Conclusion

Since his existence in this world, man has been using coloured objects. These colouring agents; dyes and its intermediate chemicals are produced in large quantities by industries like textile, paper, paint and varnishes, ink, plastics, cosmetics, etc. A notable percentage of these manufactured dyes are unused and left out during the dyeing processes and are discharged off into the water bodies like river and lake etc. without proper treatment which leads to major environmental crisis. Some of the dyes are extremely toxic and highly persistence in nature. To treat these dye wastewaters many removal methods have been proposed by researchers. Techniques like biological methods, flocculation, and reverse osmosis, adsorption on activated charcoal, chemical oxidation methods and advanced oxidation processes are some of the most vastly used methods.

Of these, physical methods such as precipitation, flocculation or adsorption using charcoal and activated carbon do not decompose the pollutants but move them from the liquid phase to the solid phase, causing secondary pollution or requiring regeneration, which is costly and time consuming. Chemical methods, including Oxidative degradation by chlorine, hydrogen peroxide and ozone, reductive degradation by sodium hydrogen sulfide, photocatalysis and electrochemical treatments require high doses of chemicals and produce large quantities of sludge and thus have proven to be expensive.

Consequently, a method that can be used with lower maintenance and cost-effective which does not create sludge and allows the reuse of recovered materials is required. In this regard, the use of liquid membranes, which are gaining an important role the separation process, is a good alternative to the existing methods. Membrane separation technology is of great importance as it is potentially energy efficient and the membranes have high permeability and selectivity. Moreover, the technique has recently gained much attention due to its low cost and high flexibility. Beside these, high performance, automatic ease of use, scalability, high purity, and relatively high flex make the technique more attractive. In this work, we have applied membrane technologies like Solvent Extraction (SELLE),

Bulk Liquid Membrane (BLM) and Supported Liquid Membrane (SLM) to remove the cationic and anionic dyes from the wastewater.

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