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Emulsion Liquid Membrane: Removal and Recovery of Organic and Inorganic Ions

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Wastewater is a potential source of pollutant causing serious problems to environments. Most of the techniques such as chemical precipitation, coagulation-flocculation, flotation, ion exchange, electro –oxidation and adsorption have their own limitations [1,2]. Hence alternative technique is required to remove and recovery of organic and inorganic matters. Emulsion Liquid Membrane (ELM) is one of the techniques to remove and recover contaminants in wastewaters [3]. It has been given considerable attention by researchers due to its outstanding characteristics such as simultaneous pollutants removal and materials recovery in a single unit, non-equilibrium mass transfer, high selectivity, high fluxes, reusability and low energy consumption [4]. The ELM technique has great potential for removal and recovery of different metal ions and hydrocarbons from wastewater, where conventional methods provide lower separation efficiency. The diffusivity of most molecules through liquids is much higher than through polymer membranes. Liquid membrane separation methods use conventional kerosene, organic solvents and carriers which are hazardous to the environment. Liquid membrane can be modified to "green liquid membrane" by using environmentally friendly materials. For example, supported liquid membrane using non-toxic vegetable oil (coconut or palm oil) as a carrier [5] can reduce toxic and hazardous chemicals level in wastewater.

Emulsion liquid Membrane provides a good separation method of noble metals like gold and silver, lanthanides and rare earths. Investigation reveals that the ELM process offers potential for dearomatization of petroleum streams like naphtha and kerosene to meet product specifications for naphtha cracker feedstock and aviation kerosene [6,7]. Carriers such as aliquat 336, tri-n-butyl phosphate (TBP), di-2-ethyl hexyl phosphoric acid (D2EHPA), tri octylamine(TOA), bis(2-ethyl hexyl) phosphoric acid (D2EHPA) modify the transport mechanism in ELM. The most widely used carriers in ELM technique have shown a relatively good efficiency in various dyes and heavy metals removal.

New generation carriers are used in anionic, cationic, non-ionic and zwitterionic (amphoteric) species. The surfactants reduce the interfacial tension between oil and water by adsorbing at the liquid-liquid interface. For breaking water-oil (w/o) emulsion in wastewater treatment, electrostatic demulsification techniques are generally used [6-10]. Emulsification & recovery of metal from water–in-oil wastewater by an ELM process has also been reported [11]. Process parameters of emulsion liquid membrane include concentration of feed solution, concentration of stripping solution mixing speed, surfactant concentration ratio of the stripping phase, p^H of the feed phase, extractant concentration etc. The membrane phase in the water–oil-water (w/o/w) type is the immiscible oil phase separating the aqueous phase, while in the (o/w/o) type the immiscible water phase separating the two organic phases acts as the membrane. The solvent carriers and phase modifiers are invariably diluted in the organic diluents such as kerosene, n-heptane and dichloro-ethane [12,13].

These petroleum based diluents, which form the bulk components in the organic phases, are usually toxic, non-renewable, non-biodegradable, flammable and volatile in nature [14]. It is thus essential to find suitable replacement for the conventional petroleum based organic solvents in order to curb the environmental problem. Using environmentally friendly and green materials (such as vegetable oils) liquid membrane process is based on the formation of a double emulsion and is referred to as Emulsion (surfactant) Liquid Membrane (ESLM). This is a three phase system which is stabilized by an emulsifier, which can be up to 5% or more of the membrane liquid. In the ELM process the main problem relates to emulsion stability. Poor stability incurs partial rapture of the membranes which reduces overall efficiency.

The diffusivities of most molecules through liquid membrane are much higher than through polymeric membrane, which are so low that exceedingly thin membrane must be constructed to produce industrially acceptable fluxes, which may lead to fabrication and mechanical integrity problems. The Liquid membrane processes can be operated continuously and are scalable. Because of its close analogy with liquid-liquid extraction operation, existing design procedures for liquid-liquid extraction can be adopted for scale-up of parameters [15]. The volume of the stripping phase is much smaller than the external phase that enables concentration of the solute along with extraction. Emulsion liquid membranes produce high transfer rate due to large surface area and large scale piloting availability.

Conclusion

Technologies are very essential in our day to day life. But the scientific advancement generated pollution by factories, industries etc. ELM technology is proposed as an environmentally friendly treatment method to remove pollutants and recover materials from wastewater using highly modified chemical carriers in these types of non- toxic (or) least little toxic liquid membranes. The future of ELM technology must move towards high efficiency, cost effectiveness and low toxicity.

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