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Analysis of methods of forming diesel and bioethanol fuel mixture

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Abstract. This article is devoted to determining, in the formation of a mixture of diesel and bioethanol fuel, the amount of bioethanol added to diesel fuel, the mixing time and temperature depending on the density, viscosity parameters. The depletion of oil reserves, the escalation of environmental problems, as well as the steady rise in the price of conventional energy resources in recent years have significantly increased interest in one of the world's renewable energy. An increase in the amount of bioethanol in the preparation of the fuel mixture led to an increase in the amount of water in the mixture, which leads to a partial increase in the corrosion rate of the metal, but it does not reduce the possibility of using the mixture in diesel engines.

1.Introduction

The depletion of oil reserves, the escalation of environmental problems, as well as the steady rise in the price of conventional energy resources in recent years have significantly increased interest in one of the world's renewable energy sources – biofuels. Bioethanol fuels are carbon-organic compounds that emit heat spontaneously as a result of combustion or natural metabolism when combined with oxygen. The process of biofuel separation depends on the ecological cycles of nature, ensuring a continuous process of obtaining energy without generating natural waste [1,2].

It is known that the primary energy in the biomass system is oxygen, and the process of photosynthesis takes place under sunlight, which is the natural regeneration of solar energy. Ethyl alcohol is a component of antifreeze, and the use of bioethanol from biomass as an additive (mixture) to petroleum fuels serves as one of the solutions to the problems of energy, environmental and petroleum saving of the Republic. In the formation of mixed fuels, it is important to determine the amount of bioethanol added to diesel fuel, the time and temperature of mixing [3,4].



2. Materials and methods

Due to the fact that there are almost no devices for the formation of diesel and bioethanol fuel mixtures in our Republic, and for research purposes, the following special device was developed to determine the amount and temperature of mixing of diesel fuel and bioethanol (Figure 1).

The device consists of a temperature stimulator designed to form diesel and bioethanol fuel mixtures and a mixture-forming dispenser. In the special vessel of the device 6 tap K5 is opened, the vessel is filled with cold water and the heater 5 is operated, then the cold water is heated to the desired temperature. The hot water temperature is controlled by temperature indicators 3 and 4. The 7 taps K1 and K6 of the heat-resistant vessel are opened and filled with the required amount of mixed fuel. The temperature of the mixed fuel was monitored using a thermometer TU252021003-38, and the temperature of the fuel mixture and water was measured 10 times every 5 minutes [5,6].

The structure and working principle of the bioethanol mixing device for diesel fuel under laboratory conditions are shown in Figure 2.



Figure 1. Bioethanol mixing device for diesel fuel under laboratory conditions: 1-control panel; 2-dispenser; 3-diesel fuel inlet pipe; 4-mixture formation vessel; 5-finished product outlet pipe

3. Results and samples

Based on the results obtained from the device, a graph of the change of the mixing temperature with respect to time was constructed.

The graphical analysis shows that the diesel fuel formed a molecular emulsion before mixing with the bioethanol, and after a while the internal temperature of the mixture rose and separated into molecular layers. Then a real transparent mixture was formed as the transfer temperature rose [7].

The temperature dependence of the density of diesel fuel was determined using the following formula.

$$\rho = \rho_t - \gamma(t - 20) \quad (1)$$

here, ρ_t is the density of the fuel under ambient temperature, γ is the coefficient of temperature change (when the density is 800 – 860 kg/m³, γ is equal to 0,00073).

The diesel fuel+bioethanol 88:12 (12% mixture), which is being studied, has a density of 825 kg/m³ at a temperature of 86 °C, and a viscosity of 3.4 sSt. The density and viscosity of the mixture have also fully met the GOST requirements [10,11].

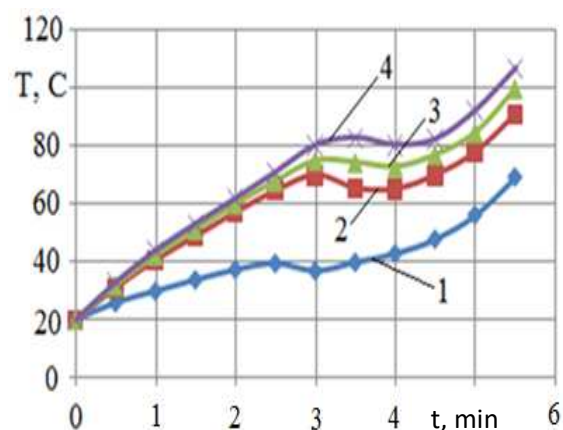


Figure 2. Variation of mixing temperature with time: 1-bioethanol content is 6%; 2- bioethanol content is 8%;3- bioethanol content is 10%; 4- bioethanol content is 12%.

In the combustion chamber of the engine, the ignition and fine corrosion of the fuel under the influence of heat released during combustion varies depending on the viscosity and density of the fuel [8,9].

Table 1. Analysis of properties of diesel and bioethanol fuel mixture

Mixture (diesel fuel:bioethanol)	Density, kg/m ³	Mixture temperature, °C	Viscosity, sSt
99:1(1 % bioethanol)	830	31	4,3
96:4 (4 % bioethanol)	828	48	4,2
95:5 (5 % bioethanol)	827	62	4,0
94:6(6 % bioethanol)	827	72	3,9
92:8 (8 % bioethanol)	826	80	3,7
90:10 (10 % bioethanol)	825	82	3,6
88:12 (12 % bioethanol)	825	86	3,4
85:15 (15 % bioethanol)	824	87	3,2

Table 2. Comparative properties of diesel fuel, bioethanol and 12% mixture fuel

№	Indicators	L-0,2-40	Ethanol	Mixture, 12%
1.	The amount of water, %	no	no	no
2.	Density at 20°C, kg/m ³	830	789	825
3.	Viscosity at 20°C, sSt	4,2	1,76-2,2	3,4
4.	Ignition temperature in a closed crucible, °C	40	35	30
5.	Acidity level, mg KON per 100 ml of fuel	3,3	3,1	3,0
6.	Theoretically the amount of air to burn 1 kg of fuel	14,91	9	13,87
7.	Evaporation temperature of fractional content (%), °C			
	- 50	280	280	280
	- 96	360	350	350
8.	Elemental composition:			
	-carbon	0,87	0,52	0,64
	-hydrogen	0,13	0,13	0,13
	-oxygen	-	0,36	0,47

An analysis of the data in Table 2 showed that the acidity of the 12% fuel mixture decreased by 3.3 milligrams compared to ethanol fuel, indicating an improvement in the quality of the fuel mixture [12].

4. Conclusions

- An increase in the amount of bioethanol in the preparation of the fuel mixture led to an increase in the amount of water in the mixture, which leads to a partial increase in the corrosion rate of the metal, but it does not reduce the possibility of using the mixture in diesel engines.

- The results of the analysis show that an engine running on this type of fuel mixture reduces the amount of toxic gases emitted into the atmosphere and reduces fuel consumption by 1.1 times, operating costs by 12%.

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