MODIFICATION OF SAGO BASED MEMBRANE FOR PERVAPORATION SEPARATION OF CESIUM FORMATE

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To whoever taught me even a word

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ABSTRACT

Pervaporation separation process has been established as an important separation unit in chemical engineering. Pervaporation is widely used for dehydration of aqueous mixtures and is expected to find further progress in organic/organic separation and the organic-water separation. In this study 3 different mixtures were prepared and casted, using mixing ratios of 40% / 60 %, 50 % / 50 % and 60 % / 40 % respectively for sago starch-water and polyvinyl alcohol (PVA)-water. All the membranes were prepared by solution casting technique. All of these membranes were cross-linked with (glutaric dialdehyde–sulphuric acid-acetone-deionized water) solution in time periods of 15 and 30 minutes. Therefore, 6 types of membranes were prepared and all of them were tested with the pervaporation unit for feed temperatures of 30˚C, 50˚C and 70˚C and concentrations of 80% and 90% of cesium formate brine to separate water from cesium formate. The results of experiments were calculated to show the values for permeation flux and separation factor. in general with increasing cesium formate concentration in feed, permeation flux and separation factor decreased and with increasing temperature, permeation flux and separation factor increased. Although it should be said that in some experiments the overall rule did not apply.

ABSTRAK

Proses pemisahan penelapsejatan telah dikenalpasti sebagai salah satu unit operasi yang penting dalam kejuruteraan kimia. Penelapsejatan digunakan secara meluas dalam penyingkiran air daripada campuran akuas dan dijangkakan perkembangan lanjut dalam pemisahan campuran organik/organik dan pemisahan air daripada campuran air/organik. Dalam kajian ini beberapa membran homogen paut-silang dengan sifat-sifat berlainan telah disediakan. Kesemua membran telah disediakan melalui teknik penuangan larutan. Di dalam langkah pertama, 3 campuran berlainan telah disediakan dan dituang menggunakan kadar-kadar yang berubah iaitu 40% / 60 %, 50 % / 50 % dan 60 % / 40 % setiap satu untuk kanji sagu-air dan polivinil alcohol(PVA)-air. Bagi langkah kedua, kesemua membran tersebut telah dihubung-silangkan dengan satu lagi larutan (sulphuric asid- glutarik dialdehid -aseton-air ternyahion) bagi jangka masa 15 dan 30 minit. Oleh itu, 6 membran telah disediakan dan kesemuanya telah diuji dengan unit penelapsejatan bagi perubahan suhu yang komprehensif pada 30°C, 50°C dan 70°C dan kandungan air garam sesium format yang dimanipulasikan pada kepekatan 80% dan 90% untuk memisahkan air daripada sesium format. Keputusan-keputusan eksperimen telah dikira bagi menunjukkan nilai-nilai fluks penelapan dan faktor pemisahan. Sebagaimana ditunjukkan secara umum dengan penambahan kandungan sesium format, fluks penelapan dan faktor pemisahan telah berkurangan, dan dengan peningkatan suhu fluks penelapan dan faktor pemisahan telah bertambah.

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CHAPTER 1

INTRODUCTION

1.1 Research Background

Oil drilling is a very complicated and time-consuming process. High Pressure High Temperature (HPHT) wells can become extremely dangerous, especially when toxic and corrosive chemicals like zinc bromide brine are constantly operated with drill bits (Bellarby, 2009). Cesium formate, a revolutionary chemical, offers the ultimate alternative brine that can help everyone working in oil and gas industry. The primary use of cesium formate fluids in oil and gas wells is to control well pressures while drilling or completion wells (Downs et al., 2005).

Reclamation of cesium formate brine has been strategically necessary due to the inherent high price of extracting cesium and its limited long term availability.

Generally, conventional filtration equipment supplemented by chemical treatment can be used to reclaim formate based fluids, if polymers are added; the viscosity of the fluids must be reduced for efficient solids removal. The polymer stability and small amount of free water in formates significantly influences standard procedures for brine recycling. Since typical polymer breakers do not work efficiently in formate environments, specialized chemical treatment is required in combination with mechanical separation using centrifuges and/or high pressure filter press. Physical loss of fluid may occurs during the reclamation processes particularly during the filtration process. It is reported that the recovery of cesium formate using this conventional technology is only about 80% (Australia, 2001; Cabot Specialty Fluids, 2008).

In this study hydrophilic membranes based on sago were developed and modified for the dehydration of cesium formate brine. Sago exhibits similar chemical properties with chitosan. To date, no published data on the utilization of sago for the preparation of hydrophilic membranes is recorded. However, due to its good film forming and hydrophilic properties, sago based membranes were effective for the removal of water from cesium formate brine.

In this research, the potential and efficiency of membrane separation technology, particularly pervaporation was investigated. The application of novel separation technologies can be applied to recover the formate fluids. This is especially useful for the case of cesium formate due to its inherently high price. The properties of cesium formate such as solubility in water, being environmental

friendly, being biodegradable and being reclaimable offers the opportunity for a highly efficient membrane separation to be applied for the recovery of cesium formate brine from drilling fluids.

1.2 Problem Statement

Conventional mechanical filtration (centrifuge) supplemented by chemical treatment is the current technology used for the recovery of cesium formate from drilling fluids. The recovery of cesium formate using the conventional technology is only about 80%. Furthermore, reclamation of cesium formate brine is necessary because of high extracting cost of cesium and limited sources of this metal. Therefore, new technology and/or approach to recover cesium formate are critical.

In this research, the recovery of cesium formate by utilization of hydrophilic membranes for the removal of water content from the brine solution via pervaporation is proposed. The recovery of cesium formate using this technology increased up to 100%. The findings of the research had demonstrated that this novel technology has tremendous potential for the complete recovery of cesium formate brine, which in turn benefits the oil and gas industry. In addition, no published data on the utilization of sago as a membrane material has been reported. This research

provides a good starting point for the future research in the use of sago for the development of hydrophilic membranes.

1.3 Objective of the Study

Based on the problem statement the objectives of this study are as follows:

i. Development and modification of hydrophilic sago based membranes for the recovery of cesium formate.

ii. Investigation of values of permeation flux and separation factor for pervaporation separation using sago based membranes for the recovery of cesium formate.

1.4 Scope of the Study

To achieve the objectives of the study, the following scopes of the study have been identified:

i. Development of sago based pervaporation membranes for cesium formate recovery with mixing weight ratios of 40/60, 50/50 and 60/40 respectively for sago and PVA.

ii. Modification of sago based pervaporation membranes with 15 and 30 minutes of crosslinking time.

iii. Pervaporation dehydration of cesium formate/water mixtures using the modified sago based membranes at 30°C, 50°C and 70°C.

iv. Pervaporation dehydration of cesium formate/water mixtures using the modified sago based membranes at 80% and 90% of cesium formate feed concentrations.

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