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## Biofuel Mixtures: Perspective Motor Fuel.

Vladimir Coicev\*, Anatoliy Kobozev, Igor Shvetsov, Dmitriy Gritsay, and Evgeniy Gerasimov

Stavropol State Agrarian University, Zootekhnicheskiylane 12, Stavropol 355017, Russia.

### ABSTRACT

This manuscript presents research about alternative fuels such as biofuel mixtures based on rapeseed oil (RO) and diesel fuel (DF), energy capacity of rapeseed oil, density and viscosity of the biofuel mixture (RO + DF), dual fuel power system, mixture-forming properties of RO + DF, mixture fuel parameters, production of biofuel

**Keywords:** biofuel, rapeseed oil, diesel fuel, energy intensity, viscosity, density, mixture formation, toxicity.

*\*Corresponding author*

## INTRODUCTION

The increase in prices for motor fuels of oil origin forces agricultural commodity producers to seek replacement. This is facilitated by a constant increase in the requirements for the toxicity of exhaust gases. The so-called alternative fuels-compressed and liquefied gases-fuel obtained from natural gas became more common, and biofuel mixtures of vegetable oils (VO) and diesel fuel (DF) mixed in certain proportions from renewable energy sources. In the European territory, the most common VO used in the production of biofuel mixtures of ICE is rapeseed oil (RO), which belongs to the class of renewable energy sources [12, 13]. In the EU, about 80% of biodiesel fuel is made from RO, the yield of which allows producing about 1190 liters of oil per hectare.

The work of the engine on a biofuel fuel mixture of mineral and vegetable origin does not require significant alterations in the fuel supply system and in the engine design, as well as the special training of machine operators. In addition, for filling fuel tanks with a biofuel mixture based on RO, available fueling facilities and storage tanks can be used.

When a pure RO is combusted, exactly the same amount of carbon dioxide is released, which was consumed from the atmosphere by the plant, which is the raw material for the production of oil. In comparison with conventional mineral fuel RO does not contain sulfur, which significantly reduces toxic emissions into the atmosphere with exhaust gases of engine, and the presence of atomic oxygen in it to 10...15% significantly improves the mixture formation inside the cylinder in the compression stroke. The ignition temperature of the biofuel mixture with a high RO content exceeds 150 °C, which allows it to be called a relatively safe fuel.

The fuel potential of oil-bearing crops per 1 ton of raw material is much higher than that of other crops. Calculations show that the costs of producing rapeseed seeds amount to 17,700 MJ/ha, 700 million MJ/ha for oil extraction, and the energy received from oil is 22,200 MJ/ha. Energy profit per hectare is 3800 MJ (for energy value this corresponds to 110 liters of diesel fuel).

To effectively use the RO as a motor fuel it is necessary to mix it with the diesel fuel and preheat this mixture so that by reducing its kinematic viscosity, it is possible to achieve more favorable conditions for pumping through fuel filters, injecting into the engine cylinders, obtaining a good spray of the mixture and complete combustion, reducing carbon formation.

Optimal viscosity of mineral fuel for diesel engines is within 1.8...7.0 mm<sup>2</sup> / s, which ensures the supply of the required amount of fuel to the cylinders, the required spray and practically does not affect the wear of the plungers of the fuel equipment. High viscosity of the biofuel mixture leads to a deterioration of filtration, dusting and combustion, interruptions in the supply.

The process of mixture formation is significantly influenced by the density of fuel, which for commercial fuels should be 830...860 kg/m<sup>3</sup>. At high density, the length of the spraying spray increases above the optimal value, at a low level it becomes insufficient to create a uniform mixture, which leads to a deterioration in the combustion process. The biofuel mixture, consisting of the maximum amount of RO and the minimum of DF, undergoes almost complete biological decomposition: in soil or water microorganisms process 99% of the mixture for 28 days, which allows to talk about minimization of environmental pollution.

