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**OR AROMATICS EXTRACTIVE DISTILLATION STUDY:  
SOLVENT SELECTION AND PROCESS MODELING**

**MRS. PIMPORN LER-UTTAIWAN**

**A THESIS SUBMITTED IN PARTIAL FULFILLMENT  
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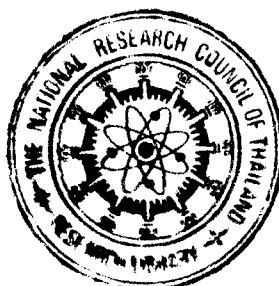
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### Abstract

A practical methodology for the design and optimization of extractive distillation is proposed in this research work. The separation of C8-aromatics isomer-mixture, as a real industrial case, is studied to illustrate the proposed methodology. The extractive distillation is generally applied to the separation of close-boiling mixtures, which by conventional distillation is difficult to separate. The combination of several computer-aided tools, such as, ProCAMD<sup>®</sup> in conjunction with the driving force concept by ICAS<sup>®</sup> and Aspen Plus<sup>®</sup> are employed as a starting point in the solvent selection. However, the experimental verification was also proved to be very crucial to achieve a successful design. In the experimental work, the VLE data of the solvents and hydrocarbon system needed to be examined, checked for thermodynamic consistency, and regressed for binary interaction parameters of the physical property package to accurately represent the real behavior of the system in the design. Finally, rigorous process design and optimization via Aspen Plus<sup>®</sup>, can produce a successful optimized design. The base-cases of the three potential solvents are firstly developed and then further optimized in terms of both energy consumption and the economic aspects. In this study, the optimization task is proposed to be carried out by using payback period as the objective function rather than the typical total annualized cost. In addition, the results from both objective functions can be illustrated and compared to understand the results of applying different objective function. The optimized design in the case study is achieved with less than two years of payback period.

**Keywords :** C8-Aromatics/ Extractive Distillation/ Computer-Aided Tools/ Process Design and Optimization

|                   |   |
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| หัวข้อวิทยานิพนธ์ | การศึกษากระบวนการกลั่นแบบใช้ตัวทำละลายกับระบบกลั่นแยกซีแปดอะโรมาติกส์ ในด้านการเลือกตัวทำละลายและการออกแบบแบบจำลองของระบบ |
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## บทคัดย่อ

ในงานวิจัยนี้เป็นการนำเสนอระเบียบวิธีในการออกแบบกระบวนการกลั่นแบบใช้ตัวทำละลาย ซึ่งเป็นขั้นตอนใหม่ที่ไม่ยุ่งยากซับซ้อน และสามารถนำไปประยุกต์ใช้งานจริงในการออกแบบกระบวนการแยกสารเอทิลเบนซินออกจากสารซีแปดอะโรมาติกส์จากอุตสาหกรรมปิโตรเคมีในประเทศไทย ซึ่งผลลัพธ์สุดท้ายของการออกแบบกระบวนการผลิตที่ได้จากงานวิจัยนี้ มีความคุ้มค่าทางเศรษฐศาสตร์พอจะนำไปสร้างเป็นกระบวนการผลิตจริงที่สามารถคืนทุนได้ภายในระยะเวลาแค่สองปีเท่านั้น

