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SOLVENT SEPARATION AND CONCENTRATION FROM ACETONE-BUTANOL  
FERMENTATION BROTH BY THE PERVAPORATION PROCESS



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พิมพ์ต้นฉบับบทคัดย่อวิทยานิพนธ์ภายในกรอบสี่เหลี่ยมนี้เพียงแผ่นเดียว



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การแยกและการทำให้ตัวทำละลายเข้มข้นจากของผสม น้ำ-อะซิโตน-บิวทานอล-เอทานอล-กรดอะซิติก-กรดบิวทริก และ น้ำหมักอะซิโตน-บิวทานอล โดยกระบวนการเพอร์เวเออเรชัน ด้วยเยื่อแผ่นซิโตนแบบทอมัด ได้กระทำขึ้นที่อุณหภูมิสายป้อนระหว่าง 40-80 องศาเซลเซียส, ความดันด้านเพอร์มิเอตระหว่าง 2-30 ทอร์ และความหนาของเยื่อแผ่นระหว่าง 0.25-1.0 มิลลิเมตร ความเข้มข้นของบิวทานอล อะซิโตน เอทานอล กรดอะซิติก และกรดบิวทริก ในสารป้อนคือ 0.7, 0.6, 0.25, 0.5 และ 0.2 กรัม/ลิตร ตามลำดับ ภาวะที่เหมาะสมต่อการปฏิบัติงานคือ อุณหภูมิขาเข้าอยู่ที่ 60 องศาเซลเซียส, ความดันด้านเพอร์มิเอต 2 ทอร์ และความหนาเยื่อแผ่น 0.25 มิลลิเมตร โดยค่าเพอร์มิเอชันฟลักซ์, ความเข้มข้นด้านเพอร์มิเอต, ค่าการเลือกของเยื่อแผ่น และค่าการเก็บเกี่ยวโดยมวลของบิวทานอลจากของผสม น้ำ-อะซิโตน-บิวทานอล-เอทานอล-กรดอะซิติก-กรดบิวทริก มีค่า 11.29 กรัม/ม<sup>2</sup>. ชั่วโมง, 24.99% โดยน้ำหนัก, 47.26 และ 9.11% โดยน้ำหนัก ตามลำดับ และของน้ำหมักอะซิโตน-บิวทานอล คือ 8.76 กรัม/ม<sup>2</sup>. ชั่วโมง, 23.02 % โดยน้ำหนัก, 43.86 และ 7.01% โดยน้ำหนัก ตามลำดับ ค่าเพอร์มิเอชันฟลักซ์จะเพิ่มขึ้นเมื่อมีการเพิ่มอุณหภูมิสายป้อน, ลดความดันด้านเพอร์มิเอต และ ลดความหนาของเยื่อแผ่น ส่วนค่าความเข้มข้นด้านเพอร์มิเอตและค่าการเลือกของเยื่อแผ่นจะไม่เปลี่ยนแปลงตามการเพิ่มของอุณหภูมิสายป้อนและความดันด้านเพอร์มิเอต เยื่อแผ่นที่หนาจะให้ค่าความเข้มข้นของเพอร์มิเอตและค่าการเลือกของเยื่อแผ่นสูงสำหรับความสามารถในการซึมผ่านและสัมประสิทธิ์การแพร่ที่คำนวณได้จากแบบจำลองสารละลาย-การแพร่ พบว่า ความสามารถในการซึมผ่านจะเพิ่มขึ้นตามน้ำหนักโมเลกุลของสาร ส่วนสัมประสิทธิ์การแพร่จะลดลงตามการเพิ่มน้ำหนักโมเลกุลของสาร

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KEY WORD: ACETONE-BUTANOL FERMENTATION BROTH/ PERVAPORATION/  
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BY THE PERVAPORATION PROCESS. THESIS ADVISOR : ASSO. PROF.  
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Solvent separation and concentration from water-acetone-butanol-ethanol-acetic acid-butyric acid mixtures and acetone-butanol fermentation broth by the pervaporation process with silicone rubber hollow fiber membrane, were carried out at varied feed temperature between 40-80 °C, permeation pressure between 2-30 torr and membrane thickness between 0.25-1.0 mm. Concentrations of butanol, acetone, ethanol, acetic acid and butyric acid of feed solution were 0.7, 0.6, 0.25, 0.5 and 0.2 g/L, respectively. The optimum operating conditions for this process were at a feed temperature of 60°C, permeation pressure of 2 torr and membrane thickness of 0.25 mm. The permeation flux, permeation concentration membrane selectivity and mass recovery of butanol in water-acetone-butanol-acetic acid-butyric mixtures were 11.29 g/m<sup>2</sup>.h, 24.99 %wt., 47.26, and 9.11 %wt., respectively and those in acetone-butanol fermentation broth were 8.76 g/m<sup>2</sup>.h, 23.02 %wt., 43.86, and 7.01 %wt., respectively. The permeation flux was increased with increasing feed temperature, decreasing permeation pressure and decreasing membrane thickness. Permeation concentration and membrane selectivity were irrelevant to the change in feed temperature and permeation pressure. Thick membrane will provide high permeation concentration and membrane selectivity. Results obtained from the solution-diffusion model indicated that permeability increased as molecular weight increased, whereas the opposite was found for diffusivity.

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## Nomenclature

A	= Effective membrane area	$[m^2]$
b	= Swelling parameter	$[m^3 \cdot g^{-1}]$
c	= Concentration	$[l^{-1}]$
D	= Diffusivity coefficient	$[h^{-1}]$
E	= Activation energy	$[J \cdot mol^{-1}]$
F	= Weight of Initial Solution	$[g]$
J	= Permeation flux	$[g \cdot m^{-2} \cdot h^{-1}]$
k	= Henry constant	$[g \cdot l^{-1} \cdot Pa^{-1}]$
l	= Distance across the membrane	$[m.]$
P	= Permeability	$[m^2 \cdot h^{-1}]$
p	= Pressure	$[torr]$
R	= Gas constant	$[J \cdot mol^{-1} \cdot K^{-1}]$
S	= Distribution coefficient	$[-]$
T	= Temperature	$[^{\circ}c]$
t	= Time	$[h]$
v	= Volumetric flow rate	$[l/h]$
W	= Weight of silicone tubing	$[g]$
X	= Liquid membrane interaction	$[-]$
x	= Mole fraction in feed side	$[-]$
y	= Mole fraction in permeate side	$[-]$
Greek Symbols		
$\alpha$	= Separation factor	$[-]$
$\beta$	= Membrane selectivity	$[-]$
$\gamma$	= Activation coefficient	$[-]$



#### Subscript, Abbreviation

- evap = Evaporation  
i,j = Component  
il = Component i in liquid  
im = Component i in membrane  
i,o = Component i without swelling effect  
i,oo = Pre-exponential factor  
mem = Membrane  
o = Pre-exponential factor  
p = apparant  
pervap = pervaporation

#### Superscript

- = Feed side  
“ = Permeate side  
o = Vapor  
 $\alpha$  = Infinite dilution

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