

BAB V

KESIMPULAN DAN SARAN

V.1. Kesimpulan

Berdasarkan percobaan yang dilakukan dan hipotesa dari jurnal yang digunakan dalam pembuatan katalis CuO-ZnO sebagai katalis dalam pembuatan biodiesel, dapat disimpulkan bahwa katalis *metal oxide* CuO, ZnO dan CuO-ZnO berhasil disintesis dan dapat diaplikasikan dalam pembuatan biodiesel. Katalis CuO-ZnO dapat disintesa dari $\text{Cu}(\text{CH}_3\text{COO})_2 \cdot \text{H}_2\text{O}$ dan $\text{Zn}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$. Rasio % massa katalis berpengaruh signifikan terhadap *yield* biodiesel yang dihasilkan. *Yield* biodiesel yang dihasilkan akan meningkat seiring meningkatnya % massa katalis hingga mencapai titik tetentu. *Yield* biodiesel yang dihasilkan dengan katalis NaOH lebih tinggi dibandingkan katalis CuO dan ZnO, namun kekurangan dari katalis NaOH yaitu sulit dilakukan proses pemisahan dan juga tidak dapat digunakan kembali dapat diatasi dengan menggunakan katalis CuO-ZnO.

V.2. Saran

Pada pembuatan katalis CuO, konsentrasi NaOH yang digunakan sebaiknya lebih besar, agar bentuk partikel seragam.

DAFTAR PUSTAKA

- [1] C. Muthukumaran, G. Sharmila, N. Manojkumar, A. Gnanaprakasam, and V. M. Sivakumar, *Optimization and Kinetic Modeling of Biodiesel Production*. Elsevier Ltd., 2018.
- [2] E. N. Ali and C. I. Tay, "Characterization of biodiesel produced from palm oil via base catalyzed transesterification," *Procedia Eng.*, vol. 53, pp. 7–12, 2013.
- [3] S. Nasreen *et al.*, "Review of Catalytic Transesterification Methods for Biodiesel Production Danial Ali," 2018.
- [4] A. Z. Abdullah, "Alkaline Earth Metal Oxide Catalysts for Biodiesel Production from Palm Oil : Elucidation of Process Behaviors and Modeling Using Response Surface Methodology," vol. 32, no. 1, pp. 113–126, 2013.
- [5] A. Nagvenkar, S. Naik, and J. Fernandes, "Zinc oxide as a solid acid catalyst for esterification reaction," *Catal. Commun.*, vol. 65, pp. 20–23, 2015.
- [6] P. K. P. J. R. Gaurav and S. D. U. S. Sharmac, "A Review on Production of Biodiesel by Transesterification using Heterogeneous Nanocatalyst," no. January, 2018.
- [7] M. Fangrui and A. H. Milford, "Biodiesel production : a review," *Bioresour. Technol.*, vol. 70, pp. 1–15, 1999.
- [8] L. Buchori, I. Istadi, and P. Purwanto, "Advanced chemical reactor technologies for biodiesel production from vegetable oils - A review," *Bull. Chem. React. Eng. & Catal.*, vol. 11, no. 3, pp. 406–430, 2016.
- [9] H. R. Ong, M. R. Khan, M. N. K. Chowdhury, A. Yousuf, and C. K.

- Cheng, "Synthesis and characterization of CuO/C catalyst for the esterification of free fatty acid in rubber seed oil," *Fuel*, vol. 120, pp. 195–201, 2014.
- [10] J. Zhu and X. Qian, "From 2-D CuO nanosheets to 3-D hollow nanospheres: interface-assisted synthesis, surface photovoltage properties and photocatalytic activity," *J. Solid State Chem.*, vol. 183, no. 7, pp. 1632–1639, 2010.
- [11] M. B. Gawande *et al.*, "Cu and Cu-Based Nanoparticles: Synthesis and Applications in Catalysis," *Chem. Rev.*, vol. 116, no. 6, pp. 3722–3811, 2016.
- [12] S. Niju, F. R. Raj, C. Anushya, and M. Balajii, "Optimization of acid catalyzed esterification and mixed metal oxide catalyzed transesterification for biodiesel production from Moringa oleifera oil," *Green Process. Synth.*, vol. 8, no. 1, pp. 756–775, 2019.
- [13] R. Yang, M. Su, M. Li, J. Zhang, X. Hao, and H. Zhang, "One-pot process combining transesterification and selective hydrogenation for biodiesel production from starting material of high degree of unsaturation," *Bioresour. Technol.*, vol. 101, no. 15, pp. 5903–5909, 2010.
- [14] M. T. Akhtar *et al.*, "Comparative study of liquid biodiesel from Sterculia foetida (bottle tree) using CuO-CeO₂ and Fe₂O₃ nano catalysts," *Front. Energy Res.*, vol. 7, no. MAR, 2019.
- [15] R. Varghese, J. P. H, and I. Johnson, "Green Synthesis and Characterizations of Flower Shaped CuO," *Sensors and Transducers*, vol. 210, no. 3, p. 2914, 2017.
- [16] S. Liu, S. Q. Bai, Y. Zheng, K. W. Shah, and M. Y. Han, "Composite Metal-Oxide Nanocatalysts," *ChemCatChem*, vol. 4, no. 10, pp.

