

## BAB V KESIMPULAN



### 5.1 Kesimpulan

Kesimpulan yang diperoleh dari penelitian ini adalah:

1. Respon temperatur distilat dan bottom berbanding lurus terhadap input reboiler duty.
2. Respon temperatur distilat dan bottom berbanding terbalik terhadap input refluks ratio.
3. Respon komposisi butyl acetate berbanding lurus terhadap input reboiler duty.
4. Respon komposisi butyl acetate berbanding terbalik terhadap input refluks ratio.
5. Respon komposisi berbanding lurus dengan temperatur.
6. Kecepatan respon temperatur lebih cepat daripada kecepatan respon komposisi butyl acetate.
7. Sistem pada fungsi ini tidak linear.

### 5.2 Saran

Saran yang dapat diberikan pada penelitian ini adalah:

1. Melakukan simulasi dinamik dengan input dan output yang lebih bervariasi.
2. Melanjutkan penelitian sampai tahap fungsi alih bahkan perancangan pengendalian.



## DAFTAR PUSTAKA

- [1] G. J. Harmsen, "Reactive Distillation: The Front-Runner of Industrial Process Intensification. A Full Review of Commercial Applications, Research, Scale-up, Design and Operation," *Chemical Engineering and Processing* 46, pp. 774-780, 2007.
- [2] S. S. a. J. r. Gmehling, "n-Butyl Acetate Synthesis via Reactive Distillation: Thermodynamic," *Ind. Eng. Chem. Res.*, no. 41, p. 5483, 2002.
- [3] Jo, S., Kim, G., Han, M., Cho, M. (2014). "Entrainer-Enhanced Reactive Distillation for the Production of Butyl," *Industrial & Engineering Chemistry Research*, no. 53, p. 8095–8105.
- [4] Babatunde A. Ogunnaiké, W. Harmon Ray. (1994). *Process Dynamics, Modeling, and Control*. Oxford University Press, Inc.
- [5] Dale E. Seborg, Thomas F. Edgar, Duncan A. Mellichamp, *Process Dynamics and Control*, John Wiley & Sons, Inc, 2004.
- [6] R. E. Treybal, *Mass-Transfer Operations*, McGraw-Hill International Editions, 1981.
- [7] C. J. Geankoplis, *Transport Processes and Unit Operations*, Prentice-Hall International, Inc..
- [8] H. Z. Kister, *Distillation Design*, California: McGraw-Hill, Inc, 1992.
- [9] H. Z. Kister, *Distillation Operation*, McGraw-Hill, p. 376.
- [10] Guilherme Duenhas Machado, Donato A. G. Aranda, Marcelo Castier, Vladimir Ferreira Cabral, and Lucio Cardozo-Filho, "Computer Simulation of Fatty Acid Esterification in Reactive Distillation Columns," *Industrial & Engineering Chemistry Research*, 2011.
- [11] Rameshwar S. Hiwale, Nitin V. Bhate, Yogesh S. Mahajan, Sanjay M. Mahajani, "Industrial Application of Reactive Distillation: Recent Trends," *International Journal of Chemical Reactor Engineering*, vol. 2, 2004.
- [12] R. Taylor, R. Krishna, "Modelling Reactive Distillation," *Chemical Engineering Science* 55, pp. 5183-5229, 2000.
- [13] S. Chemtech, "Separation Technology for the Chemical Process Industry".
- [14] B. W. V. Hasselt, *The three-levels-of-porosity reactor*, 1999.
- [15] William L. Luyben, Cheng-Ching Yu, *Reactive Distillation Design and Control*, Hoboken, New Jersey: John Wiley & Sons, Inc, 2008.

- [16] M. A. Suryawanshi, N. H. Shinde and R. V. Nagotkar, "Kinetic Study of Esterification Reaction for the," *International Journal of Advanced Research in Science*, vol. 1, no. 1, 2014.
- [17] Kirk-Othmer, *Encyclopedia of Chemical Technology*, 4th edition, vol. 27, New York: John Wiley & Sons, 2001.
- [18] J. G. Smith, *Organic Chemistry*, 3rd edition, University of Hawai'i at Ma-noa: McGraw-Hil, 2001.
- [19] W. H. Brown, "Acetic Acid (CH<sub>3</sub>COOH) Chemical Compound," *Encyclopedia Britannica*, 2009.
- [20] H. Cheung, R. S. Tanke and P. Torrence, "Ullmann's Encyclopedia of Industrial Chemistry," in *Acetic Acid*, Weinheim, Wiley-VCH, 2005.
- [21] I. Scienelab.com, "Material Safety Data Sheet Acetic acid MSDS," Texas, 2013.
- [22] OECD SIDS, "n-Butyl Alcohol, SIDS Initial Assessment Report," Unep Publication, Switzerland, 2001.
- [23] L. A. Hazelwood, J.-M. Daran, A. J. van Maris, J. T. Pronk and J. Dickinson, The Ehrlich pathway for fusel alcohol production: a century of research on *Saccharomyces cerevisiae* metabolism, 2008.
- [24] I. Mellan, *Industrial Solvents*, New York: Van Nostrand Reinhold, 1950.
- [25] A. Doolittle, *The Technology of Solvents and Plasticizers*, New York: Wiley, 1954.
- [26] I. Scienelab.com, "Material Safety Data Sheet 1-Butanol MSDS," Texas, 2013.
- [27] C. H. a. U. H. Silke Lönning, "Theoretical Investigations on the Quaternary System n-Butanol," *Chem. Eng. Technol.* 23, p. 789, 2000.
- [28] Scienelab.com, "Material Safety Data Sheet n-Butyl acetate MSDS," Texas, 2013.
- [29] J. Hagen, *Industrial Catalysis*, Mannheim, Germany: Wiley-VCH, 2006.
- [30] A. & S. M. Chakrabarti, "Cationic Ion Exchange Resin as Catalyst," *Reactive Polymers*, pp. 1-45, 1993.
- [31] M. K. A. Hamid, *HYSYS®: An Introduction to Chemical Engineering Simulation (Manual Book)*, Malaysia.
- [32] E. Muzenda, "From UNIQUAC to Modified UNIFAC Dortmund: A Discussion," *3rd International Conference on Medical Sciences and Chemical Engineering (ICMSCE'2013)*, 2013.
- [33] *Aspen HYSYS V8.8 (Software)*.