สำหรับระบบการกลั่นแบบใช้ตัวทำละลายนั้น เป็นกระบวนการที่เหมาะสมสำหรับการแยกสารที่มีจุดเดือดใกล้เคียงกันมากเกินกว่าที่ระบบการกลั่นแบบธรรมดาจะสามารถประยุกต์ใช้ได้ แต่เนื่องจากการเลือกตัวทำละลายที่เหมาะสมนั้นเป็นงานที่ค่อนข้างยากและใช้เวลานาน เมื่อต้องทำการทดลองกับทุกตัวทำละลายที่เป็นไปได้ ดังนั้นขั้นตอนการออกแบบที่เสนอในงานวิจัยนี้จะเริ่มต้นด้วยการประยุกต์ใช้คอมพิวเตอร์ซอฟต์แวร์ ได้แก่ ProCAMD®, ICAS® และ Aspen Plus® มาช่วยในการเลือกตัวทำละลายที่เหมาะสมเบื้องต้นก่อนการทำการทดลองในขั้นต่อไป อย่างไรก็ตามขั้นตอนการทดสอบตัวทำละลายด้วยการทำการทดลองนั้นมีความสำคัญมาก เนื่องจากคอมพิวเตอร์ซอฟต์แวร์ดังกล่าวมาข้างต้นเป็นเพียงตัวช่วยในการเลือกแค่อเบื้องต้นเท่านั้น ไม่สามารถนำข้อมูลประสิทธิภาพของตัวทำละลายไปใช้ในการออกแบบได้จริง ดังนั้นขั้นตอนที่จำเป็นหลังจากที่เลือกตัวทำละลายได้แล้ว นั่นคือ การตรวจสอบคุณสมบัติของตัวทำละลายเพื่อหาข้อมูลสมมูลไอ-ของเหลวของระบบ เพื่อนำ

ข้อมูลที่ได้ไปใช้ในการออกแบบกระบวนการผลิตที่ถูกต้องต่อไป ในงานวิจัยนี้โปรแกรม Aspen Plus® ได้ถูกใช้เป็นโปรแกรมหลักในการออกแบบกระบวนการผลิตที่เหมาะสมที่สุด โดยที่เป้าหมายของการออกแบบระบบในงานวิธีการออกแบบที่นำเสนอในงานวิจัยนี้ คือให้ได้ระบบที่มีระยะเวลาการคืนทุนที่สั้นที่สุดแทนที่จะเป็นการออกแบบระบบที่มีค่าใช้จ่ายที่ต่ำที่สุด ดังเช่นกระบวนการออกแบบที่ใช้กันอยู่ทั่วไป ทั้งนี้การออกแบบโดยตั้งเป้าหมายทั้งสองแบบนี้จะให้ผลลัพธ์ที่แตกต่างกัน ซึ่งได้นำมาเปรียบเทียบผลให้เห็นอย่างชัดเจน รวมถึงการทำการวิเคราะห์ความสำคัญของตัวแปรต่าง ๆ ที่เกี่ยวข้องกับการออกแบบต่อระยะเวลาในการคืนทุนของกระบวนการผลิตแบบต่าง ๆ ด้วย

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# CONTENTS

|   | PAGE      |
|---|-----------|
| ABSTRACT  | ii        |
| ACKNOWLEDGEMENT   | v         |
| CONTENT   | vi        |
| LIST OF TABLES  | viii      |
| LIST OF FIGURES   | xi        |
| <br><b>CHAPTER</b>  |           |
| <b>1 INTRODUCTION</b>   | <b>1</b>  |
| 1.1 Problem statement   | 1         |
| 1.2 Objective   | 3         |
| 1.3 Scope of work   | 3         |
| <br><b>2 THEORY AND LITERATURE REVIEW</b>   | <b>4</b>  |
| 2.1 The theory of extractive distillation system  | 4         |
| 2.2 The solvent selection methodology   | 7         |
| 2.3 Theory of the activity coefficient prediction   | 11        |
| 2.4 Solvent selectivity at infinite dilution  | 18        |
| 2.5 Driving force concept   | 19        |
| 2.6 Hansen's solubility parameter   | 20        |
| 2.7 VLE data analysis and binary interaction parameter regression   | 21        |
| 2.8 Process design and optimization   | 26        |
| 2.9 Literature review   | 29        |
| <br><b>3 METHODOLOGY</b>  | <b>35</b> |
| 3.1 Overall research methodology  | 35        |
| 3.2 Methodology of the solvent screening  | 36        |
| 3.3 Detail equipment in the apparatus and operating method  | 37        |
| 3.4 Thermodynamic consistency test of the VLE data  | 42        |
| 3.5 Binary interaction parameter regression by Aspen Plus®  | 43        |
| 3.6 Base-case process design and preliminary economic evaluation<br>for the selection of the best solvent | 45        |