## MATERIALS AND METHODS

Laboratory of Fuel and Lubricants and Power Supply Systems of Automotive Tractor Engines of the Faculty of Agricultural Mechanization of the Stavropol State University conducted laboratory studies of RO + DF fuel mixtures of various concentrations with the establishment of density and viscosity at various temperatures, their adaptation as a motor fuel in internal combustion engines (figure 1).

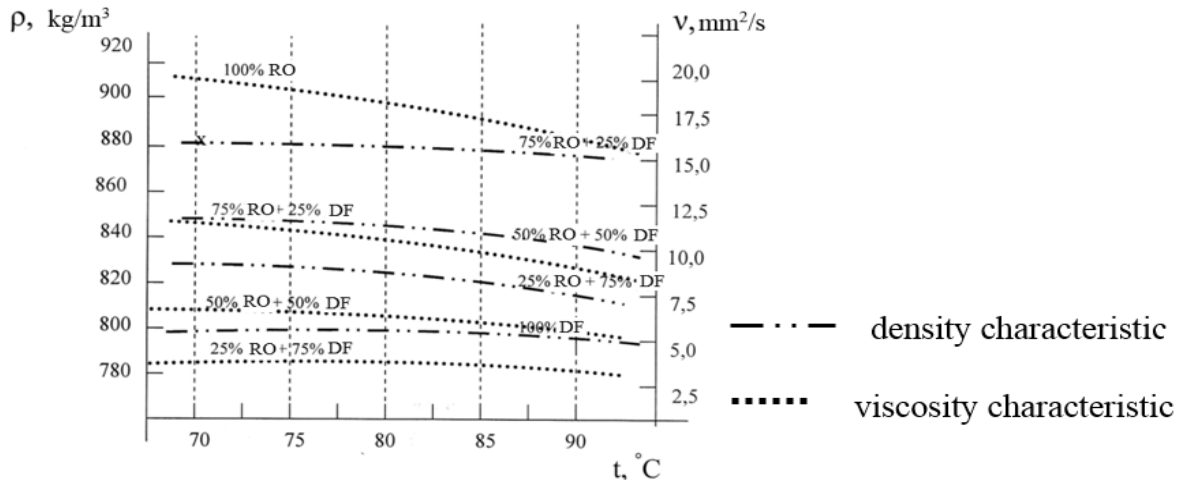


Figure 1: The effect of temperature on the density ( $\rho$ ) and the kinematic viscosity ( $\nu$ ) of the top-mix RO + DF

The most optimal compositions of RO + DF, in terms of pumpability through fuel filters and plunger pairs, are established for mixtures at a concentration of 50% RO + 50% DF and 75% RO + 25% DF, respectively, for the winter and summer periods of the engine operation.

Table 1: Characteristics of biofuel mixtures (RO + DF) during heating

Type of fuel	Lower heat of combustion, MJ/kg	Parameters at temperature, °C									
		Density, kg/m <sup>3</sup>					Viscosity, mm <sup>2</sup> /s				
		70	75	80	85	90	70	75	80	85	90
100% DF	42,437	799	796	794	792	788	1,99,	1,92	1,77	1,69	1,62
25% RO + 75% DF	41,142	825	821	819	816	815	3,80	3,45	3,25	3,06	2,90
50% RO + 50% DF	39,758	849	845	841	838	835	7,11	6,10	5,65	5,01	4,71
75% RO + 25% DF	37,545	879	876	873	869	866	13,26	12,29	11,63	10,52	9,43
100% RO	37,081	894	892	887	884	883	21,48	19,59	17,95	16,58	15,30

A dual-circuit fuel supply system for a diesel engine with a mechanical adapter for heating the fuel mixture was developed and tested at the KI-5543U engine-brake unit with the D-245.12S engine (figure 2).

