

**PERFORMANCE OF SODIUM A ZEOLITE MEMBRANE FOR WATER-
ETHANOL SEPARATION IN PERVAPORATION SYSTEM**

Dacho Kunnakorn

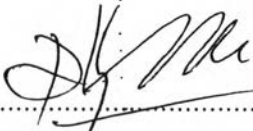
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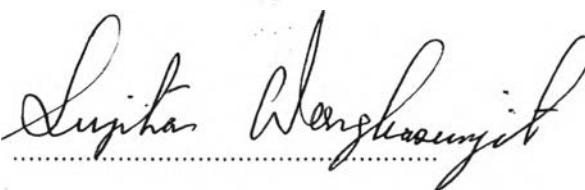
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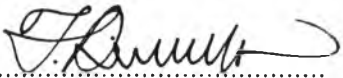
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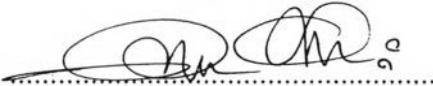
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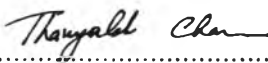

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ABSTRACT

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In this study, NaA zeolite membranes were mainly synthesized using silica and alumina as precursors via microwave, autoclave (or conventional heating), and electrophoretic techniques. The influences of composition, seeding time, synthesized time, and temperature were investigated. The results showed the successfully synthesized NaA zeolite membranes on the tubular alumina support using 2 min seeding time at 333-363K synthesized temperature for 20 min to 20 h, depending on the technique used. The performance of NaA zeolite membranes was investigated using pervaporation system for water-ethanol separation, and the results showed the total water flux higher than 1.0 kg/m²/h with the separation factor higher than 10,000, indicating a good performance of the synthesized membranes. However, when the thickness of NaA zeolite membrane was decreased, the total water flux of the system increased to higher than 2.0 kg/m²/h with the separation factor higher than 10,000. Moreover, the synthesized NaA zeolite membranes also showed a good stability in the pervaporation system.

The techno-economic analysis of the pervaporation system for ethanol production was studied to compare with a conventional process using PRO II simulation program by using 50:50 of ethanol to water ratio with 1000 kg/h as a feed stream. From the techno-economic results using the hybrid system (a commercial distillation followed by the pervaporation system), it was found more economically

attractive than the azeotropic distillation system (a commercial distillation followed by the practical azeotropic distillation) for producing ethanol with purity around 99.5%wt at around 500 kg/h. It not only saved significant energy required for producing 99.5 %wt of ethanol, but also was an environmentally friendly process.

บทคัดย่อ

เดโช ชุมนคร : การสังเคราะห์และประสิทธิภาพของแผ่นเยื่อบางชนิดโซเดียม-เอ ในการแยกน้ำจากเอทานอลด้วยกระบวนการแยกด้วยแผ่นเยื่อบาง (Performance of NaA zeolite membrane for water-ethanol separation in pervaporation system) อ. ที่ปรึกษา: รศ.ดร. สุจิตรา วงศ์เกษมจิตต์, รศ.ดร.ธีรศักดิ์ ฤกษ์สมบูรณ์ และ ดร. สันติ กุลประทีปปัญญา 103 หน้า

ในงานวิจัยนี้ สารตั้งต้นซิลิกอนไดออกไซด์และอะลูมิเนียมไฮดรอกไซด์ เป็นสารตั้งต้นหลักที่ใช้ในการสังเคราะห์แผ่นเยื่อบางซีโอไลท์โซเดียม-เอด้วยเครื่องไมโครเวฟ, เตาอบให้ความร้อน และเครื่องปฏิกรณ์ไฟฟ้า มีการศึกษาถึงปัจจัยต่างๆ ที่มีผลต่อการสังเคราะห์แผ่นเยื่อบางด้วยได้แก่ อัตราส่วนของสารประกอบ, เวลาที่ใช้ในการเตรียมพื้นผิว, เวลาและอุณหภูมิที่ใช้ในการสังเคราะห์ จากการศึกษาพบว่า แผ่นเยื่อบางซีโอไลท์โซเดียม-เอนี้ สามารถสังเคราะห์ขึ้นบนตัวรองรับอะลูมินาแบบแท่งได้ด้วยการใช้เวลา 1.5-2 นาที ในการเตรียมผิว อุณหภูมิในการสังเคราะห์ประมาณ 60-90 องศาเซลเซียส เป็นเวลาประมาณ 20 นาที จนถึง 20 ชั่วโมง ขึ้นอยู่กับเครื่องมือที่ใช้ในการให้ความร้อน ประสิทธิภาพของแผ่นเยื่อบางชนิดโซเดียม-เอที่สังเคราะห์ได้นี้ ศึกษาโดยนำไปใช้แยกน้ำออกจากส่วนผสมระหว่างน้ำและเอทานอล ซึ่งพบว่า แผ่นเยื่อบางชนิดโซเดียม-เอที่สังเคราะห์ขึ้นมาได้ให้ค่าการแยกที่มากกว่า 10,000 โดยที่สามารถแยกน้ำออกมาได้มากกว่า 1.0 กก./ตร.ม./ชม. อย่างไรก็ตาม ถ้าลดความหนาของแผ่นเยื่อบางที่สังเคราะห์ได้ให้บางขึ้น จะทำให้สามารถแยกน้ำออกมาได้มากกว่า 2.0 กก./ตร.ม./ชม. โดยที่ค่าการแยกของแผ่นเยื่อบางยังคงไม่เปลี่ยนแปลง นอกจากนี้ ยังพบว่า แผ่นเยื่อบางชนิดโซเดียม-เอนี้ มีความเสถียรและคงทนเป็นอย่างดีดีสำหรับการใช้เป็นแผ่นเยื่อบางในระบบการแยกน้ำออกจากเอทานอลเป็นเวลานานอีกด้วย

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ABBREVIATIONS

SEM	Scanning Electron Microscope
FE-SEM	Field Emission Scanning Electron Microscope
XRD	X-ray Diffractometer
GC	Gas Chromatography
TGA	Thermogravimetric Analysis
FTIR	Fourier Transform Infrared Spectroscopy
EG	Ethylene Glycol
TIS	Triisopropanolamine
NaA	Sodium A
ACMs	Autoclave membranes (NaA zeolite membrane synthesized by autoclave technique)
MWMs	Microwave membranes (NaA zeolite membrane synthesized by microwave technique)
EPMs	Electrophoretic membranes (NaA zeolite membrane synthesized by electrophoretic technique)