Effects of Immobilized $AgNO_3$ in Composite Polysulfone-Polyethyleneimine Membrane towards Antibacterial Properties

Khairul Anwar Mohamad Said
Department of Chemical Engineering and Energy Sustainability, Faculty of Engineering, Universiti Malaysia Sarawak (UNIMAS)
Office: 082583235
Phone: 0189792066
Email: mskanwar@unimas.my

Acknowledgement

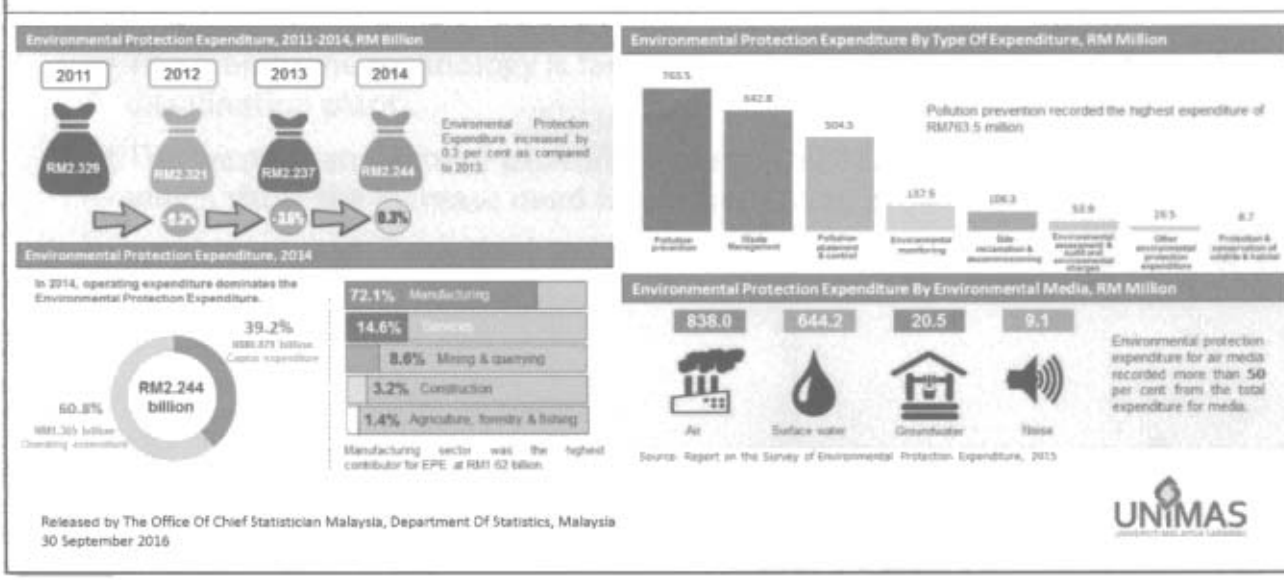
- The authors acknowledge the Ministry of Higher Education Malaysia for the fund FRGS/TK04(03)/1140/2014(07) as well as Department of Chemical Engineering and Energy Sustainability, Faculty of Engineering, Universiti Malaysia Sarawak for the research facilities.

Scope

- What make a membrane?
- How to prepare a membrane?
- How antibacterial agent work?
- Analyzing the membrane
- Future of membrane technology

UNIMAS
UNIVERSITI MALAYSIA SARAWAK

The statistics



Released by The Office Of Chief Statistician Malaysia, Department Of Statistics, Malaysia
30 September 2016

UNIMAS

Forecast

Growing acceptance of wastewater management

"The necessity for safe, usable water has created the demand for water recycling, which has led to an increase in demand for membranes in the desalination and wastewater management industries. Also, rising awareness regarding health and safety and stringent environmental regulations are further boosting the adoption of membranes," says Mahitha, a lead analyst at Technavio for plastics, polymers, and elastomers research.[1]

[1]https://www.technavio.com/report/global-plastics-polymers-and-elastomers-global-membrane-market-2017-2021

UNIMAS

Summary

- The membrane technology is far from saturated (replacement and desalination plant).
- The waste management expenditure was RM642.8 mil. for 2015 which show the increase need for membrane to provide clean water.

UNIMAS
UNIVERSITI MALAYSIA SARAWAK

Objective

- To investigate the effect of silver nitrate to membrane morphology
- The relationship of membrane morphology to flux
- The effect of silver nitrate content to antibacterial properties

UNIMAS
UNIVERSITI MALAYSIA SARAWAK

What make a membrane?

In definition

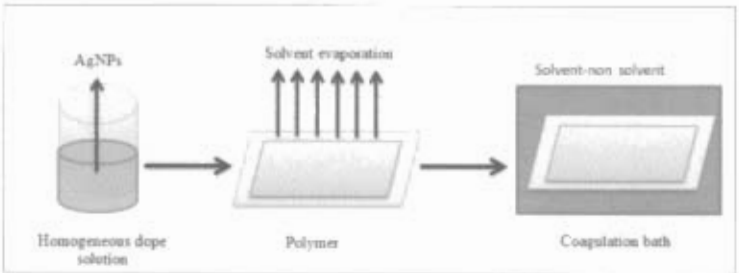
- A membrane is a thin layer of semi-permeable material that separates substances when a driving force is applied across the membrane.

