State-of-the-Art of the Synthesis and Applications of Sulfonated Carbon-Based Catalysts for Biodiesel Production: a Review

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ABSTRACT

Sulfonated carbon-based catalysts (SCC) are favorable heterogeneous acids for acid-catalyzed reactions including esterification and transesterification for biodiesel production. They are covalently functionalized with □SO_3H groups via C□PhSO_3H or C□SO_3H linkages with special carbon structures. To date, the types of SCC for biodiesel production ranges from biochar (BC), activated carbon (AC), graphene, graphite oxides, multiwalled carbon nanotubes, order mesoporous carbon, and graphitic carbon nitride. Lignocellulosic and biomass wastes are important carbon precursors for low-cost BC and AC production. This review critically reviews and summarizes the most up-to-date research progress in the evolution of SCC for biodiesel production. Systematic discussions and comparisons on the different carbon materials, preparation methods, and sulfonation preparation parameters which directly affect the physicochemical attributes and catalytic performance are provided. The applications and reusability studies of these materials in biodiesel production are also included. Finally, the challenges to be addressed and future prospects of the research direction on the applications of SCC for biodiesel production are discussed.

KEYWORDS

Biodiesel; Carbon-based; Esterification; Sulfonated; Transesterification

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1. Atabani, A.E., Silitonga, A.S., Badruddin, I.A., Mahlia, T.M.I., Masjuki, H.H., Mekhilef, S. A comprehensive review on biodiesel as an alternative energy resource and its characteristics(2012) *Renewable and Sustainable Energy Reviews*, 16 (4), pp. 2070-2093. Cited 1079 times. doi: 10.1016/j.rser.2012.01.003

2. Farabi, M.S.A., Ibrahim, M.L., Rashid, U., Taufiq-Yap, Y.H. Esterification of palm fatty acid distillate using sulfonated carbon-based catalyst derived from palm kernel shell and bamboo (2019) *Energy Conversion and Management*, 181, pp. 562-570. Cited 53 times. https://www.journals.elsevier.com/energy-conversion-and-management doi: 10.1016/j.enconman.2018.12.033

3. Chong, C.C., Aqsha, A., Ayoub, M., Sajid, M., Abdullah, A.Z., Yusup, S., Abdullah, B. A review over the role of catalysts for selective short-chain polyglycerol production from biodiesel derived waste glycerol (2020) Environmental Technology and Innovation, 19, art. no. 100859. Cited 17 times. http://www.journals.elsevier.com/environmental-technology-and-innovation/doi: 10.1016/j.eti.2020.100859

4. Xue, B.-J., Luo, J., Zhang, F., Fang, Z. Biodiesel production from soybean and Jatropha oils by magnetic $CaFe_2O_4$-$Ca_2Fe_2O_5$-based catalyst (2014) *Energy*, 68, pp. 584-591. Cited 96 times. www.elsevier.com/inca/publications/store/4/8/3/ doi: 10.1016/j.energy.2014.02.082

5. Nata, I.F., Putra, M.D., Irawan, C., Lee, C.-K. Catalytic performance of sulfonated carbon-based solid acid catalyst on esterification of waste cooking oil for biodiesel production (2017) *Journal of Environmental Chemical Engineering*, 5 (3), pp. 2171-2175. Cited 62 times. http://www.journals.elsevier.com/journal-of-environmental-chemical-engineering/ doi: 10.1016/j.jece.2017.04.029