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Features of obtaining diesel fuels with the involvement of components of synthetic origin

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ABSTRACT: The article presents the state and prospects for the production of diesel fuels with improved characteristics in the face of ever-increasing demand and tightening of modern requirements for the quality of diesel fuels. The place and role of alternative non-petroleum raw materials and components in solving the issues of increasing the production of diesel fuels and improving their environmental and operational properties are shown. Studies have been carried out related to the development of the composition of environmentally friendly diesel fuel corresponding to the EURO-5 and EURO-6 classes by introducing diesel fraction of synthetic origin into the base hydrotreated diesel fuel of oil refineries according to the Fischer-Tropsch method. It is shown that the preparation of blended compositions of diesel fuels based on petroleum diesel fuel of the diesel fraction of the GTL process will allow, along with the improvement of environmental and operational properties, to significantly increase the resources for the production of environmentally friendly diesel fuels.

KEY WORDS: diesel fuel, alternative raw materials, GTL technology, synthetic diesel fraction, compounding.

I. INTRODUCTION

In the context of the global trend of gradual depletion of oil reserves and an increase in the level of consumption of diesel fuels, the relevance and prospects of finding ways to expand raw materials for the production of diesel fuels and, above all, through the use of alternative non-petroleum types of raw materials are increasing. Along with this, at the same time, the requirements for the quality of diesel fuel are increasing, which must meet the ever-increasing stringent requirements of modern standards, including the content of sulfur and polycyclic aromatic hydrocarbons.

II. REFERENCE INFORMATION

In recent years, one of the most studied promising alternative fuels or fuel components for diesel engines are biofuels derived from vegetable oils, which is due to the possibility of improving the environmental properties of the resulting diesel fuels [1, 2].

However, the use of biodiesel fuels causes a number of difficulties associated mainly with the relatively high cost of such biofuels, their increased viscosity and coking capacity, and low oxidation stability [3].

At the present stage of development of gas chemical processes in the republic, one of the potential promising components for the production of environmentally friendly diesel fuels is the use of synthetic distillate fractions of the process of converting natural gas into liquid synthetic products, called gas-to-liquids (GTL) technology [4, 5]. One of the main products of the GTL production process is a synthetic diesel fraction, which is characterized by a practically absence of sulfur and polycyclic aromatic hydrocarbons, which is very important due to the presence of severe restrictions on their content in modern environmentally friendly diesel fuels, an increased content of paraffinic hydrocarbons. At the same time, the synthetic diesel fraction GTL has a more improved cetane number - more than 70 points versus 55 - for diesel fuel obtained by hydrotreatment of the diesel fraction of petroleum origin [4].

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III. SCOPE OF RESEARCH

This circumstance makes it relevant and dictates the need for scientific research aimed at studying the possibility of using GTL synthetic diesel fraction as an additional alternative component for the preparation of composite environmentally friendly diesel fuel based on traditional hydrotreated diesel fuel of the oil refining industry.

IV. METHODOLOGY

With this in mind, we have studied the possibility of using the GTL diesel fraction as part of a composite diesel fuel with hydrotreated diesel fuel and optimizing the composition of such diesel fuel with the development of an estimated dependence to determine the limiting quantitative content of the GTL diesel fraction in the composite diesel fuel.

Hydrotreated diesel fuel from the Bukhara Oil Refinery and the diesel fraction of the Uzbekistan GTL plant were chosen as the objects of study, the main physical and chemical properties of which are presented in Table. 1.

As can be seen from Table 1, a distinctive feature of the GTL synthetic diesel fraction is a relatively lighter fractional composition, lower density and kinematic viscosity, improved values of cetane index and filterability limit temperature, as well as a significantly lower content of sulfur and polycyclic aromatic hydrocarbons.

At the same time, the lubricity index, equal to 507 microns, exceeds the value of the norm established for commercial diesel fuel with a value of no more than 460 microns, which is due to the high content of saturated hydrocarbons in the GTL diesel fraction.

With this in mind, the maximum possible amount of added GTL diesel fraction in hydrotreated diesel fuel was evaluated by the lubricity index of the blended fuel, which was determined according to ASTM D 6079.

Table. 1. Basic physical and chemical properties of hydrotreated diesel fuel and GTL diesel fraction

№	The name of indicators	Hydrotreated diesel fuel	Diesel fraction GTL
1	Density at 20 °C, kg/m3	829,1	760,4
2	Cetane index	54,9	71,4
3	Fractional composition, distilled: at a temperature of 250 °C,% vol. at a temperature of 350 °C,% vol. 95% at temperature, °C	 36 93 360	 52 - 327
4	Limiting filterability temperature, °C	minus 7	minus 15
5	Kinematic viscosity at 40 °C, mm^2/s	3,1	2,4
6	Mass fraction of sulfur, mg/kg	5,2	0,054
7	Corrosion of a copper plate (3 hours at 50 °C, unit on a scale)	1a	1a
8	The content of polycyclic aromatic hydrocarbons, % wt.	4,7	0,11
9	Lubricity: adjusted wear scar diameter (wsd 1.4) at 60°C, mm	413	507

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V. RESEARCH RESULTS

The dependence of the change in the lubricity of mixed diesel fuel on the content of the GTL diesel fraction is shown in Fig. 1.

