Esterification and Transesterification of Rapeseed Oil/Fatty Acids Mixture in Presence of Sulfuric Acid

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I. Introduction

Currently biodiesel is one of the most promising first generation biofuel. It is possible to produce biodiesel from any raw materials containing either vegetable or animal fatty acids or their mono-, di- and triglycerides. In the case of fatty acid glycerides, the most common method for producing the biodiesel is using transesterification reaction with methanol in the presence of homogeneous alkaline catalysts [1]. Inexpensive, but valuable biodiesel feedstock, such as the by-products of vegetable oil refining, used cooking oils, animal fat, fats contained in crude glycerol, etc. contain high levels of free fatty acids which completely eliminate the use of alkaline catalysts, but increase the possibilities of acid catalyst application [2]. Due to the high activity and low cost sulfuric acid has become the most widespread acidic catalyst used in the biodiesel production [3]. Considerable amounts of energy and raw materials could be saved and thus reduction in overall product costs could be attained as a result of optimization of various fatty acids containing mixtures esterification and transesterification in the presence of sulfuric acid.

II. Results and Discussion

To study how different concentrations of RFA (fatty acids of rapeseed oil) affect transesterification and esterification reactions (see Fig.1) various mixtures of fatty acid and rapeseed oil were used (free fatty acid concentrations 100, 90, 50, 30, and 0%). Experiments were conducted at 70 ^{o}C with a reaction time of 0 - 360 min using 5.0 moles of methanol per one mole of fatty acids. In the case of 100 and 90% fatty acid mixtures esterification 1.0% (from the weight of the mixture) of sulfuric acid was used, otherwise the 0.5% of sulfuric acid was applied. In experiments a refined rapeseed oil was used, while the fatty acids used were derived from the same oil hydrolysis reaction in presence of sulfuric acid (acid number ~185.0-187.0 mgKOH/g). After the separation of reaction by-products and other impurities the control parameter for esterification and transesterification reaction processes was set to be the acid number (using standard method LVS EN ISO 14104:2005) and ester content (using gas chromatography standard method LVS EN ISO 14103:2003).

It was established that only esterification reaction occurs when acid catalysis reactions where realized using mixtures with free fatty acid concentration of ≥30%. Both esterification and transesterification reactions occured if lower concentrations of fatty acids were used. In the prescribed conditions reaction equilibrium was reached in 240-270 min when esterificating 100% fatty acids and thus obtaining 97.6% RME content. The experimental results shows that oil transesterification is slower than free acid esterification. Transesterification of pure rapeseed oil did not reach the reaction equilibrium within 360 min and the maximum RME content obtained was only 15%.

III. Summary

In this research various mixtures containing fatty acids and rapeseed oil were prepared to examine how different concentrations of RFA affect transesterification and esterification reactions.

IV. References

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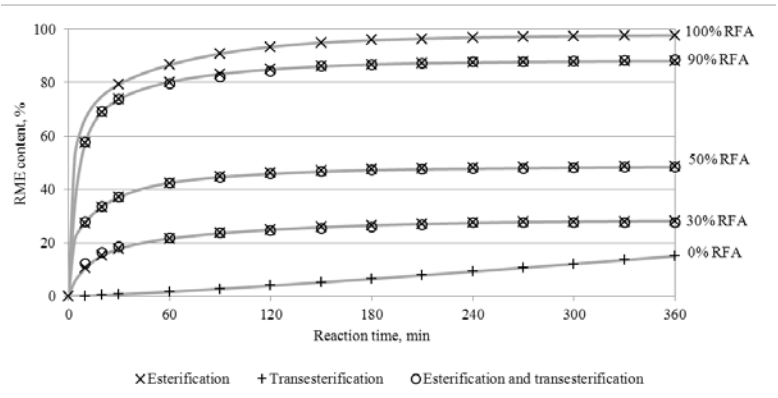

Fig. 1. Influence of RFA on esterefication and transesterification reactions

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