- 1462–1484, 2012.
- [17] Z. Kesic, I. Lukic, M. Zdujic, H. Liu, and D. Skala, “Mechanochemically synthesized CaO ZnO catalyst for biodiesel production,” *Procedia Eng.*, vol. 42, pp. 1169–1178, 2012.
 - [18] R. Varghese. and J. H. J. I., “Synthesis and Characterizations of Needle- Shaped CuO Nanoparticles.,” *Int. J. Adv. Res.*, vol. 5, no. 1, pp. 1642–1648, 2017.
 - [19] T. Wirunmongkol, N. O-Charoen, and S. Pavasupree, “Simple hydrothermal preparation of zinc oxide powders using thai autoclave unit,” *Energy Procedia*, vol. 34, pp. 801–807, 2013.
 - [20] J. M. Encinar, A. Pardal, and G. Martínez, “Transesterification of rapeseed oil in subcritical methanol conditions,” *Fuel Process. Technol.*, vol. 94, no. 1, pp. 40–46, 2012.
 - [21] C. Reilly, “Synthesis of Copper Oxide Nanoparticles in Droplet Flow Reactors,” 2017.
 - [22] P. Chand, A. Gaur, A. Kumar, and U. K. Gaur, “Effect of NaOH molar concentration on morphology, optical and ferroelectric properties of hydrothermally grown CuO nanoplates,” *Mater. Sci. Semicond. Process.*, vol. 38, pp. 72–80, 2015.
 - [23] I. Istadi, D. D. Anggoro, L. Buchori, D. A. Rahmawati, and D. Intaniningrum, “Active Acid Catalyst of Sulphated Zinc Oxide for Transesterification of Soybean Oil with Methanol to Biodiesel,” *Procedia Environ. Sci.*, vol. 23, no. Ictcred 2014, pp. 385–393, 2015.
 - [24] S. Sulaiman, “Identification of Fatty Acid Methyl Ester in Palm Oil Using Gas Chromatography- Mass Spectrometer,” pp. 63–74, 2018.
 - [25] M. Hasheminejad, M. Tabatabaei, Y. Mansourpanah, and M. Khatamifar, “GLYCERIN ULTRA PURIFICATION ; A KEY,” no.

May 2014, 2010.

- [26] B. Gurunathan and A. Ravi, "Biodiesel production from waste cooking oil using copper doped zinc oxide nanocomposite as heterogeneous catalyst," *Bioresour. Technol.*, vol. 188, pp. 124–127, 2015.
- [27] A. S. Yusuff and J. O. Owolabi, "Synthesis and characterization of alumina supported coconut chaff catalyst for biodiesel production from waste frying oil," *South African J. Chem. Eng.*, vol. 30, pp. 42–49, 2019.
- [28] S. Sharma, V. Saxena, A. Baranwal, P. Chandra, and L. M. Pandey, *Engineered nanoporous materials mediated heterogeneous catalysts and their implications in biodiesel production*, vol. 1, no. 1. The Authors, 2018.
- [29] I. B. Laskar, L. Rokhum, R. Gupta, and S. Chatterjee, "Zinc oxide supported silver nanoparticles as a heterogeneous catalyst for production of biodiesel from palm oil," *Environ. Prog. Sustain. Energy*, vol. 39, no. 3, 2020.
- [30] M. B. Navas, J. F. Ruggera, I. D. Lick, and M. L. Casella, "A sustainable process for biodiesel production using Zn / Mg oxidic species as active , selective and reusable heterogeneous catalysts," *Bioresour. Bioprocess.*, 2020.
- [31] M. L. Pisarello, B. Dalla Costa, G. Mendow, and C. A. Querini, "Esterification with ethanol to produce biodiesel from high acidity raw materials: Kinetic studies and analysis of secondary reactions," *Fuel Process. Technol.*, vol. 91, no. 9, pp. 1005–1014, 2010.
- [32] M. Balajii and S. Niju, "Biochar-derived heterogeneous catalysts for biodiesel production," *Environ. Chem. Lett.*, vol. 17, no. 4, pp. 1447–

1469, 2019.

- [33] J. Z. Yin, Z. Ma, D. P. Hu, Z. L. Xiu, and T. H. Wang, “Biodiesel production from subcritical methanol transesterification of soybean oil with sodium silicate,” *Energy and Fuels*, vol. 24, no. 5, pp. 3179–3182, 2010.