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EXTRACTION AND STRIPPING OF Cu(II) IONS FROM AQUEOUS SOLUTION BY CONTINUOUS WASTE COOKING OIL-BASED LIQUID MEMBRANE

ALIF AZWAN BIN ABDUL WAHAB

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ABSTRACT

This study aimed to extract and strip Cu(II) ions from aqueous solution by a waste cooking oil-based liquid membrane (WCLM). At first, the physicochemical properties of different types of waste cooking oil (WCO) were examined. The most favourable type of WCO was then selected for extraction behaviour study of Cu(II) ions from aqueous solution to determine the effects of pH, di-2-ethylhexylphosphate (D2EHPA) concentration and operating temperature using liquid – liquid extraction (LLE). Eventually, the optimum conditions from LLE experiments were used to operate WCLM system. Only the remaining parameters which associated to WCLM were selected and optimized in the response surface methodology (RSM). It was found that the densities among different types of WCO samples studied were relatively similar to each other, while the viscosity, free fatty acid (FFA) content and acid value increased with the darkness of the oil samples. The most favourable types of WCO was selected as it showed the percentage of extraction (%E) of Cu(II) ions was 96% when added with D2EHPA (carrier) and tributylphosphate (TBP) (phase modifier). In the extraction behaviour of Cu(II) ions, it was found that the pH equilibrium was 4.5, the optimum D2EHPA concentration was 20 mM and the operating temperatures shown insignificant effect on the Cu(II) extraction while the stoichiometric ratio of Cu(II) to D2EHPA was calculated as 1:2 in Cu(II)–organic complexes. In the effect of stripping reaction, H_2SO_4 at 1 M was found as effective condition with 94% percentage of stripping (%S) of Cu(II) ions. Eventually the maximum conditions for the optimization study in WCLM system for responses %E and %S were 90.21% and 52.62% respectively which were given by feed phase flowrate at 2.52 L/h, membrane phase flowrate at 2.69 L/h, extraction time in 5.15 h and stripping time in 23.36 h. Confirmation test was conducted to validate the optimum results and found the small deviation on the %E (3.66%) and %S (0.11%). Therefore, this study shows that the WCO has high potential as organic solvent for the continuous system of WCLM and is suitable for expanding to the industrial scale.

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CHAPTER ONE
INTRODUCTION

1.1 INDUSTRIAL WASTEWATER – SOURCE OF HEAVY METAL POLLUTION

In the middle of 18th century, the industries were much restricted to small areas. The rapid industrialization and urbanization from the Industrial Revolution until now have led to severe water pollution problems all over the world when various toxic organic and inorganic pollutants are discharged excessively into waterways by various industries such as iron and steel, agricultures, fertilizers, textiles and leather, pulp and paper, petrochemicals and refineries, chemicals, nonferrous and ferrous foundries, mining, electrics and electronics [1]–[3]. This poses a serious threat to drinking water and aquatic life, and subsequently to humans as a consumer. As the manufacturing industry is a second largest wastewater contribution in Malaysia, the government has proclaimed the policies and regulations for monitoring the quality of wastewater effluent through Environmental Quality Act 1974 (amendment 2012) [3], [4]. In this act, 'Industrial Effluents' can be defined as any waste in the form of liquid or wastewater generated from manufacturing process including the treatment of water for water supply or any activity occurring at any industrial premises [3]. Besides that, the term 'Sewage' is classified as any liquid waste or wastewater discharge containing human, animal, domestic, or putrescible matter in suspension or solution, and includes liquids containing chemicals in solution either in the raw, treated or partially treated form [3]. The discharge of those effluents must comply according to the Standard A or B. Standard A refers to the any inland waters within the catchment areas as specified in the Sixth Schedule of the act while Standard B refers to the any other inland waters or Malaysian waters [3].

Heavy metals, a type of inorganic pollutants, are particularly toxic to living organisms due to their persistence, bio-accumulation and non-biodegradable characteristics. Heavy metals in the industrial effluents are gradually increased along with industrial activities. The leading sources of these metals pollutant are metal finishing and processing, electroplating, foundries, mining and printed circuit board processing [5]. Metals that are usually found in wastewater are nickel, copper,