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PERFORMANCE PROPERTIES OF COTTONSEED OIL BIODIESEL BLENDS WITH PETROLEUM DIESEL FUEL

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In practice, biodiesel (fatty acid methyl esters, FAME) is used less often in pure form (B100) than in blends with petroleum diesel fuel, designated by the volume fraction of FAME (B5, B10, B20). Blending makes it possible to benefit from the advantages of biodiesel – a high flash point, practically no sulphur and good lubricity – without significant engine modification [1, 2]. For Uzbekistan, where cottonseed oil is the main vegetable oil processed, it is of interest to evaluate the properties of blends based on cottonseed oil methyl esters.

The aim of this work was to study the effect of the cottonseed FAME fraction on the main performance properties of its blends with summer-grade diesel fuel.

Materials and methods. Biodiesel was produced by transesterification of cottonseed oil with methanol (6:1 molar ratio, 1.0 % KOH, 60 °C, 60 min). Diesel fuel grade “…” (EN 590) was used as the base fuel. Blends B5, B10 and B20 were prepared by volume. Density was determined according to EN ISO 12185, kinematic viscosity according to EN ISO 3104, flash point according to EN ISO 2719, cold filter plugging point (CFPP) according to EN 116, and lubricity using an HFRR rig according to EN ISO 12156-1.

Results. The properties of the fuels are given in Table 1.

Table 1

Properties of diesel fuel, biodiesel and their blends

Property	B0	B5	B10	B20	B100
Density at 15 °C, kg/m³	836	838	840	845	879
Viscosity at 40 °C, mm²/s	2.85	2.89	2.94	3.06	4.12
Flash point, °C	64	66	68	72	164
CFPP, °C	−8	−8	−7	−5	+2
HFRR corrected wear scar diameter, μm	470	290	250	220	190

As the FAME fraction increases, the density and viscosity of the blends rise almost linearly; however, for blends up to B20 they remain within the EN 590 requirements [4] (density 820–845 kg/m³, viscosity 2.0–4.5 mm²/s). The cold filter plugging point deteriorates as the biodiesel fraction increases, which is explained by the high content of saturated palmitic acid in cottonseed oil [3]; therefore, in winter it is advisable to limit the FAME content or to use pour point depressant additives. The most pronounced effect is observed for lubricity: already at 5 % FAME the wear scar diameter decreases from 470 to 290 μm, i.e. below the EN 590 limit (≤ 460 μm). This confirms the high lubricity of fatty acid esters, which makes it possible to compensate for its loss in ultra-low-sulphur diesel fuels [1].

Conclusions. B5–B20 blends based on cottonseed oil methyl esters meet the density and viscosity requirements for diesel fuel and have considerably better lubricity. The limiting factor is the deterioration of cold-flow properties, which must be taken into account when choosing the biocomponent fraction for the climatic conditions of Uzbekistan.

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