|  |            |
|--|------------|
| 3.7 Methodology of the extractive distillation design and optimization                   | 46         |
| <b>4 RESULTS AND DISCUSSION</b>  | <b>49</b>  |
| 4.1 Solvent screening  | 49         |
| 4.2 Experiment solvent verification  | 62         |
| 4.3 VLE data determination   | 71         |
| 4.4 VLE data regression  | 79         |
| 4.5 Important note on the solvent effect   | 93         |
| 4.6 Base-case process design   | 95         |
| 4.7 Process optimization   | 106        |
| 4.8 Evaluation of the uncertainty in property prediction in the<br>process design scheme | 111        |
| <b>5 CONCLUSIONS</b>   | <b>116</b> |
| <b>REFERENCES</b>  | <b>118</b> |
| <b>APPENDIX:</b>   | <b>123</b> |
| A ProCAMD <sup>®</sup> program's feature and input data                                  | 123        |
| B Optimization and sensitivity blocks in Aspen Plus <sup>®</sup><br>model analysis tool  | 128        |
| C Solvent lists  | 134        |
| D Input and output data of the base-cases designs  | 155        |
| <b>CURRICULUM VITAE</b>  | <b>167</b> |

## LIST OF TABLES

| TABLE   | PAGE |
|---|------|
| 1.1 Thailand's chemical import data (January 2007 – July 2010)  | 1    |
| 1.2 Sensitivity analysis of the number of stages vs reflux ratio for ethylbenzene distillation column (from C8 aromatics)           | 2    |
| 2.1 Examples of extractive distillation and salt extractive distillation  | 6    |
| 2.2 Part of Robbins Chart taken from Perry's chemical handbook  | 8    |
| 2.3 Sample of UNIFAC-VLE subgroup's $k$ , $R_k$ and $Q_k$ parameters  | 15   |
| 2.4 Sample of UNIFAC-VLE subgroup binary interaction parameter  | 16   |
| 3.1 Calibration report of the Pt-100 for vapor temperature certifying by Metrological Center Siam Cement Industrial company limited | 40   |
| 3.2 Vapor-liquid equilibrium data from the literature   | 41   |
| 3.3 $C_E$ equation for each equipment type derived from Aspen Process Economic Analyzer <sup>®</sup> (V7.1)                         | 47   |
| 4.1 Solvent list for ethylbenzene and p-xylene extractive distillation system that was selected based on the heuristic rule         | 53   |
| 4.2 Selected solvent from ProCAMD <sup>®</sup> for heavy acyclic alcohols and ketones ( $T_b > 418$ K)                              | 55   |
| 4.3 Selected solvents by ProCAMD <sup>®</sup> at normal boiling point greater than or equal to 418 K                                | 57   |
| 4.4 Selected solvents by ProCAMD <sup>®</sup> at normal boiling point equal to or less than 409 K                                   | 57   |
| 4.5 Enhanced relative volatility of ethylbenzene and p-xylene by solvents from ProCAMD <sup>®</sup> that have $T_b > 418$ K         | 58   |
| 4.6 Enhanced relative volatility of ethylbenzene and p-xylene by solvents from ProCAMD <sup>®</sup> that have $T_b < 409$ K         | 58   |
| 4.7 Enhanced relative volatility of heuristically selected solvents   | 60   |
| 4.8 Candidate solvent list sorting by UNIFAC estimation   | 60   |
| 4.9 Candidate solvent list sorting by UNIFAC-DMD estimation   | 61   |
| 4.10 Material used in the experiment to verify the solvent effect   | 62   |

