**Nanochemistry and biotechnology**

**Molecular mass and molecular mass distribution of nanostructures in biodiesel fuel**

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Biodiesel makes an alternative to diesel fuel. World biodiesel production reaches 10 million tons and continues to grow rapidly. According to the current forecasts, world production of biofuels should increase to 150 million tons by the end of 2030. Ukraine is poor in fossil fuel resources, but rich in rapeseed and sunflower oils, so biofuel production is quite promising for our country. Germany is the leader in producing biodiesel, while Ukraine is the only producer of oilseeds.and vegetable oils[1]. The most commonly used method for biodiesel production is gomogeneous or geterogeneous transerterification of vegetable oils with methanol or ethanol. Compared to methyl, ethyl esters have a high oxidation characteristics[2], lower iodine number and better lubricating properties, so it is less aggressive to the fuel system of the car. The study of new homogeneous catalysts and the improvement of technological conditions for the biodiesel synthesis is considered to be an urgent problem.

Biodiesel is synthesized by transesterification of rapeseed cold drawn oil (DSTU ISO 5509-2002) with a specially prepared absolute ethanol, which prevents the presence of additional water in the reaction system. Sodium ethoxide is used as a catalyst. Synthesis can be described by the following equations:

С2Н5ОН+ NaОН→ С2Н5ОNa+Н2О (1)

3С2Н5ОNa+СН2ООСR1- СНООСR2 - СН2ООСR3→ R1 R2 R3(СООNa)3+ СН2ОС2Н5 - СНОС2Н5 - СН2ОС2Н5 (2)

R1 R2 R3(СООNa)3+3H2SO4→ R1СООН+ R2СООН+ R3СООН+3Na2SO4 (3)

R1СООН+ R2СООН+ R3СООН+3С2Н5ОН Н2SO4 R1СООС2Н5+ R2СООС2Н5+ R3СООС2Н5+ 3Н2О (4)

A chromatographic method with additional methanol esterification (according to DSTU ISO 5509-2002. Vegetable oils - Method for determination of fatty acid composition) and the mass spectrometric methods of MALDI-ToF and LDI-ToF were used to determine the biodiesel molecular mass and the molecular mass distribution of biodiesel fractions.

Basing on chromatographic and mass spectrometric analysis, we can claim that during the synthesis of biodiesel, ethyl ethers of glycerol (mono-, di- and tri-ethyl ethers of glycerol) with boiling temperatures below 250 ° C are formed. This is confirmed by the presence of two main fractions of biodiesel. In contrast, oil diesel and rapeseed oil consist of at least 3 or 4 fractions. The latter fractions are distilled at significantly higher temperatures (320-360 ° C).

It was found that when rapeseed biodiesel is blended with diesel fuel its cetane number can reach 59,9 units for 25% biodiesel blends and 60,1 unitts for 50% biodiesel blends. Additionally, the physical and chemical properties of biodiesel diesel blends meet the ASTM standards[3].

Particular attention was paid to the study of molecular mass and the molecular mass distribution of petroleum diesel fuel (DF), biodiesel (BD) and rapeseed oil (RO), which was a raw material for biodiesel production. The decoding tables for the mass spectrometry were also made and the molecular mass distribution (MMD) curves of the obtained product were constructed.

We can claim that the DF largest fraction (70%) consists of saturated hydrocarbons (paraffins) with chain length C14-C20 and its molecular mass (MM) is equal to 195-281. Consequently, petroleum diesel has a polydispersed distribution of molecular mass, which is shown on the MMD curves. The results prove that 89.6% of biodiesel consists of an ester fraction with the carbon chain length C15-C19 and a molecular weight of 265-340. But the obtained biodiesel also contains 10% of the low molecular weight fraction with the carbon chain length C5-C9 (mono-, di- and tri-ethyl ethers of glycerol) with MM C5-C9 = 135-159, which is significantly different from petroleum diesel fuel, where these fractions are contained two times less (5%). At the same time, the high molecular fraction with the carbon chain length C21-C31 is almost absent (0.32%) in biodiesel. The molecular mass distribution of rapeseed oil shows the presence of the three main fractions of the rapeseed oil (C15-C17), which causes low-temperature properties of rapeseed oil and is distilled at 320-360 ° C.The content of C17 fraction is 82%, which is 7 times more than the content of the same fraction in the diesel fuel (12%). Therefore, the BD has a much higher cetane number (62) that causes a positive effect on the characteristics of biodiesel-diesel blends as was shown higher.

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