UNIVERSITI TEKNOLOGI MARA

ROBUSTNESS OF PTFE MEMBRANE MATERIAL IN THE PRESENCE OF IMPURITIES AND HEAVY HYDROCARBONS

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ABSTRACT

The presence of heavy hydrocarbons such as toluene, and n-hexane are a problem in carbon dioxide separation which causes loss of flux and selectivity of the membranes. Moreover, small amounts of condensable heavy hydrocarbons also can cause membrane failure and premature aging. Thus, these impurities and heavy hydrocarbons need to be removed before natural gas undergoes carbon dioxide separation in acid gas removal process. Most studies on membrane contactor in separation of gas has focused on polymeric membrane. PTFE is used in this study because of its hydrophobicity and delivers the best performance with high efficiency compared to other materials that have been studied, due to its stability and structure. The PTFE hollow fibre membrane was obtained from PETRONAS Research Sdn Bhd. This research aim is to study the effect of such hydrocarbons and impurities to carbon dioxide separation based on chemical and physical characteristic. The hydrocarbons and impurities include toluene, pentane, n-heptane, hexane, and amine solvent. The data is analysed based on membrane characterization such as Fourier Transform Infrared (FTIR) Spectroscopy, Thermogravimetric Analysis (TGA), digital microscope, mercury porosimeter and tensile strength. Based on this study's findings, for TGA, rapid weight loss for the PTFE hollow fiber membrane happened starting the temperature 600^{o}C to 650^{o}C and the weigh loss decreases as the period of exposure increases. The wall thickness of the membrane also decreases as the period of exposure increases. The porosity and tensile strength of the membrane also shows a decrease trends which is validated by the thinning of the membrane wall. For second objective, the same trends as the first objective is shown. For TGA, rapid weight loss for the PTFE hollow fiber membrane happened starting the temperature 600^{o}C to 620^{o}C and the weight loss decreases as the temperature of exposure increases. The porosity and tensile strength of the membrane decreases as the temperature of exposure increases. The thickness of the membrane wall does not show any changes which may be due to short time of heating process. From the findings, the exposure of the membrane material to heavy hydrocarbons decreases the thermal, morphology, porosity, and mechanical properties of the hollow fibre membrane but did not show any changes in chemical stability.

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CHAPTER ONE
INTRODUCTION

1.1 Research Background

Population growth has led to a growing demand for energy worldwide. In addition, the need to tackle environmental effects for example the emission of greenhouse gas is the main concern of the present. For that reasons, researchers have searched and explored the alternatives for potential energy that is more sustainable and environmentally friendly. High quality, economic feasibility, and environmental sustainability energy that can fulfil the global demand has been the world's main concern. Present, natural gas is one of the most vital components of the global energy source that meets the above requirements (Kang et al., 2017).

Natural gas refers to gas that contain high amount of hydrocarbon which originate from natural gas fields, oil fields and coal beds (Faramawy et al., 2016). It was used as a light source in the 19th century before being used as gas transport for long-distance pipelines due to technical advances after the Second World War.

Natural gas has characteristics of odourless, shapeless, and colorless in its pure state. Besides, it is a combustible gas and when burned, it releases a significant amount of energy. Natural gas is considered as environmental friendly compared to other fossil fuels such as crude oil and coal (Faramawy et al., 2016) because natural gas combustion release lower amount of carbon dioxide and nitrous dioxide compared to others which later helps to reduce problems such as acid rain, and greenhouse gases (Ramanathan et al., 2009).

However, natural gas in the well contain various contaminants such as acid gases (CO_2) and H_2S), Nitrogen (N_2) and heavies (toluene and heptane). Removal of these gases from natural gas streams are vital in order to meet pipeline specification. Moreover, gas such as hydrogen sulphide, H_2S are lethal to human if they are being exposed to high level of it. Besides, carbon dioxide (CO_2) gas has corrosive property in