| TABLE  | PAGE |
|--|------|
| 4.11 Plan for experimental study of enhanced relative volatility of EB/PX at various S:F Ratio                             | 65   |
| 4.12 Enhanced relative volatility data of EB/PX in each solvent  | 66   |
| 4.13 Possible change of activity coefficients and relative volatility by effect of solvent.                                | 68   |
| 4.14 Percent error of the simulation by UNIFAC and UNIFAC-Dortmund compared to experimental results at S:F = 1 and S:F = 5 | 70   |
| 4.15 Chemicals used in the VLE data determination  | 71   |
| 4.16 Regression equations for the calibration curves for VLE data determination  | 74   |
| 4.17 Standard deviation of the measured equilibrium temperature  | 75   |
| 4.18 Thermodynamic consistency checking results of the VLE data  | 79   |
| 4.19 Residues from the regression comparison among four different activity coefficient models                              | 83   |
| 4.20 Residual root mean square error of each selected VLE data   | 85   |
| 4.21 Residual root mean square error of MSL system resulted from utilizing full-range of VLE data.                         | 85   |
| 4.22 Residual root mean square error of each system from utilizing VLE data only $T < 180^{\circ}\text{C}$ (453.15 K)      | 86   |
| 4.23 Regressed binary parameters for Methyl Salicylate system  | 92   |
| 4.24 Regressed binary parameters for Isophorone system   | 93   |
| 4.25 Regressed binary parameters for Benzaldehyde system   | 93   |
| 4.26 Binary interaction parameter input into Aspen Distil <sup>®</sup>   | 96   |
| 4.27 Related parameters for design of the extractive distillation column   | 98   |
| 4.28 C8-aromatics composition and flowrate   | 102  |
| 4.29 Summation of energy optimization results  | 104  |
| 4.30 The simulation results of the optimization study by “The minimization of annual cost” objective function              | 107  |

| TABLE   | PAGE |
|---|------|
| 4.31 The simulation results of the optimization study by<br>“The minimization of payback period” objective function | 107  |
| 4.32 The sensitivity results of the payback period by the changing<br>of pricings when heating cost was constant    | 110  |
| 4.33 The sensitivity results of the payback period by the changing<br>of heating cost when pricings were constant   | 111  |
| 4.34 List of the unit operations in the final design  | 112  |
| 4.35 Comparison of the design parameters computed from<br>predictive and experimental methods                       | 114  |
| 4.36 Comparison of the economic factors computed from predictive<br>and experimental methods                        | 115  |
| A.1 Input data to ProCAMD®  | 126  |
| C.1 The 1 <sup>st</sup> name list of solvents   | 134  |
| C.2 The 2 <sup>nd</sup> Name list of solvents with molecular structure<br>(NBP > o-Xylene at least 30°C)            | 146  |
| D.1 Input data for the base-case simulation of case MSL-1 and MSL-2   | 155  |
| D.2 Input data for the base-case simulation of case MSL-3 and MSL-4   | 156  |
| D.3 Input data for the base-case simulation of case ISP-1 and ISP-2   | 157  |
| D.4 Input data for the base-case simulation of case ISP-3 and ISP-4   | 158  |
| D.5 Input data for the base-case simulation of case BZH-1 and BZH-2   | 159  |
| D.6 Input data for the base-case simulation of case BZH-3 and BZH-4   | 160  |
| D.7 Input data for the base-case simulation of case MSL-1 and MSL-2   | 161  |
| D.8 Input data for the base-case simulation of case MSL-3 and MSL-4   | 162  |
| D.9 Input data for the base-case simulation of case ISP-1 and ISP-2   | 163  |
| D.10 Input data for the base-case simulation of case ISP-3 and ISP-4  | 164  |
| D.11 Input data for the base-case simulation of case BZH-1 and BZH-2  | 165  |
| D.12 Input data for the base-case simulation of case BZH-3 and BZH-4  | 166  |

