

DETERMINATION OF SOME PHYSICAL AND TRANSPORT PROPERTIES OF PALM OIL AND OF ITS METHYL ESTERS

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Abstract— In this article the results of the experimental determination of a group of physical and transport properties of palm oil and of its methyl esters are presented, so as to generate reliable information for the execution of works done by chemical engineers, such as the modeling, the equipment sizing and the simulation of processes. Melting ranges, heats of fusion, boiling points, heats of combustion, were experimentally determined, and density, viscosity and heat capacity as a function of temperature were measured. The experimental values were adjusted to empirical models. In addition, density, viscosity and heat capacity as a function of temperature for three mixtures of palm oil and its methyl esters were measured, from where it was concluded that the density and heat capacity can be calculated as if the mixture would behave as ideal solutions, while the viscosity can be calculated with Andrade's model.

Keywords— Palm oil, methyl esters, biodiesel, properties.

I. INTRODUCTION

The World's decrease of the probed reserves of oil and the constant conflict in the Middle East, have taken the oil price to historical levels, and this makes more feasible, from an economical point of view, to replace some of the petrochemical derivatives which make part of the every day life, for some other coming from renewable raw materials and more friendly with the environment. Within these raw materials, oils and fats can be transformed into a large quantity of products, with diverse applications and uses.

The possibility to use fatty acid methyl esters (FAME), product of the methanolysis of oil and fats, as a partial or total substitute of petrochemical diesel (Barnwal and Sharma, 2005), and as a raw material to produce fatty acid methyl esters sulphonates (MES), which can replace the traditional linear alkyl benzene sulphonates (LABS) in detergents (Hama and Ohbu, 2002), has increased the interest in developing processes that increase the productivity and facilitate the stages of separation and purification.

Colombia is the fifth World palm oil producing country and the first in Latin America, with an annual production of about 650,000 tons. The agricultural industry of palm oil is one of the main job-generating in the Colombian rural sector and an important protagonist in the export commerce of oils and fats. The Colombian

government has identified this potential, and based on the legislation promotes the cultivation of African palm (*Elaeis guineensis*) and the production of biodiesel, which by the year 2008 will be added to the petrochemical diesel in order to replace the 5%, in a similar way to that used for the oxygenation of gasoline with ethanol.

In this study the results of the measurement of some physical and transport properties of palm oil, its methyl esters and three of its mixtures, are presented. Melting ranges, heats of fusion, boiling points and heats of combustion were experimentally determined, and the properties density, heat capacity and viscosity, were measured as a function of temperature.

With these experimental values and the empirical models obtained from them, it is pretended, for example, in the case of a process simulation, to facilitate the evaluation of the calculation methods of the properties, the validation of properties and the estimation of parameters not available in the data base of the simulator. To have reliable values of properties is fundamental in order for the results of the processes simulation and the posterior economical evaluation gets closer to reality (Carlson, 1996).

In the case of the density and viscosity of palm oil methyl esters, the study is justified because, although Tate *et al.* (2006a, 2006b) obtained densities and kinematics viscosities of FAME from 20°C to 300°C, FAME from palm oil was not included. In other hand, even though researchers have reported some models to predict the viscosity of FAME from their fatty acid composition (Allen, 1999), or from the pure component topological index (Shu, 2007), these models did not relate viscosity and temperature.

II. METHODS

A. Material

Refined, bleached and deodorized palm oil edible grade (RBD) obtained from INTERGRASAS S. A. (Bogotá D.C.). The origin was the eastern production zone of palm oil in Colombia, and the fatty acid composition, determined by GC, and some of its properties are shown in Table 1. Methanol, sodium hydroxide, pyridine, benzoic acid and hydrochloric acid were of analytical grade obtained from MERCK (Darmstadt, Germany). Palm oil methyl ester of >98.5% purity, free of glycerol, 0.15 wt% of water and acid value 0.13 mg KOH/g, was obtained through methanolysis of the palm oil, under the conditions described further. Reference standards chro-