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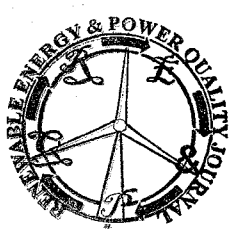
Biodiesel production performance estimation from simple viscosity measurements



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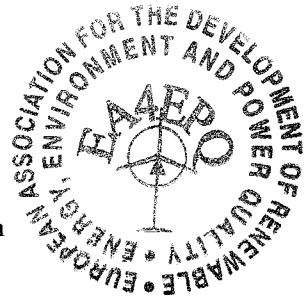

Abstract. In a biodiesel production industry a quick monitorization of the reaction extent achieved in the process it is important. The usual way to determine the reaction yield is to analyze the FAME content in the biodiesel reaction product. Analytic methods used, mainly gas chromatography, require previous sample treatment or tedious calibrations. Recently, less complicated analytic methods (nuclear magnetic resonance, infrared spectrophotometry) have been developed but they require costly equipment and analysis. The aim of this paper is to develop a cheap and fast method in order to quantify the FAME content in the reaction mixture from simple dynamic viscosity measurements and then the transesterification reaction yield. Therefore, experimentally obtained correlations from biodiesel proceeding of several oil feedstocks are presented in order to estimate the biodiesel FAME content from its dynamic viscosity, a fast determination parameter.

Key words

Biodiesel, FAME, NMR, dynamic viscosity

1. Introduction

Biodiesel, an alternative diesel fuel, is made from renewable biological production such as vegetables oils and animal fats [1]. Biodiesel production is a very modern and technological area for researchers. Its relevance comes from petroleum price increasing and from biodiesel environmental advantages [2], mainly diminishing global warming gases levels such as carbon dioxide. Moreover, its use has also showed improvements on engine exhaust emissions. For instead, combustion of biodiesel decreases carbon monoxide (CO) emissions by 46.7%, particulate matter emissions by 66.7% and unburned hydrocarbons by 45.2% [3]. Additionally, biodiesel is non-toxic, making it useful for transportation applications in highly sensitive environments, such as marine ecosystems and mining enclosures [4]. Transesterification is one of the most commercially useable methods to produce biodiesel [5]. Transesterification is a reversible reaction of a fat or oil with alcohol (methanol or ethanol) to form fatty acid alkyl esters (FAME) and glycerol in presence of a suitable catalyst.

The biodiesel production from vegetables oils is relatively simple using alkaline homogeneous transesterification, with conversion efficiency higher 98% [6]. However, the homogeneous catalyzed transesterification reaction has some disadvantages as it consumes large amount of water for wet washing to remove the salt produced from the neutralization process [7]; besides, the catalyst cannot be reutilized, they favour the formation of stable emulsions making the methyl esters (biodiesel product) separation difficult, glycerol is obtained as an aqueous solution of relatively low purity and the reaction becomes very sensitive to the presence of water and free fatty acids [8,9]. An alternative path for biodiesel production involves the use of heterogeneous catalysts. A heterogeneous catalyst can be easily removed from the produced biodiesel [10] without the use of water as washing agent and it can be reused for further reactions.

Biodiesel can be commercialized as pure biofuel or blending stock for diesel fuels, it must meet a set of requirements defined in standard specifications for a safe and satisfactory engine operation, one of these specifications is the content of fatty acid methyl esters (FAME). Besides, this parameter indicates the performance of the transesterification reaction for biofuel production from vegetable oils. There are several methods to determinate FAME content in biodiesel samples (chromatography, nuclear magnetic resonance