Esterification of free fatty acids in used cooking oil using ion-exchange resins as catalysts: An efficient pretreatment method for biodiesel feedstock

Sumaiya Zainal Abidin[ab;] *Kathleen F. Haigh*[a;] *Basudeb Saha*[c]

[a] Department of Chemical Engineering, Loughborough University, Loughborough, Leicestershire, LE11 3TU, United Kingdom

[b] Faculty of Chemical and Natural Resources Engineering, Universiti Malaysia Pahang, Lebuhraya Tun Razak, 26300 Gambang, Kuantan, Pahang Darul Makmur, Malaysia

[c] Department of Applied Science, Faculty of Engineering, Science and the Built Environment, London South Bank University, London, SE1 0AA, United Kingdom

ABSTRACT

The esterification of used cooking oil (UCO) with methanol was studied using different types of ion-exchange resins, that is, Purolite D5081, Purolite D5082, and Amberlyst 36. Several catalyst characterization analyses (elemental analysis, surface area measurement, particle size distribution analysis, scanning electron microscopy analysis, true density measurement, and acid capacity analysis) have been conducted in the screening stage. Of all of the catalysts investigated, Purolite D5081 resin showed the best catalytic performance and was selected for further experimental studies. The esterification process was carried out in a jacketed stirred batch reactor for 8 h. Elimination of mass transfer resistances and the effect of catalyst loading (0.5–1.5% w/w), reaction temperature (50–65 °C), and methanol to UCO feed mole ratio (4:1–12:1) on the conversion of FFAs were investigated. The highest FFAs conversion was found to be 92%, at a catalyst loading of 1.25% w/w, 60 °C reaction temperature, 6:1 methanol to UCO molar ratio, and stirring speed of 475 rpm. During the reusability study, the conversion of catalyst dropped by 8–10% after each reutilization cycle. Several experiments have been conducted through the homogeneous contribution study, and the results confirmed that both resin pore blockage and sulfur leaching are dominant factors that decrease the catalytic performance of Purolite D5081 ion-exchange resin.

KEYWORDS:

Acid capacity; Amberlyst; Biodiesel feedstock; Catalyst characterization

REFERENCES:

1. Sharma, Y.C., Singh, B., Upadhyay, S.N. Advancements in development and characterization of biodiesel: A review (2008) Fuel, 87 (12), pp. 2355-2373. Cited 735 times. doi: 10.1016/j.fuel.2008.01.014

2. oehman, A.L. Biodiesel production and processing (2005) Fuel Processing Technology, 86 (10), pp. 1057-1058. Cited 69 times. doi: 10.1016/j.fuproc.2004.11.001

3. Lotero, E., Liu, Y., Lopez, D.E., Suwannakarn, K., Bruce, D.A., Goodwin Jr., J.G. Synthesis of biodiesel via acid catalysis (2005) Industrial and Engineering Chemistry Research, 44 (14), pp. 5353-5363. Cited 1163 times. doi: 10.1021/ie049157g

4. Gui, M.M., Lee, K.T., Bhatia, S.Feasibility of edible oil vs. non-edible oil vs. waste edible oil as biodiesel feedstock (2008) Energy, 33 (11), pp. 1646-1653. Cited 650 times. www.elsevier.com/inca/publications/store/4/8/3/ doi: 10.1016/j.energy.2008.06.002

5. Stamenković, O.S., Veličković, A.V., Veljković, V.B.The production of biodiesel from vegetable oils by ethanolysis: Current state and perspectives (2011) Fuel, 90 (11), pp. 3141-3155. Cited 135 times. doi: 10.1016/j.fuel.2011.06.049