STUDY OF SOLID-LIQUID EQUILIBRIUM IN BIODIESEL/DIESEL COMPONENTS: A STEP FORWARD IN THE FORMULATION OF FUEL BLENDS TO AVOID FLOW ASSURANCE PROBLEMS

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ABSTRACT

Biodiesel is a renewable alternative to fuels derived from petroleum which consists essentially in a mixture of fatty acid alkyl ester components obtained by reaction between fats or oils and alcohol in an alkaline medium. Its production has been stimulated in recent years due to economic reasons and environmental legislation. Blends of biodiesel and conventional hydrocarbon-based diesel are products commonly distributed for use. The "B" factor indicates the amount of biodiesel in any fuel mixture. For instance, fuel containing 20% of biodiesel is labeled as B20 and pure biodiesel is called B100. B20 can be generally used in engines without previous modification. However, the use of pure biodiesel at low temperatures is limited by the crystallization of its components, leading to flow assurance problems and damage of engines. Biodiesel composition depends on the biomass source and the alcohol used in the production process, normally methanol or ethanol. Most sources have more appreciable quantities of stearic (C18:0), oleic (C18:1) and linoleic (C18:2) acids; coconut, with a predominance of lauric acid (C12:0) and myristic (C14:0), as well as palm, with a predominance of palmitic acid (C16:0), are exceptions. The reliable prediction of solid liquid equilibrium (SLE) by thermodynamic models would help to select the raw materials in order to produce a biodiesel having a favourable composition at cold environments, as well as to formulate, transport and storage diesel/biodiesel blends. The main factor that difficults model predictions is the scarcity of experimental data to check their reliability. Some authors have analyzed single pure compounds and binary or ternary mixtures of fatty acid esters [1-2], but few phase diagrams of systems of ethyl or methyl esters and diesel components have been obtained. Exceptions are references [3] and [4], where mixtures of ethyl myristate and p-xylene as well as fatty acid methyl esters with heavy alkanes, respectively were studied. In this work, binary mixtures of ethyl oleate with n-decane, decylbenzene and dodecylcyclohexane (usual components of petroleum diesel [5]) were analyzed by differential scanning calorimetry. Results show the presence of a eutectic transition in all cases. The complex phase behavior of these mixtures may have unexpected impacts on the biodiesel performance at low temperatures. The thermodynamic modeling considering immiscible solid phases and the Flory-Huggins equation for liquid-phase non-ideality yielded reasonable agreement for those systems.

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