UNIVERSITI TEKNOLOGI MARA

FABRICATION AND PERFORMANCE OF NANOFILTRATION HYBRID MEMBRANE USING NANO CELLULOSE FROM COCONUT COIR NANO CELLULOSE FOR EXTRACTION OF HORMONE FROM POULTRY WASTEWATER

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Thesis submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy

Faculty of Civil Engineering

April 2019

ABSTRACT

Wastewater filtration by membrane application had been widely used to improve environmental water quality. Compared to the membranes that were fabricated using pure organic polymer and inorganic material, hybrid thin layer membrane has better mechanical and thermal stability. In this research, hybrid membrane as the barrier layer in the thin film composite membrane (TFC) was used for estrogen rejection. Coconut coir undergoes mechanical and chemical digestion to obtain coconut coir nano cellulose fibre (CCNC). In this research, polysulfone were casted as the porous based support layer whereas the hybrid membrane as the active barrier layer. Polymer blend of polyvinyl alcohol (PVA) and poly amide (PA) was chosen to be the polymer to undergo reaction with the organic cellulose of CCNC. To improve the plasticizing effect of the hybrid membrane, CCNC was added as an organic additive. The research involved seven stages of work. Analysis had been carried out to determine the polysulfone membrane water flux. Investigation on the suitability of the polymer and CCNC concentrations to fabricate the active layer were also determined. Physical and chemical characterization together with evaluation on performances on the thin film hybrid membrane was carried out. The evaluations were in order to analyse performances on the flux rate, estrogen and salt rejection. High surface hydrophilicity besides the good chemical and mechanical stability was observed on the application of hybrid membrane with the incorporation of CCNC compared to the base support polysulfone and pure polymer. The incorporation of CCNC had enhanced the membrane matrix and flexibility. Moreover, the incorporation of the cellulose had overcome brittleness of the ordinary hybrid membrane and the rigidity structure of the membrane. In the research, major findings were the suitable range of polymer (PA/PVA) which is between 8 wt. % to 10 wt. %. On the other hand, the CCNC concentrations were between 1 to 4 w/w %. Characterization of the estrogen and salt rejection were carried out at the second stage by using the hybrid membranes. Main purpose of the characterization was to obtain the pattern for estrogen and salt rejection with sufficient flux. Based on the evaluations, higher percentage of polymer formulation in the fabricated hybrid membrane leads to higher percentage of salt and estrogen rejection. However, nanostructure surface of 10 wt. % polymer which is the highest concentration of polymer suffers some aggregates and showed unsmooth nano surface layer due to incomplete reaction. Incorporation of CCNC concentration portrayed a significant impact to the salt and estrogen rejection. It can be seen that higher CCNC concentration with lower polymer concentration produce higher estrogen rejection. Therefore, the best polymer concentration for the polymer concentration and CCNC concentration in order to formulate hybrid membrane particularly for the condition in the feed solution temperature, reasonable flux, estrogen and salt rejection were justified. From the regression equation generated by using the experiment, it is accurately predicted for all the responses that the best formulation was achieved at 8 wt. % polymer, 4 w/w % CCNC and 12% polysulfone (PSF) with 75% w/w water addition. In conclusion, 82.85% estrogen rejection, 41.78% NaCl rejection and 26.43 L/m^3day of flux rate were obtained. This newly fabricated membrane had the advantage of operating at low pressure and room temperature for separation.

ACKNOWLEDGEMENT

In order to complete this study, there are many people that I owed instead of my personal effort. First and foremost, I would like to express my deepest thanks to Allah S.W.T. who had made all things possible and give me the ability and chance all the way to complete this research.

My deepest sincere gratitude goes to my supervisors that is Assoc. Prof. Dr. Ramlah Mohd. Tajuddin (Universiti Taknology MARA) for her precious supervision, interest, involvement and encouragement. This study would not be completed on time without her help, guidance, support and commitment. Not to forget to my Co-supervisor Dr. Amnorzahirah Amir (Universiti Teknology MARA) and Prof. Ramli Abdullah (University Malaya) for their kindness and support. Their help is fully appreciated.

I would also like to extend my thanks and appreciation to the Faculty of Civil Engineering for giving me the opportunity to learn and get new experience regarding in this journey of research. I also wish to extend my thanks to the staff of department of Civil Engineering that have helped me a lot with my lab work and for their kindness and guidance to finish this research.

My special thanks and appreciation goes to my beloved husband Abdul Hafiz Sathakathulla, my children (Muhamad Izzudeen Irfan, Muhamad Ridaudeen Farhan, Wan Saidatul Aisyah and Wan Raudhahtul Jannah) for their sacrifies of time, commitment and understanding towards my journey.

Last but not least, many thanks to all my family members especially my beloved mother and father (Wan Zahari Binti Abu Hassan and Mazlan Bin Tahir) and friends (Mardiana Mohd. Noor, Khairul Anam Moktar, Joyce Daniel and Mustapha Kamal Ariffin) who share their moments and ideas directly or indirectly in order to complete this research.

This piece of victory is dedicated to all of us. Alhamdulillah.

Thank you.

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CHAPTER ONE INTRODUCTION

1.1 Hormones Contamination Production in Malaysia

Water supply in Malaysia extracted surface water from rivers as its main water resources. However, the river water is subjected to many pollutants. Normal detected pollutants were focused on physical, chemical and biological characteristics that cover Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), pH and Ammoniacal Nitrogen. Parameters stated were the major existing component factors were used to calculate the Water Quality Index (WQI) and hence classifying standard quality of water.

However, there are other parameter that had been neglected even though they are vital to human health and environment. According to Solomon and Schettler (2000), these parameters such as steroidal estrogen of 17-β estradiol (E2), 17- α estradiol (EE2) as well as estrone are contributed by the pollutants that can cause cancer and human fertility degradation. These hormones were currently existing in the surrounding environment such as river water, lakes and estuarine and were excreted from human and animal waste (Ismail et al. 2007).

Concentrations of 17-β estradiol (E2) in river water located around Peninsular Malaysia are detected in a very wide range. The data ranges from as low as none to almost 3700 ng/L (Ahmad et al. 2014). Based on Nazari and Suja (2016), the E2 mean concentrations in Malaysia can also be classified based on their regions. E2 mean concentration at the south region is 15.66 ng/L,north region is 95.04 ng/L and the middle region with almost 150 ng/L which is the highest average among all other regions. The north regions were also once recorded with highest average concentration of estradiol in Malaysia with its extreme amount of 3677.4 ng/L.

On the other hand, the lakes in Malaysia have the mean amount value of 11.83 ng/L. Even though lakes did not record with the lowest mean concentration but it has the least mean concentration which is 27.7 ng/L among all. The minimum value of E2 concentration was around 2.1 ng/L to not detectable (Nazari and Suja, 2016).

Moreover, Nazari and Suja (2016) and Koyama et al. (2006) stated that estradiol concentrations stretching from 6.1 to 284 ng/L were present in the river water around Kuala Lumpur, Malaysia while Ismail et al. (2007) found the values ranged from non-