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Biodiesel production through esterification using ionic liquids as catalysts

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There is a growing interest in the development of alternative technologies to the oil economy, based on renewable energy sources. A possible solution is a biofuel usable in compression-ignition engines, produced from biomass rich in fats and oils. Biodiesel is an alternative fuel that can be produced from a wide range of raw materials such as vegetable oils and animal fats. Yet, the use of sources that do not compete with the food market, like waste cooking oils - which usually feature high levels of free fatty acids (FFA's) -, can lead to problems in the process of biodiesel production through alkaline transesterification. Ionic liquids (ILs) could be employed in the biodiesel production to partially overcome these problems; since they are able to catalyze the esterification reaction of FFA's to biodiesel. In this work, experimental results will be presented concerning the study of the influence of ILs in the catalysis of esterification reactions of organic acids to the corresponding methyl esters.

Different imidazolium-based ILs were tested for biodiesel production through an esterification reaction of oleic acid, using a previously optimized reaction methodology [1]: 1-butyl-3-methylimidazolium hydrogen sulfate ([BMIM][HSO_4]), 1-butyl-3-methylimidazolium methanesulfonate, 1-butyl-3-methylimidazolium methyl sulfate, 1-metylimidazolium hydrogen sulfate ([HMIM][HSO_4]) and tributylmethylammonium methylsulfate. The experimental values obtained for the conversion of the oleic acid through an esterification reaction showed that the ionic liquid ([BMIM][HSO_4]) would be one of the most promising catalysts.

The recovery of the selected [BMIM][HSO_4] ionic liquid was studied for different catalyst loading: 10, 15 and 20 wt% - relative to the mass of oleic acid. The reaction yield was determined by acidity using a titrimetric method (EN 14104). The composition characterization of the biodiesel samples (identification of fatty acid methyl esters) was evaluated by gas chromatography with FID detector (EN 14103) [2]. Table 1 displays the variation in the yield after several cycles for each catalyst loading. The obtained results confirm that it is possible to reuse [BMIM][HSO_4] ionic liquid in successive reactions without great loss of yield and, thereafter, to significantly reduce the costs associated with the use of ILs as catalysts. Moreover, the esterification reaction with the [HMIM][HSO_4] IL was also studied and further comparison of the methyl esters content obtained with each catalyst will be possible.

Table 1. *Reaction yield after several cycles*

Catalyst loading (wt%)	Number of cycles	1st reaction	Last reaction
10	4	76.6%	58.8%
15	5	83.3%	75.2%
20	5	84.8%	77.1%

References:

[1] I. Alimova, A. Ribeiro, A. Queiroz, P. Brito. III Congresso Ibero-Americano de Empreendedorismo, Energia, Ambiente e Tecnologia, 12 a 14 de Julho de 2017, Instituto Politécnico de Bragança, Portugal.

[2] CEN - European Committee for Standardization, "EN 14214:2008 - Automotive fuels - Fatty acid methyl esters (FAME) for diesel engines - Requirements and test methods," 2008.