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PHD THESIS: *OBTAINING: BIOPRODUCTS FROM VEGETABLE OILS IN THE SYSTEM OF A FLOW REACTOR SUPPORTED BY MICROWAVE ENERGY*

SUMMARY

Methyl esters of fatty acids (FAME) are widely used in the production of, for example: biosurfactants, biolubrants, "green solvents", hydraulic fluids, dispersants, as well as cosmetic and pharmaceutical products. They are non-toxic and renewable with a high degree of biodegradability. Moreover, they have good lipid solubility and excellent wetting at the interface, which makes them attractive components of cosmetic formulations. The FAME parameters are also similar to those of diesel fuel, so they can be used as biofuel. They are produced by the transesterification of higher fatty acids with low molecular weight alkyl alcohols, most often in the presence of a catalyst. Various sources of triacylglycerols , such as vegetable oils, animal fats, and algae oil, can be used for the transesterification reaction. In industrial conditions, alkyl esters of higher fatty acids are formed by the transesterification reaction of vegetable oils with the use of alcohol (methanol or ethanol) in the presence of a homogeneous basic or acid catalyst. Conventional heating is also used. This method is characterized by a long separation time between the glycerol phase and the ester phase. In addition, it is characterized by a high process cost, which results from the technology of heating the reactants during the reaction. Additionally, despite the fact that these catalysts are cheap and relatively active, their use may have a negative impact on the environment. Replacing conventional chemical methods of biodiesel production with more environmentally friendly processes is one of the main trends in research on biodiesel production.

The research work was divided into two stages:

- carrying out the transesterification reaction of vegetable oils with methanol under conventional heating;
- carrying out the transesterification reaction of vegetable oils with methanol under microwave heating.

In the first stage, reactions involving basic catalysts (KOH, CH_3ONa) and an enzymatic catalyst (lipase) were performed. Then, the obtained methyl esters were tested for utility by determining parameters such as: density, kinematic viscosity and cold filter plugging point. These data allowed for the chemical analysis of selected

bioproducts with the best results. At this stage, the reactions with the use of heterogeneous catalysts were also introduced, where the support for the basic (KOH) and enzymatic (lipase) catalysts was active carbon obtained from beech wood. The obtained biodiesels were subjected to the same analysis as above. Additionally, experiments with the use of activated carbon modified with sulfuric acid VI were performed, and the obtained methyl esters were also analyzed, as in the previous tests. In the second stage, transesterification of vegetable oils with methanol was carried out using microwave heating in the presence of homogeneous basic (KOH and CH_3ONa) and enzymatic (lipase) catalysts. As above, a functional analysis of the obtained biodiesels was carried out, followed by a chemical analysis of selected parameters with the best values.

It can be concluded that the transesterification process carried out with under microwave heating has the potential to use this system on an industrial scale. Microwave radiation acts specifically on polar molecules, resulting in a rapid temperature increase that leads to an increase in the rate of the transesterification reaction. A consequence of the use of microwave heating is also a shorter separation time of the glycerin and ester phases. As a result, the process of obtaining biodiesel is significantly shortened, which translates into lower production costs. In the presented studies, high biodiesel yields were obtained with a significantly shortened reaction time (from 24 h to 10 min with the use of lipase and from 4 h to 1 min, when transesterification is carried out in the presence of KOH) and obtaining bioesters with satisfactory physical properties. Additionally, activated carbon obtained from beech wood is a potential application in the creation of heterogeneous catalysts, where the active phase is KOH and lipase. It minimizes the well-known problems associated with the use of homogeneous catalysts, such as one-time use and the generation of huge amounts of waste water. Conducting the transesterification reaction in the presence of heterogeneous or enzymatic catalysts may lead to the simplification of the separation and purification section of bioesters, as well as a reduction in the amount of generated waste, e.g. reducing water consumption.