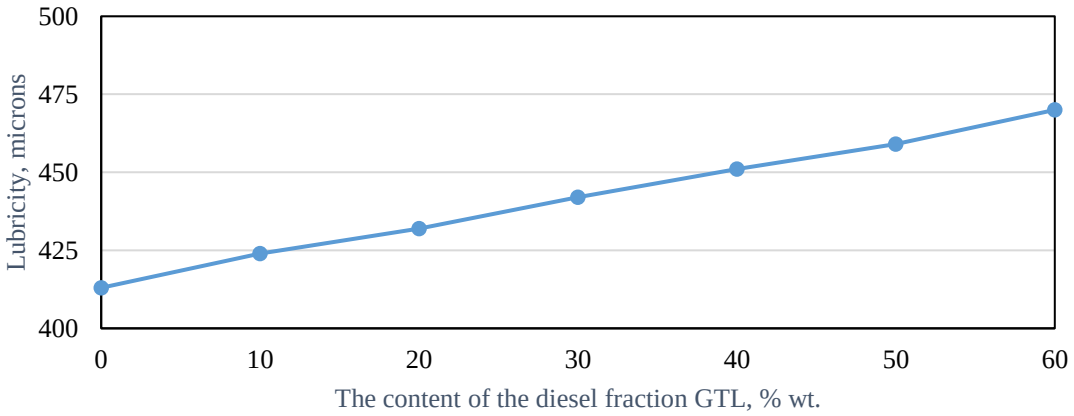

Fig. 1. Influence of the content of the GTL diesel fraction on the change in the lubricity of composite diesel fuel

As can be seen, in order to ensure the regulated values of Ts 16472899-044:2020 for the lubricity of diesel fuel, the maximum allowable amount of the GTL diesel fraction in the composition of the composite environmentally friendly diesel fuel is no more than 51%.

With this in mind, a sample of mixed diesel fuel was prepared, including 50% wt. hydrotreated diesel fuel and 50% wt. diesel fraction GTL. For the prepared sample, a complete analysis of the physicochemical properties was carried out in accordance with the requirements of the Ts 16472899-044:2020 standard, which is presented in Table 2.

Table 2. Physical and chemical parameters of a sample of environmentally friendly diesel fuel containing 20% of the GTL diesel fraction

№	The name of indicators	Value according to Ts 16472899-044:2020	Mixed diesel fuel
1.	Cetane number, not less than	51	57
2.	Cetane index, not less than	46,0	62
3.	Density at 20°C, kg/m^3, max	860	797,1
4.	Fractional composition, distilled: at a temperature of 250 ° C,% vol. less at a temperature of 350 ° C,% vol. at least 95% at temperature, °C, not less	 65 85 360	 46 93 356
5.	Mass fraction of water, mg/kg	200	69
6.	Limiting filterability temperature, °C, not higher	minus 5	minus 14
7.	Coking capacity 10% residue, wt %, not more than	0,3	0,01
8.	Ash content, % (mass fraction)	0,01	0,001
9.	Mass fraction of sulfur, mg/kg, no more	10	3,2
10.	Corrosion of a copper plate (3 hours at 50 °C), unit on a scale	Класс 1	1a
11.	Kinematic viscosity at 40 °C, mm^2/s	2,0-4,5	2,7
12.	Flash point, determined in a closed crucible, °C, not lower	55	61
13.	Mass fraction of polycyclic aromatic hydrocarbons, %, max	8,0	3,8
14.	General pollution, mg/kg, no more	24	9,1

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15.	Oxidative stability: - total amount of sludge g/m3, not more than - hours, not less	 25 20	 7,4 20
16.	Volume fraction of methyl esters of fatty acids, %, max	7,0	0,13
17.	Lubricity: corrected wear scar diameter (wsd 1.4) at 60°C, mm, max	460	459

VI. CONCLUSION

As can be seen from the table, this sample of composite diesel fuel fully meets the requirements of the domestic standard Ts 16472899-044:2020 for environmentally friendly Euro 5 diesel fuel, it has improved environmental characteristics due to a significantly lower content of sulfur and polycyclic aromatic hydrocarbons compared to the established values of the current standard .

VII. RECOMMENDATION

At the same time, the ratio of components of petroleum and synthetic origin in the composition of composite diesel fuel is proposed to be determined by calculation based on the actual indicators of the diameter of the wear scar of the original components used.

Thus, the use of GTL diesel fraction as an additional component involved in the composition of composite diesel fuel can significantly expand production resources, as well as significantly improve the environmental and operational properties of environmentally friendly diesel fuels. At the same time, the permissible limiting amount of GTL diesel fraction involved in composite diesel fuel can be determined by the proposed calculation method.

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- study of the characteristics of the composition and properties of distillate fractions obtained in the GTL process;
- development and production of composite motor fuels with improved environmental and operational properties using synthetic distillate fractions of the GTL process as additional components;
- development of criteria for optimizing the composition of composite motor fuels based on components of petroleum and synthetic origin by the Fischer-Tropsch method.

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- development and implementation of innovative technologies for the production of petrochemical products with high added value;
- expansion of resources and improvement of the quality of oil and gas processing products;
- production of composite motor fuels based on diesel fuels of the oil refining industry and alternative raw materials of non-petroleum and synthetic origin of the GTL process.