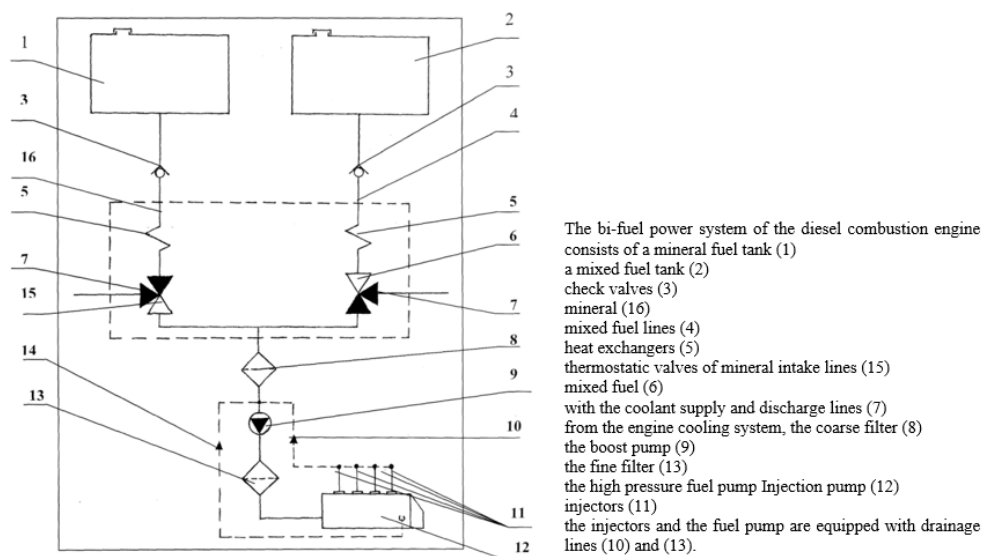


Figure 2: Two-fuel power system of diesel engine with mixed adapter.

The thermostatic valve of the mineral fuel sampling line (15) is normally open, with the closing at a temperature of 700 °C, and the thermostatic valve of the line for collecting the mixture fuel (6) is normally closed, with the opening of the engine at a temperature of more than 50 °C.

## RESULTS AND DISCUSSION

Initial tests showed that the RO + DF mixer engine is softer and there is no reduction in engine power. Applications of fuel mixtures of 75% RO + 25% DF as motor fuel in ICE are most suitable for tractors of agricultural enterprises in the production of ecologically pure products in animal husbandry, horticulture, viticulture, while the emission of toxic agents in the exhaust gases is substantially reduced.

Fuel mixtures consisting of RO + DF of different concentrations can be produced simply in the conditions of the farm itself or a collective consisting of several enterprises, in the presence of a small workshop for the production of vegetable oil in one of them, with the addition of anti-inflammatory and carbon-containing additives that can slightly increase the cost production of biofuels. The prime cost of production of RO for the production of mixed fuel is much lower than the prices for diesel fuel.

## SUMMARY

The use of a biofuel mixture as a motor fuel in an engine has a significant advantage in comparison with mineral fuels not only in terms of cost, but also in terms of cetane number, lubricating properties, a significant reduction in toxic emissions into the atmosphere, oxygen content, promoting better mixture formation and combustion.

The production and use of biofuel mixtures for combustion engines in agricultural enterprises that have at their disposal small shops for the production of vegetable oils from oilseeds will ensure the partial independence of the agro-industrial complex from the oil market.

The most actual use of machine-tractor aggregates and self-propelled agricultural machines with engines working on biofuel mixtures, in the production of environmentally friendly products in viticulture, horticulture, in the cultivation of vegetable and melon crops.

The production of rape by 10 ... 12% of the acreage of the farm will provide fuel for the equipment during the warm period of the year. In addition, it is environmentally friendly to affect the soil and atmosphere and does not reduce the fertility of soils.

Based on the analysis of literature sources [1, 4-13], the use of rapeseed-based fuel is preferable in diesels with volumetric-film mixing, especially in the application of pure rapeseed oil.

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