- [34] A. Plus, *Aspen Tutorial #6: Aspen Distillation*, pp. 52-68.
- [35] Irene J.A. Baker, Barry Matthews, Hector Suarez, Irena Krodkiewska, D. Neil Furlong, Franz Grieser, Calum J. Drummond, "Sugar Fatty Acid Ester Surfactants: Structure and Ultimate Aerobic Biodegradability," 2000.
- [36] B. T. C. Company, *GPS Safety Summary, Fatty acids, C8-16, 2-ethylhexyl ester*, 2012.
- [37] Yogesh C. Sharma, Bhaskar Singh, John Korstad, "Advancements in Solid Acid Catalysts for Ecofriendly and Economically Viable Synthesis of Biodiesel," *Biopfr*, 2010.
- [38] Fang Ren Chen, Gisele Coudurier, Jean-Francois Joly, Jacques C. Vedrine, "Superacid and Catalytic Properties of Sulfated Zirconia," *Journal of Catalysis* 143, pp. 616-626, 1993.
- [39] Joon Ching Juan, Jingchang Zhan, Mohd Ambar Yarmo, "Study of Catalysts Comprising Zirconium Sulfate Supported on a Mesoporous Molecular Sieve HMS for Esterification of Fatty Acids under Solvent-Free Condition," *Applied Catalysis A: General* 347, pp. 133-141, 2008.
- [40] Zuoxiang Zeng, Li Cui, Weilan Xue, Jing Chen and Yu Che, "Recent Developments on the Mechanism and Kinetics of Esterification Reaction Promoted by Various Catalysts," *Intech*, 2012.
- [41] F. Omota, A. C. Dimian, A. Bliet, "Fatty Acid Esterification by Reactive Distillation: Part 2—Kinetics-Based Design for Sulphated Zirconia Catalysts," *Chemical Engineering Science* 58, p. 3175 – 3185, 2003.
- [42] Eastman, *2-Ethylhexanol (Material Safety Data Sheet)*, 2015.
- [43] Oltchim, *2-Ethylhexanol/Octanol (Material Safety Data Sheet)*, 2011.
- [44] J C J Bart, N Palmeri, S Cavallaro, *Biodiesel Science and Technology: From Soil to Oil*, Woodhead, 2010.
- [45] G. V. Research, *Fatty Acid Esters Market Analysis, Market Size, Application Analysis, Regional Outlook, Competitive Strategies And Forecasts, 2015 To 2022*, San Francisco.
- [46] A. Market, "Global Fatty Acid Esters Market Revenue Expected To Grow At a CAGR Of 4.0% From 2015 To 2022: Acute Market Reports," 2016.
- [47] U. gov, "PubChem," National Center for Biotechnology Information, 2004. [Online]. Available: <https://pubchem.ncbi.nlm.nih.gov/>. [Accessed 9 February 2016].
- [48] Costin Bildea, Florin Omota, Alexandre Dimian, Alfred Bliet, "Dynamics and Control of a Reactive Distillation Process for Fatty Acid Esterification".

- [49] J. Oreta, *Esterification: Methods, Reactions, and Applications*, Okayama: WILEY-VCH, 2003.
- [50] D. R. • A. H. • Srinophakun, "Simultaneous Conversion of Triglyceride/Free Fatty Acid Mixtures into Biodiesel Using Sulfated Zirconia," *Top Catal*, vol. 53, p. 773–782, 2010.
- [51] Anton A. Kiss, Alexandre C. Dimian, Gadi Rothenberg, "Solid Acid Catalysts for Biodiesel Production - Towards Sustainable Energy," *Adv. Synth. Catal*, vol. 348, pp. 75-81, 2006.