UNIMAS
UNIVERSITI MALAYSIA SARAWAK

Preparing a membrane

Composition of silver nitrate varied from 0.5, 1.0, 1.5 & 2.0%

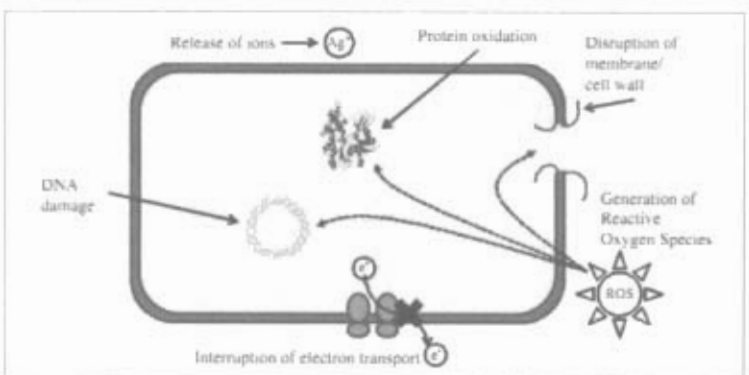
Dope solution:
Polysulfone, N-Methyl-2-pyrrolidone, Polyethyleneimine, activated carbon



Sample of flat sheet membrane

UNIMAS
UNIVERSITI MALAYSIA SARAWAK

Antibacterial mechanism



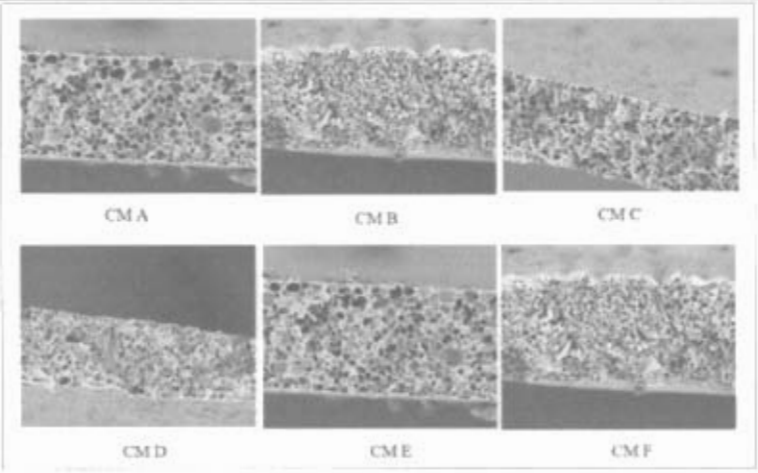
In general, there are three mechanism stipulated contribute to silver antibacterial properties.

a. Disruption of cell wall
b. Reactive oxygen species
c. Interruption of electron transport

1)El-nour, K. M. M. A., Al-warthan, A. & Ammar, R. A. A. 2010 Synthesis and applications of silver nanoparticles. *Arab. J. Chem.* **3**, 135–140. (doi:10.1016/j.arabjc.2010.04.008)
2)Sawada, I., Fachrul, R., Ito, T., Ohmukai, Y., Maruyama, T. & Matsuyama, H. 2012 Development of a hydrophilic polymer membrane containing silver nanoparticles with both organic antifouling and antibacterial properties. *J. Memb. Sci.* **387–388**, 1–6. (doi:10.1016/j.memsci.2011.06.020)

UNIMAS
UNIVERSITI MALAYSIA SARAWAK

Membrane morphology



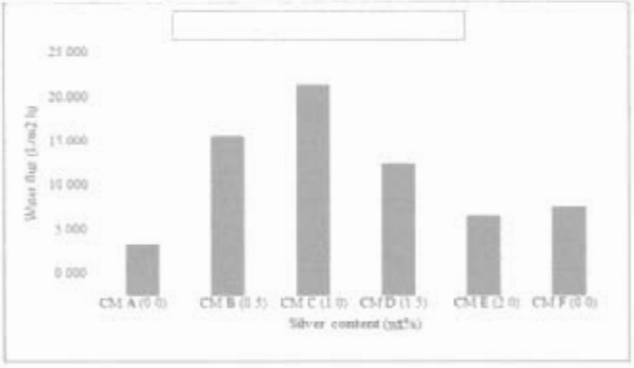
Membrane type	Composition (wt %)				
	$AgNO_3$	PSf	PEI	NMP	AC
CM A	-	15.0	-	85.0	-
CM B	0.5	15.0	0.3	83.7	0.5
CM C	1.0	15.0	0.3	83.2	0.5
CM D	1.5	15.0	0.3	82.7	0.5
CM E	2.0	15.0	0.3	82.2	0.5
CM F	-	15.0	0.3	84.2	0.5

