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A STUDY OF B10 FUEL MIXTURES WITH PHENOLIC ADDITIVES

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The increasing concentration of greenhouse gases in the atmosphere has led to an urgent demand for reducing the consumption of conventional fossil fuels and substituting them with alternative energy sources. Such a transition is expected to contribute significantly to the restoration of the Earth's ecological balance. Among the available renewable energy options, biofuels have demonstrated the greatest potential in recent years. The utilization of plant-derived biomass for fuel production offers several advantages, the most important of which is the environmental safety of biomass-based energy systems. A major technological trend of the past two decades has been the development of low-waste and zero-waste production processes. In this regard, the synthesis of biofuels from waste vegetable oils-one of the primary waste-management challenges for restaurant and café networks-has become increasingly promising. Nevertheless, despite their notable advantages, biofuels also exhibit several limitations. These include relatively poor storage stability (due to rapid oxidative degradation), high ignition temperature, elevated viscosity, and other physicochemical constraints.

Keywords: diesel, fossil fuels, biomass, biodiesel

INTRODUCTION

To compensate for these inherent limitations, biofuels are generally not employed in their neat form. Instead, the contemporary approach favors the use of diesel–biofuel blends, which exhibit more balanced and reliable performance characteristics. These mixtures are classified according to the volumetric share of the biofuel component and are conventionally denoted as B10, B20, B30, B40, and higher grades. Extensive scientific literature documents the incorporation of oxygenated additives aimed at improving the physicochemical stability, combustion efficiency, and overall functional properties of such blended fuels. These additives play a significant role in enhancing the operational suitability and long-term performance of fuel mixtures [1–8].

EXPERIMENTAL

The performance characteristics of the prepared fuel blends were examined using standard analytical techniques. Density was measured by the pycnometric method and kinematic viscosity was determined using an Ostwald viscometer. The flash point was evaluated in a closed cup apparatus, whereas the freezing and cloud points were measured

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with a Beckmann thermometer. Corrosion resistance was assessed qualitatively by observing the change in color of a copper strip after exposure to the fuel sample at 100°C for 3 hours.

RESULTS AND DISCUSSION

According to a widely described methodology in the literature, biodiesel was synthesized via the transesterification of sunflower oil with methanol in the presence of an alkaline catalyst. Considering that biodiesel is commonly produced from waste vegetable oils, this work is of significant practical relevance. Prior to synthesis, the used oils were subjected to purification.

As a continuation of our research, B10-grade fuel blends were prepared. These blends were obtained by mixing biodiesel and diesel in a volumetric ratio of 10:90. As noted earlier, phenolic-type additives were incorporated into the B10 fuel blends to improve their operational properties.

According to published data, phenolic additives exhibit strong antioxidative activity. Ionol was used as the reference standard. Eucalyptus oil was also introduced into the fuel blends as an additional component. The additives were prepared in several variations: both in the pure form of the phenolic compounds mentioned above and as two-component systems consisting of these phenolic additives combined with eucalyptus oil. It is well established in the literature that eucalyptus oil decreases viscosity. A decrease in viscosity is advantageous for fuel transport and atomization in diesel engines.

The formulated fuel blends containing these additives were tested according to ASTM standards. For comparative evaluation, the operational characteristics of the B10 blends with phenolic additives were examined alongside those of conventional diesel fuel and biodiesel. The obtained results are presented in the table below.

Table. Operational properties of the fuel blends

Properties	ϑ_{20}	ϑ_{40}	Density	Flash point	Corrosion	$T_{Clouding}$	$T_{freezing}$
Diesel	6.2	3.44	0.837	70℃	№2	+7℃	0℃
Biodiesel	8.92	5.42	0.880	110℃	№1	+4℃	-3℃
B10	5.31	3.36	0.8494	72℃	№1	-12℃	-21℃
B10+ionol	5.49	3.42	0.8538	77℃	№1	-16℃	-30℃
B10+ionol+Eucalyptus oil	5.38	3.38	0.8523	95℃	№1	-20℃	-36℃

As seen from the table, biodiesel exhibits a noticeable increase in density compared with conventional diesel. The density of diesel and biodiesel varied within the range of 0.837 to 0.880, whereas for the B10 fuel blend this value was 0.8494. The introduction of phenolic additives led to a slight increase in density above 0.8494 in all B10 blends. In this case, the difference appeared only in the second decimal place. Nevertheless, this minor increase in density does not exert a significant influence on the operational performance of the B10 fuel blends containing phenolic-type additives.

According to the table, the viscosity of the B10 blends with phenolic additives decreased sharply at both 20°C and 40°C compared with biodiesel. At20 °C, a pronounced reduction in viscosity was observed for the B10 + ionol + eucalyptus oil mixture, where the value decreased from 8.92 to 5.38. A similar situation was observed at 40°C, where the viscosity declined from 5.42 to 3.38. Such a substantial reduction in viscosity positively affects the operational characteristics of all B10 fuel blends.

As seen from the table, the flash point temperatures of all the fuel systems prepared in this study were slightly lower than that of pure biodiesel. The most favorable values were observed for the B10 blend and the B10 + ionol formulation, with flash points of 72°C and 77 °C, respectively.

Furthermore, as shown in the table, the corrosion resistance of the B10 fuel systems containing phenolic-type additives was markedly improved compared with that of conventional diesel fuel.

Phenolic-type additives produced a pronounced reduction in both the cloud point and crystallization temperature of the B10 fuel blends examined. The most significant improvements were recorded for the blends containing the two-component additive system: B10 + ionol + eucalyptus oil. In particular, the crystallization temperature of this formulation decreased to –36°C, while its cloud point was lowered to –20 °C.

A detailed analysis of the experimental data suggests that incorporating eucalyptus oil into phenolic additive systems enhances not only the viscosity characteristics but also the low-temperature behavior of the fuel blends, including crystallization and clouding properties.

Overall, the tabulated results clearly demonstrate that the combined use of phenolic-type additives and eucalyptus oil substantially improves the operational performance of the B10 fuel blends, particularly under low-temperature conditions.

CONCLUSION

In conclusion, it should be noted that, compared with conventional diesel fuel, the B10 fuel blends containing phenolic-type additives exhibit superior operational properties. Therefore, the use of such fuel formulations in diesel engines can contribute to improved compliance with environmental standards and may serve as a viable alternative energy source.

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