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THE REDUCTION OF *E. FAECALIS* IN WATER ENVIRONMENT BASED ON ULTRAFILTRATION: THE EFFECT OF MEMBRANE ZETA POTENTIAL ON REMOVAL EFFICIENCY

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PENGAKUAN DAN PENGESAHAN LAPORAN PROJEK PENYELIDIKAN I DAN II

Adalah ini diakui dan disahkan bahawa laporan penyelidikan bertajuk:
THE REDUCTION OF *E. FAECALIS* IN WATER ENVIRONMENT BASED ON ULTRAFILTRATION: THE EFFECT OF MEMBRANE ZETA POTENTIAL ON REMOVAL EFFICIENCY oleh JUSTINA ROSE A/P NASIMUTHU, No.Matrik UK7830 telah diperiksa dan semua pembetulan yang disarankan telah dilakukan. Laporan ini dikemukakan kepada Jabatan Sains Kejuruteraan sebagai memenuhi sebahagian daripada keperluan memperolehi Ijazah SARJANA MUDA TEKNOLOGI (ALAM SEKITAR), Fakulti Sains dan Teknologi , Universiti Malaysia Terengganu.

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LIST OF ABBREVIATIONS / SYMBOLS

Abbreviation

MF	Microfiltration
UF	Ultrafiltration
NF	Nanofiltration
RO	Reverse Osmosis
DBPs	Disinfection by-products
SMP	Soluble Microbial Product
PSF	Polysulfone
NMP	*N*-Methyl-2-Pyrrolidone
PVP	Polyvinylpyrrolidone
EKA	Electro Kinetic Analyzer
ZP	Zeta Potential
CFU/100mL	Colony forming unit per 100 milliliter
MWCO	Molecular Weight Cutoff
E.faecalis	*Enterococcus faecalis*
SEM	Scanning Electron Microscope
J_v	Pure Water Flux
R (%)	Percentages of Rejection
ND	Not detectable

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ABSTRACT

Membranes are being used for a wide range of applications globally. The ability of membranes as a disinfection apparatus for domestic water supply replacing chlorination is of great interest. Chlorination is the most common disinfection method used. Although effective in eliminating microorganisms, it produces harmful disinfection by-products (DBPs) which are harmful to human health. Membrane technology can be considered as an alternative disinfection method since it is an effective barrier for suspensions, bacteria, viruses and other microorganisms. Although membrane technology is a safe alternative, biofouling of membranes with bacteria is a significant problem which affects removal efficiency. The aim of this research was to investigate the effect of zeta potential on the performance of Ultrafiltration (UF) membranes in the removal of *E. faecalis* in water. Performance of produced membranes was evaluated based on the membrane surface charge value obtained from EKA analysis. Three membranes: PSF 13 wt%, PSF 15 wt% and PSF 17 wt% were fabricated and zeta potential value was measured in the range of -4.645 mV to -6.93 mV. The ZP value of membrane PSF 13 wt%, PSF 17 wt%, and PSF 15 wt% was in the range of -6.03 mV to –6.93 mV, -5.025 mV to -5.17 mV, and -4.654 mV to -4.96 mV, respectively. Membrane PSF 13 wt% recorded the most negative ZP value followed by PSF 17 wt% and PSF 15 wt%. All membranes recorded 100 % removal percentage for *E. faecalis*. Therefore it can be concluded that ZP values in the range of -4.645 mV to -6.93 mV is suitable for bacteria removal application. Although all membranes achieved 100 % removal efficiency, membrane PSF 13 wt% obtained the best flux followed by membrane PSF 17 wt% and PSF 15 wt%. Membrane PSF 13 wt%, PSF 15 wt% and PSF 17 wt% produced flux in the range of 17.04 L/m^2h - 64.89 L/m^2h, 1.90 L/m^2h - 5.76 L/m^2h, and 0.93 L/m^2h - 13.80 L/m^2h, respectively for bacteria removal. The PVP concentration and flux increased in this order: PSF 13 wt% > PSF 17 wt% > PSF 15 wt%. This order corresponds with more negative to least negative ZP value. Better flux for bacteria removal was produced by more negatively charged membranes.

ABSTRAK

Teknologi membran semakin banyak diaplikasikan dalam pelbagai bidang pada hari ini. Keupayaan membran untuk diaplikasikan bagi tujuan penyahjangkitan air mentah menjadi salah satu penyelidikan yang giat dilakukan oleh penyelidik seluruh dunia. Walaupun berkesan sebagai agen penyahjangkitan, ia akan membentuk bahan sampingan yang merbahaya kepada kesihatan manusia. Membran dipilih sebagai alternatif untuk penyahklorinan disebabkan oleh ciri-cirinya sebagai penghadang mikroorganisma serta bahan ampaian yang berkesan. Akan tetapi, kecekapan membran untuk penyahjangkitan terjejas dengan pembentukan lapisan gel (biofouling) yang berlaku pada permukaan membran. Penyelidikan ini bertujuan untuk mengkaji peranan 'zeta potential' ke atas prestasi membran UF dalam penyigkiran *E. faecalis* dari air. Prestasi membran dinilai dari aspek cas pada permukaan membran yang didapati melalui analisis EKA. Tiga formulasi membran: PSF 13 wt%, PSF 15 wt% dan PSF 17 wt% yang dihasilkan memberi nilai zeta potential dalam lingkungan -4.645 mV ke -6.93 mV. Zeta potential untuk membran PSF 13 wt%, PSF 17 wt%, dan PSF 15 wt% masing-masing didapati dalam lingkungan -6.03 mV hingga –6.93 mV, -5.025 mV hingga -5.17 mV, dan -4.654 mV hingga -4.96 mV. Membran PSF 13 wt% merekodkan nilai ZP yang paling negatif diikuti oleh membrane PSF 17 wt% dan PSF 15 wt%. Ketiga-tiga membran berkesan dalam penyingkiran *E.faecalis* dimana 100% penyingkiran dicapai. Oleh itu dapat dirumuskan bahawa nilai ZP dalam lingkungan -4.645 mV to -6.93 mV sesuai untuk penyingkiran bakteria. Fluks untuk bakteria paling tinggi didapati untuk membran PSF 13 wt% diikuti oleh membran PSF 17 wt% dan PSF 15 wt%. Membran PSF 13 wt%, PSF 15 wt%, dan PSF 17 wt% menghasilkan fluks dalam lingkungan 17.04 L/m^2h - 64.89 L/m^2h, 1.90 L/m^2h - 5.76 L/m^2h, and 0.93 L/m^2h - 13.80 L/m^2h masing-masing. Kepekatan PVP dan fluks bertambah dalam urutan berikut : PSF 13 wt% > PSF 17 wt% > PSF 15 wt%. Urutan ini sejajar dengan nilai ZP yang semakin negatif. Membran yang mempunyai cas ZP yang lebih negatif menghasilkan fluks yang lebih baik untuk penyingkiran bakteria.