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ENHANCED HYDROPHILICITY OF INTEGRAL MEMBRANE

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B. Eng. (Hons) Chemical

July 2019

ABSTRACT

Membrane separation plays a big role in filtering heavy metals in wastewater. In order to achieve good separation, the membrane needs to possess certain properties such as high thermal stability, high water uptake, and high percentage of metal removal. Thus, the fabrication of a blend membrane from chitosan (CS), polysulfone (PSf), and polyvinyl alcohol (PVA) aims to achieve these desirable properties to ensure that a high amount of mercury can be eliminated from wastewater. In this study, a novel blend membrane from PSf, PVA and CS was fabricated by phase inversion method. The integral membranes with different compositions of PVA (1 wt% and 2 wt%) were characterized in terms of thermal stability, water uptake, pure water flux, antifouling properties, and mercury removal. Prior to performance testing, the blending of the integral membranes were confirmed via FTIR analysis. Results show that the integral membranes exhibit higher thermal stability, water uptake and pure water flux compared to pure PSf membrane. PSf/CS/PVA 2 wt% has the highest water uptake and pure water flux which are 233% and 57.96 L/m^{2}h respectively. This enhanced hydrophilicity is attributed to the presence of OH groups in PVA. Meanwhile, PSf/CS/PVA 1 wt% exhibited constant and total mercury removal (100%) during a filtration period of 1 hour. PSf/CS/PVA 2 wt% achieved 70.57% of mercury removal in the first 15 minutes but the percentage decreased to 68.21% at the 30th minute before falling to 0%. In terms of antifouling properties, both membranes undergo irreversible fouling. This may be due to the high concentration of humic acid used during filtration. Hence, further studies are required on the antifouling performance of the membranes.

ACKNOWLEDGEMENT

This report would not be possible without the guidance and support of my supervisor, Dr Norin Zamiah Kassim Shaari. I am grateful for her ideas and patience in assisting me throughout this research.

Aside from that, the support and assistance of Pn Roswati Hasim and En Mohd Nazmi Mukhelas are also deeply appreciated. The research would also not be successful if not for the laboratory facilities provided by Universiti Teknologi MARA, Shah Alam.

Last but not least, I am eternally thankful to my parents, Rozlee Hussein & , my siblings, and my best friend, Mohd Shaharil Omar, for their endless encouragement, motivation and emotional support.

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INTRODUCTION

1.1 Research Background

In this era of globalization, industrialization and urbanization are becoming more and more rampant. These activities often result in releases of toxic heavy metals into the environment – either through the air, water, or soil. These elements, also known as trace elements, include selenium, manganese, cobalt, aluminium, gold, iron, lead, cadmium, chromium, copper, nickel, silver, zinc, arsenic, and mercury. Most of the listed metals are carcinogenic, toxic, non-biodegradable, and highly soluble in water (Dalgleish et al., 2007; Gunatilake, 2015).

The ubiquitous nature of the compounds makes it easy for them to accumulate in the environment, especially in water sources. In humans, the mode of entries are through inhalation, absorption through skin, and accidental ingestion. Metals such as mercury, arsenic, and lead are referred to as systemic toxicants due to their ability to induce toxicity at lower levels of exposure (Jan et al., 2015). Among this three, mercury, or quicksilver, is regarded as the most toxic metal. In industrial wastewaters, the element is present at levels of parts per billion (ppb) and industries are required to adhere to strict discharge regulations (Walterick Jr. & Smith, 2012). Many of the industries are facing challenges in meeting the limits set by the respective governing bodies.

The issue of minimizing the amount of mercury in wastewater can be achieved by implementing various removal techniques which include adsorption, absorption, filtration, coagulation, reverse osmosis, and chemical precipitation (Shafeeq et al., 2012; K. Singh, Renu, & Agarwal, 2017). One of the methods that is explored widely is membrane separation. Currently, many applications utilize polymers such as polysulfone, polyvinyl alcohol, chitosan, and polyethylene glycol in the synthesis of the membranes (Salehi, Daraei, & Arabi Shamsabadi, 2016). In order to increase the membranes' properties such as tensile strength, thermal stability, and swellability, the membranes are fabricated by blending the compounds together and introducing crosslinking agents such as tetraethylorthosilicate (TEOS), glutaraldehyde (GA), formaldehyde, and other aldehydes (Bolto, Tran, Hoang, & Xie, 2009).