## LIST OF FIGURES

| FIGURE  | PAGE |
|---|------|
| 2.1 Typical extractive distillation sequences. component A is less associated with the solvent  | 4    |
| 2.2 Basic steps of CAMD   | 9    |
| 2.3 Driving force as a function of composition for $\beta_{ij} = 3$   | 20   |
| 2.4 Optimization of a process with recycle; repeated simulation (feasible path approach)  | 29   |
| 2.5 Optimization of a process with recycle; infeasible path approach  | 29   |
| 2.6 Optimization of a process with recycle; compromise approach   | 30   |
| 3.1 The overall extractive distillation design methodology  | 35   |
| 3.2 Workflow of the experimental works  | 37   |
| 3.3 Fischer VLE-apparatus breakdown equipment   | 38   |
| 3.4 The Fischer VLE 602 with the ventilation system   | 40   |
| 3.5 Accuracy testing of Fischer VLE602 by comparing between own developed VLE data and data from literature of n-Hexane and n-Heptane system          | 41   |
| 3.6 Flowchart indicates the idea of thermodynamic consistency checking of VLE data by (A) Standard Database (B) DECHEMA (C) Herington (X) Gibbs/Duhem | 42   |
| 3.7 Concept of the data regression in Aspen Plus®   | 44   |
| 3.8 New data set creation for binary parameter regression (example for UNIQUAC parameter regression for MSL-EB system)                                | 44   |
| 3.9 Binary parameter regression (example for UNIQUAC parameter regression for MSL-EB system)  | 45   |
| 3.10 Workflow of the base-case process design and preliminary economic evaluation for the best solvent selection                                      | 45   |
| 3.11 The overall process design and optimization procedure  | 46   |
| 3.12 The optimization algorithm by utilizing Aspen Plus®  | 48   |

| FIGURE   | PAGE |
|--|------|
| 4.1 Rule of thumb economic calculator proposed by Berg   | 50   |
| 4.2 Single stage flash drum model for relative volatility simulation   | 51   |
| 4.3 The relationships of $S_{ij}^{\infty}$ and $\alpha_{ji}$ after applying the solvent from 20 sample solvents estimated by using UNIFAC method     | 51   |
| 4.4 The relationships of $S_{ij}^{\infty}$ and $\alpha_{ji}$ after applying the solvent from 20 sample solvents estimated by using UNIFAC-DMD method | 51   |
| 4.5 Residue curve map of EB-PX-MSL, at 1 atm, shows no azeotropic point  | 52   |
| 4.6 Example of the GC peak area results from the GC of Varian, Inc. (Column = Cp-Sil 8 CB For Amines)  | 63   |
| 4.7 Calibration curves of EB in EB-PX-solvent mixture  | 63   |
| 4.8 Calibration curves of PX in EB-PX-solvent mixture  | 64   |
| 4.9 Calibration curves of solvents in EB-PX-solvent mixture  | 64   |
| 4.10 Enhanced relative volatility of EB-PX at various S:F ratio  | 67   |
| 4.11 Comparison of relative volatilities between experimental and simulation results at S:F = 1  | 69   |
| 4.12 Comparison of relative volatilities between experimental and simulation results at S:F = 5  | 69   |
| 4.13 Driving force of ethylbenzene ( $DF = Y_{EB} - X_{EB}$ ) at S:F = 1 simulated by UNIFAC   | 69   |
| 4.14 Driving force of ethylbenzene ( $DF = Y_{EB} - X_{EB}$ ) at S:F = 1 simulated by UNIFAC-Dortmund  | 70   |
| 4.15 UNIFAC binary interaction metrix (In Aspen Plus <sup>®</sup> )  | 71   |
| 4.16 Calibration curves of Methyl Salicylate systems (a) MSL-EB, (b) MSL-PX, (c) MSL-MX, (d) MSL-OX  | 72   |
| 4.17 Calibration curves of Isophorone systems (a) ISP-EB, (b) ISP-PX, (c) ISP-MX, (d) ISP-OX   | 73   |
| 4.18 Calibration curves of Benzaldehyde systems (a) BZH-EB, (b) BZH-PX, (c) BZH-MX, (d) BZH-OX   | 73   |