- [1]PEI act as pore forming agent
  - Exist in polymer-rich
- All composite membrane show a sponge-like structure
- [2]Appearance of macrovoid might be cause by Marangoni Effect

1)Ananth, a., Arthanareeswaran, G. & Wang, H. 2012 The influence of tetraethylorthosilicate and polyethyleneimine on the performance of polyethersulfone membranes. *Desalination* **287**, 61–70. (doi:10.1016/j.desal.2011.11.030)
2)Kharea, V. P., Greenberga, A. R., Zartmana, J., Krantzb, W. B. & Todd, P. 2002 Macrovoid growth during polymer membrane casting. *Desalination* **145**, 17–23.

UNIMAS

Flux, $J_o = \frac{V}{A\Delta t} J_0$ is pure water flux ($Lm^{-2}\ h^{-1}$), Q is the permeate volume (L), A is the membrane area (m^2) and Δt is the time (h)

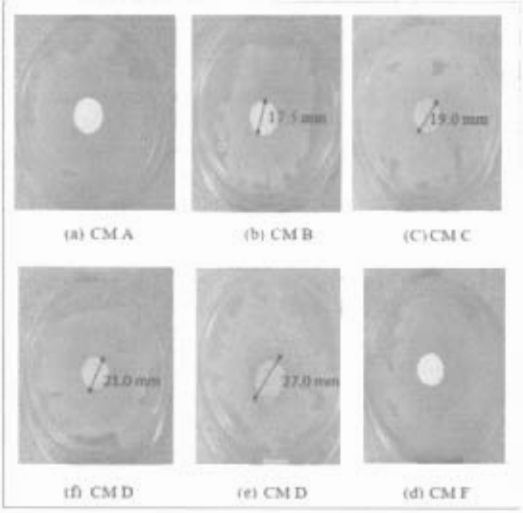


increasing the concentration of silver nanoparticles on the membrane resulting low water flux due to barrier created by the presence of silver nanoparticles or agglomeration of nanoparticles on the membrane surface

1)Phelane, L., Muya, F. N., Richards, H. L., Baker, P. G. L. & Iwuoha, E. I. 2014 Polysulfone Nanocomposite Membranes with Improved Hydrophilicity. *Electrochim. Acta* 128, 326–335. (doi:10.1016/j.electacta.2013.11.156)
2)Basri, H., Ismail, A. F. & Aziz, M. 2011 Polyethersulfone (PES) – silver composite UF membrane : Effect of silver loading and PVP molecular weight on membrane morphology and antibacterial activity. *DES* 273, 72–80. (doi:10.1016/j.desal.2010.11.010)

UNIMAS
UNIVERSITI MALAYSIA SARAWAK

Antibacterial result



- Diameter of each membrane samples were 17 mm
- Incubated at 36°C for 24 hours
- Kirby Bauer test carried out to investigate effective inhibition
- We believed the sponge-like structure help to retain the silver nanoparticles inside the membrane matrix therefore contribute to 27mm inhibition area

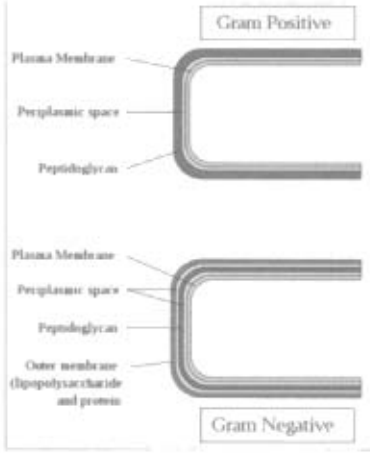
UNIMAS
UNIVERSITI MALAYSIA SARAWAK

Summary

- Sponge-like structure has affect the membrane flux considerably with highest flux around 22 L/m^2.h
- The sponge-like structure help retain silver in membrane matrix

UNIMAS
UNIVERSITI MALAYSIA SARAWAK

Possible future study



Effect of silver antibacterial agent to gram negative and gram positive bacteria

UNIMAS
UNIVERSITI MALAYSIA SARAWAK

INTERNATIONAL UNIMAS STEM ENGINEERING CONFERENCE
ENCON
ENGINEERING CONFERENCE 2017

"GEARING TOWARDS a GREENER FUTURE"

13-15 SEP 2017 | IMPERIAL HOTEL, KUCHING, SARAWAK, MALAYSIA

ORGANIZER UNIMAS 35 CO-ORGANIZER

IMPORTANT DATES

Full paper submission deadline : 20th April 2017
Notification of Acceptance : 31st May 2017
Camera-ready Submission Deadline : 30th June 2017
Early Bird Registration Deadline : 30th June 2017
Normal Registration Deadline : 20th July 2017