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TITLE:

PRELIMINARY CHEMICAL PROPERTIES STUDY ON ADDITION OF TITANIUM DIOXIDE NANOPARTICLES INTO DOUBLE LAYER POLYSULFONE SUBSTRATE FOR DESALINATION PROCESS

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AUTHOR’S DECLARATION

“I hereby declare that the work in this report is my own except for quotations and summaries which have been duly acknowledged. It is original and is the result of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any other degree or qualification.

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ABSTRACT

As the global population continues to grow, the demand for freshwater resources is increasing. Desalination has become an essential method for obtaining potable water with substrate technology playing a crucial role due to its efficiency, low energy consumption and chemical resistance. In this study, a double-layered polysulfone (PSf) substrate incorporated with 0.02% titanium dioxide (TiO_2) nanoparticles was fabricated and tested for its chemical stability in desalination applications. The substrate was prepared using 15% polysulfone (PSf), 5% polyvinylpyrrolidone (PVP) and 84.5% N-methyl-2-pyrrolidone (NMP), with 0.02% TiO_2 nanoparticles added to enhance performance. The substrate's resistance to 1M sulfuric acid (H_2SO_4), 1M sodium hydroxide (NaOH) and 0.1M potassium permanganate ($KMnO_4$) was observed and evaluated over a period of five days. Experimental results indicate that the membrane exhibited strong stability in both acidic and basic conditions that showing minimal physical and structural changes. However, exposure to $KMnO_4$ caused significant degradation and confirming that oxidative agents have a severe impact on substrate structure. The study concludes that TiO_2-modified polysulfone substrate offer enhanced durability in extreme pH conditions but require further improvements to resist oxidative degradation. Based on these findings, it is recommended that future studies explore alternative polymer blends or surface modifications to enhance oxidation resistance. Additionally, optimizing TiO_2 concentration and dispersion methods could further improve substrate performance. Extending the exposure duration and testing under real desalination conditions are also suggested to better simulate long-term applications. These improvements would contribute to the development of more durable and efficient substrate for water treatment and desalination applications.

CHAPTER ONE BACKGROUND

1.1 Introduction

Matt Williams' research states that the earth is composed of 71% water while 29% is made up of landmass and islands. Earth's water predominantly exists in the form of saltwater at 96.5% where only 3.5% is freshwater [1]. Moreover, Maat Williams has also noted that 69% of the freshwater are stored in the form of ice within glaciers and ice caps at the poles. The remaining freshwater is contained within the soil, beneath the ground as well as in lakes and rivers on the surface of Earth [2]. Abdel-Fatah and Al Bazedi however tells us that not all the water is fresh or suitable for consumption [3]. Water resources are scarce because freshwater has to meet a wide range of needs every day. An article released approximately 8 years ago states that 42% of our freshwater is consumed in agricultural uses while 39% are used in electricity production, 11% for residential, commercial and hotel services and the last 8% is used in mining and manufacturing industries [2]. Chamhuri Siwar *et al.* [4] reported that Malaysia's water consumption for agriculture, industry, and domestic purposes grew from 8.9 billion m_3 in 1980 to 15.5 billion m_3 in 2000. This reveals that the amount of water available for each person is decreasing. It was also revealed that the nation's rural areas have a lower availability of clean and safe drinking water compared to their urban population. Consequently, the water supply industry is now preoccupied with the quantity and quality of water consumption by rural citizens while the main goal remains the same: to meet the per capita consumption of water targets [4].

Water scarcity does not discriminate, it affects all parts of the world without distinction. T. L. Lau et al. [5] discovered that globally, approximately 884 million people lack access to safe water supplies and more than 3.5 million people die annually from water-related diseases. Only 2.5% of the Earth's water is fresh, with less than 0.01% available for human use, highlighting the severity of water scarcity issues [5]. Rapid urbanization and climate change exacerbate these problems, leading to increased flooding and pollution [5]. A significants research issued in 2007 indicates that approximately 1.2 billion individuals, which accounts for almost 20% of the world population, exist in regions of extreme shortage [6]. Additionally, approximately 500 million are approaching this circumstance. Further, there are 1.6 billion people or nearly 25% of the world’s total population who struggle with economic water scarcity, lack of infrastructure to transport water from the rivers and aquifers being the primary