| FIGURE  | PAGE |
|---|------|
| 4.19 Analysis of the pure component boiling temperature measurement in term of (a) STD, and (b) %difference from normal-boiling point, plotted against the purity of the components                                 | 76   |
| 4.20 VLE data of C8-aromatics (hydrocarbon) System (a) EB-PX, (b) EB-MX, (c) EB-OX, (d) MX-OX, (e) PX-MX, (f) PX-OX   | 77   |
| 4.21 VLE data of Benzaldehyde system (a) BZH-EB, (b) BZH-PX, (c) BZH-MX, (d) BZH-OX   | 78   |
| 4.22 VLE data of Isophorone system (a) ISP-EB, (b) ISP-PX, (c) ISP-MX, (d) ISP-OX   | 78   |
| 4.23 VLE data of Methyl salicylate system; (a) MSL-EB, (b) MSL-PX, (c) MSL-MX, (d) ISP-OX   | 79   |
| 4.24 Temperature's effect on consistency of VLE data  | 81   |
| 4.25 Thermodynamic consistency data calculating results (a) Total data points plot (b) Total data points point but in reduced y-axis (c) Final selected data plot (d) Final selected data plot separated by solvent | 82   |
| 4.26 Plots for comparison between experimental data, regression data by Maximum Likelihood algorithm, and literature data for various systems   | 87   |
| 4.27 Plots for comparison between experimental data, regression data by Barker algorithm, and literature data for various systems   | 88   |
| 4.28 Plot of activity coefficient of MSL-C8As systems   | 89   |
| 4.29 Plot of activity coefficient of ISP-C8As systems   | 90   |
| 4.30 Plot of activity coefficient of BZH-C8As systems   | 91   |
| 4.31 Driving force curve plots by UNIQUAC model for various data set  | 92   |
| 4.32 The solvent selection diagram  | 94   |
| 4.33 Simple PFD of the initial ethylbenzene separation process  | 95   |
| 4.34 Equilibrium plots of Methyl salicylate system  | 96   |
| 4.35 Equilibrium plots of Isophorone system   | 97   |

| FIGURE  | PAGE |
|---|------|
| 4.36 Equilibrium plots of Benzaldehyde system   | 97   |
| 4.37 Example of input window for Benzaldehyde system  | 98   |
| 4.38 Example of design results of Methyl salicylate system  | 99   |
| 4.39 Aspen Distil <sup>®</sup> design results of Methyl salicylate system   | 99   |
| 4.40 Aspen Distil <sup>®</sup> design results of Isophorone system  | 100  |
| 4.41 Aspen Distil <sup>®</sup> design results of Benzaldehyde system  | 100  |
| 4.42 Possible design region by Methyl salicylate system   | 101  |
| 4.43 Possible design region by Isophorone system  | 101  |
| 4.44 Possible design region by Benzaldehyde system  | 101  |
| 4.45 The overall process design (the similar scheme were applied for every solvent system)                            | 102  |
| 4.46 Summary of plots of all the base-cases   | 103  |
| 4.47 The process scheme used for the optimization   | 106  |
| 4.48 The plot of optimization parameter of the case study   | 109  |
| 4.49 The Sensitivity analysis results of the price and cost parameters involved in the optimization of the case study | 109  |
| 4.50 The final process design scheme of the MSL system  | 112  |
| A.1 Input windows of ProCAMD <sup>®</sup>   | 124  |
| B.1 Window for defining the related process variables in the optimization tool of Aspen Plus <sup>®</sup>             | 129  |
| B.2 Window for specifying the objective function and constrains in the optimization tool of Aspen Plus <sup>®</sup>   | 129  |
| B.3 Window for specifying the variables to be varied in the optimization tool of Aspen Plus <sup>®</sup>              | 130  |
| B.4 Window for specifying the variables to be varied in the optimization tool of Aspen Plus <sup>®</sup>              | 130  |
| B.5 Window for defining the related process variables in the sensitivity tool of Aspen Plus <sup>®</sup>              | 131  |



| FIGURE   | PAGE |
|--|------|
| B.6 Window for defining specifying the variables to be varied in the sensitivity tool of Aspen Plus® | 132  |
| B.7 Window for defining parameters to be tabulated by the sensitivity tool of Aspen Plus®            | 132  |
| B.8 Fortran input window in the Sensitivity tool of Aspen Plus®                                      | 133  |