

UNIVERSITI TEKNOLOGI MARA

**DEVELOPMENT OF MoS₂-TiO₂/
PVDF-BASED HOLLOW FIBRE
MEMBRANES FOR MEMBRANE
DISTILLATION DESALINATION**

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ABSTRACT

Membrane distillation (MD) is a hybrid system that combines membrane technology with thermal distillation, which has recently emerged as one of the technologies used for seawater desalination. However, MD faced several limitations that hamper its comprehensive utilization for clean water production, such as low desalination efficiency and temperature polarization. In this study, a series of MoS₂-TiO₂/PVDF membranes were fabricated to improve the performance of MD desalination. The MoS₂-TiO₂ composite was first synthesized using a one-step hydrothermal with different ratios then the fabrication of PVDF-based hollow fibre membrane was fabricated with varied air gap and additional of polyethersulfone (PES) and finally the surface modification of PVDF-based hollow fibre membrane was done where MoS₂-TiO₂ was mixed with trichloro(octadecyl)silane in (OTS) for the dip coating process in the fabrication of MoS₂-TiO₂/PVDF-based membranes. After that that, the XRD, FTIR, TGA, UV-vis, TEM and BET characterization for composite and 5M5T MoS₂-TiO₂ (50 wt% MoS₂ and 50 wt% TiO₂) was chosen for surface modification due to its narrow band gap. After the porosity, contact angle, SEM, and mechanical strength analysis, the PVDF-PES which is the fabricated hollow fibre membrane at a 20 cm air gap with the additional of PES (PP20) was found to have better properties and suitable to be used as support for MD application due to its high porosity and low membrane thickness. It was observed that the contact angle of the MoS₂-TiO₂/PVDF-based membrane increased to $136.8 \pm 2.33^\circ$ when the membrane was coated with 0.2% of 5M5T MoS₂-TiO₂ compare to bare PVDF-PES hollow fibre membrane which is $90.6 \pm 1.5^\circ$. The MD performances were then investigated via an in-house MD system using highly saline feed water ($35\text{g}\cdot\text{L}^{-1}$ NaCl) where the hot stream temperature was varied from 50-70 °C. The results indicated that the performances of MoS₂-TiO₂ coated membranes were much better than previously reported membranes due to the high hydrophobicity and porosity that can enhance the overall permeate flux and rejection. The effects of higher temperature hot feed stream temperature were found to be able in increasing the permeate flux where at 50 °C the permeate flux was $2.97\text{ kg}\cdot\text{m}^{-2}\cdot\text{h}^{-1}$ while at 70 °C, the permeate flux was $23.3\text{ kg}\cdot\text{m}^{-2}\cdot\text{h}^{-1}$. The percentage difference for rejection rate for the membranes at various operating temperature was less than 0.1%. The highest permeate flux obtained was $23.3\text{ kg}\cdot\text{m}^{-2}\cdot\text{h}^{-1}$, with 99.85% salt rejection at 70 °C for 0.2PP20 membrane. Overall, the results obtained in this work suggest that surface hydrophobicity plays a vital role in membrane distillation performances besides the properties of membrane support.

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TABLE OF CONTENTS

	Page
CONFIRMATION BY PANEL OF EXAMINERS	ii
AUTHOR'S DECLARATION	iii
ABSTRACT	iv
ACKNOWLEDGEMENT	v
TABLE OF CONTENTS	vi
LIST OF TABLES	ix
LIST OF FIGURES	x
LIST OF ABBREVIATIONS	xiii
LIST OF NOMENCLATURE	xvi
CHAPTER ONE INTRODUCTION	1
1.1 Research Background	1
1.2 Problem Statement	3
1.3 Objectives	5
1.4 Scope and Limitation	5
1.5 Significant of research	6
CHAPTER TWO LITERATURE REVIEW	8
2.1 Desalination Technologies for Clean Water Production	8
2.2 Membrane-based Technologies for Desalination	12
2.2.1 Reverse Osmosis	12
2.2.2 Forward osmosis	13
2.2.3 Reverse electrodialysis (RED)	14
2.2.4 Membrane Distillation	15
2.3 Membrane Distillation (MD)	16
2.3.1 Configurations of MD	16
2.3.2 Characteristics of MD membranes	18
2.3.3 Effects of operating conditions on MD performances	19
2.3.4 Challenges in Membrane Distillation (MD) Desalination	22

2.3.5	Modification of MD membranes	24
2.3.5.1	<i>Nanomaterial-Modified Membranes</i>	25
2.3.5.2	<i>Surface coating techniques</i>	29
CHAPTER THREE RESEARCH METHODOLOGY		31
3.1	Introduction	31
3.2	Chemicals and materials	33
3.3	Synthesis of MoS ₂ -TiO ₂ composites	33
3.4	Fabrication of PVDF and PVDF-PES hollow fibre membrane using the dry-wet spinning method.	33
3.5	Deposition of MoS ₂ -TiO ₂ composite onto PVDF-based hollow fibre membrane via dip-coating method	36
3.6	Characterization of TiO ₂ -MoS ₂ composite powder	36
3.7	Characterization of uncoated and coated PVDF-based hollow fibre membranes	37
3.7.1	Porosity and Pore Size	37
3.7.2	Contact angle	38
3.7.3	SEM	38
3.7.4	Mechanical Tester	39
3.7.5	Membrane Distillation Performances Test	39
CHAPTER FOUR RESULTS AND DISCUSSION.		42
4.1	Physicochemical, optical and morphological properties of MoS ₂ -TiO ₂ composites	42
4.2	Effects of air gap on the morphologies, structure, wettability and mechanical strength of PVDF (PV) and PVDF-PES (PP) membranes	52
4.3	Characterization and Performances Evaluation of MoS ₂ -TiO ₂ /PVDF-based membranes for desalination via membrane distillation	58
4.4	Membrane distillation performances	62
CHAPTER FIVE CONCLUSION & RECOMMENDATION		68
5.1	Conclusion	68
5.2	Recommendation	69