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Short Communication

Biodiesel production by two-stage transesterification with ethanol by washing with neutral water and water saturated with carbon dioxide

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HIGHLIGHTS

- A first washing with neutral water improves the purification procedure.
- Water saturated with CO_2 can be used as the second purification step.
- Lower acidity in the final biodiesel is obtained using this procedure.
- This procedure successfully purified biodiesel with high soap content.
- Conventional acid-washing cannot be used in case of high soap containing biodiesel.

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ABSTRACT

Industrial production of ethyl esters is impeded by difficulties in purifying the product due to high amounts of soap formed during transesterification. A simple biodiesel wash process was developed that allows successful purification of samples containing high amounts of soap. The key step was a first washing with neutral water, which removed the soaps without increasing the acidity or affecting the process yield. Afterward, the biodiesel was washed with water saturated with CO_2, a mild acid that neutralized the remaining soaps and extracted impurities. The acidity, free-glycerine, methanol and soaps concentrations were reduced to very low levels with high efficiency, and using non-corrosive acids. Independently of the initial acidity, it was possible to obtain biodiesel within EN14214 specifications. The process included the recovery of soaps by hydrolysis and esterification, making it possible to obtain the theoretical maximum amount of biodiesel.

1. Introduction

Biodiesel is produced industrially by alkaline-catalyzed transesterification of triacylglycerides derived from vegetal oils or animal fats (Freedman et al., 1984; Reid, 1911). The alcohol most frequently used in this process is methanol since its price has historically been lower than that of other alcohols; however, growth of ethanol production and consumption has led to an ethanol price lower than that of methanol in some countries such as Brazil in 2007 and 2008 (Methanol price: <http://www.methanex.com/products/documents/MxAvgPrice_Aug2011.pdf>, Ethanol price: <http://www.unica.com.br/q10/alcanidro.asp>). Ethyl ester-based biodiesel presents numerous advantages compared to methyl esters. From an environmental point of view, ethyl esters exhibit lower emissions of particulate matter and greenhouse gases, such as carbon dioxide and nitrogen oxides (NOx) and are more biodegradable than methyl esters (Boehman, 2005). Compared to methyl esters, ethyl esters have a higher cetane index and heating power, a lower cloud and pour point, and better cold filter plugging point. The maximum amount of product that can be obtained per unit mass of triacylglycerides is higher in the case of ethanol since its molecular weight is higher than that of methanol. This represents an economical benefit. According to the transesterification reaction stoichiometry, three moles of alcohol react with one mol of triacylglyceride to produce three moles of alkyl ester and one mol of glycerol. Once the reaction is finished, the glycerine-rich phase is separated from the biodiesel phase by decantation or centrifugation. This crude biodiesel phase contains mainly alkyl esters, and minor amounts of impurities such as soaps, catalyst, water, metals, alcohol and free glycerine, which have to be removed (Vicente et al., 2007) in order to meet the required biodiesel quality (EN 14214, IRAM, ASTM D 6751, etc.). Most of the large biodiesel plants use wet purification consisting of two consecutive liquid–liquid extraction stages (commonly named *washings*). In the first stage, neutralization of the crude biodiesel is performed by means

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