POTENTIAL OF CELLULOSE TRI ACETATE (CTA) MEMBRANE FOR
SEAWATER TREATMENT BY FORWARD OSMOSIS

CHIANG XIN YI

BACHELOR OF CHEMICAL ENGINEERING
UNIVERSITI MALAYSIA PAHANG
POTENTIAL OF CELLULOSE TRI ACETATE (CTA) MEMBRANE FOR SEAWATER TREATMENT BY FORWARD OSMOSIS

CHIANG XIN YI

Thesis submitted in partial fulfilment of the requirements for the award of the degree of Bachelor of Chemical Engineering

Faculty of Chemical & Natural Resources Engineering
UNIVERSITI MALAYSIA PAHANG

JANUARY 2017
SUPERVISOR’S DECLARATION

We hereby declare that we have checked this thesis and in our opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Bachelor of Chemical Engineering.

Signature: 
Name of main supervisor: PM DR. MAZRUL NIZAM BIN ABU SEMAN
Position: LECTURER
Date: JANUARY 2017
STUDENT’S DECLARATION

I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged. The thesis has not been accepted for any degree and is not concurrently submitted for award of other degree.

Signature : 
Name : CHIANG XIN YI
ID Number : KA13114
Date : JANUARY 2017
DEDICATION

I would like to dedicate this research work to my family and my research supervisor, PM Dr. Mazrul Nizam bin Abu Seman for their guidance and support. Besides that, I dedicate this research work to University Malaysia Pahang for providing me the opportunity in performing a research study as an undergraduate chemical engineering student.
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<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
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<tbody>
<tr>
<td>$J_w$</td>
<td>Water flux</td>
</tr>
<tr>
<td>$A$</td>
<td>Water permeability</td>
</tr>
<tr>
<td>$M$</td>
<td>Molarity</td>
</tr>
<tr>
<td>$J_s$</td>
<td>Reverse flux of the solute</td>
</tr>
<tr>
<td>$C_f$</td>
<td>Final feed solution concentration</td>
</tr>
<tr>
<td>$C_i$</td>
<td>Initial feed solution concentration</td>
</tr>
<tr>
<td>$\Delta V$</td>
<td>Volume of water which permeates through the membrane</td>
</tr>
<tr>
<td>$A$</td>
<td>Effective area of the membrane</td>
</tr>
<tr>
<td>$\Delta t$</td>
<td>Time taken for water permeation in minutes</td>
</tr>
<tr>
<td>$R$</td>
<td>NaCl rejection</td>
</tr>
<tr>
<td>$C_p$</td>
<td>Concentration of NaCl in draw solution</td>
</tr>
<tr>
<td>$C_F$</td>
<td>Concentration of NaCl in feed solution</td>
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</table>

**Greek**

<table>
<thead>
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<th>Symbol</th>
<th>Description</th>
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<tbody>
<tr>
<td>$\sigma$</td>
<td>Reflection coefficient</td>
</tr>
<tr>
<td>$\Delta \pi$</td>
<td>Osmotic pressure difference across the membrane</td>
</tr>
<tr>
<td>$\pi$</td>
<td>Osmotic pressure</td>
</tr>
<tr>
<td>$\pi_D$</td>
<td>Bulk osmotic pressure of the draw solution</td>
</tr>
<tr>
<td>$\pi_F$</td>
<td>Bulk osmotic pressure of the feed solution</td>
</tr>
<tr>
<td>$\eta$</td>
<td>Viscosity of the polyelectrolyte solution</td>
</tr>
<tr>
<td>$\eta_r$</td>
<td>Relative viscosity</td>
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<tr>
<td>$\eta_0$</td>
<td>Viscosity of the ionized water</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>BOD</td>
<td>Biochemical oxygen demand</td>
</tr>
<tr>
<td>COD</td>
<td>Chemical oxygen demand</td>
</tr>
<tr>
<td>CTA</td>
<td>Cellulose Tri Acetate</td>
</tr>
<tr>
<td>DS</td>
<td>Draw solution</td>
</tr>
<tr>
<td>ECP</td>
<td>External concentration polarization</td>
</tr>
<tr>
<td>FESEM</td>
<td>Field Emission Scanning Electron Microscopy</td>
</tr>
<tr>
<td>FO</td>
<td>Forward osmosis</td>
</tr>
<tr>
<td>FS</td>
<td>Feed solution</td>
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<tr>
<td>HTI</td>
<td>Hydration Technology Inc.</td>
</tr>
<tr>
<td>ICP</td>
<td>Internal concentration polarization</td>
</tr>
<tr>
<td>IP</td>
<td>Interfacial polymerization</td>
</tr>
<tr>
<td>MD</td>
<td>Membrane distillation</td>
</tr>
<tr>
<td>NF</td>
<td>Nanofiltration</td>
</tr>
<tr>
<td>OER</td>
<td>Osmotic energy recovery</td>
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<tr>
<td>RO</td>
<td>Reverse osmosis</td>
</tr>
<tr>
<td>TFC</td>
<td>Thin film composite</td>
</tr>
<tr>
<td>TSS</td>
<td>Total suspended solids</td>
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