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Features of the properties of the GTL synthetic gasoline fraction and its use in the production of motor gasoline

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ABSTRACT: The aim of the work is to study the possibility and feasibility of the production of motor gasoline using as an additional component in its production a synthetic gasoline fraction of the GTL process. A complex of experimental studies was carried out to study the features of its basic physical and chemical properties, operational characteristics and hydrocarbon composition (capillary gas chromatography method) and it was shown that the GTL gasoline fraction does not contain aromatic hydrocarbons, including benzene, and is characterized by the almost absence of sulfur. The possibility of using GTL gasoline fraction as an environmentally friendly component in the preparation of commercial motor gasoline with improved characteristics is shown.

KEY WORDS: gasoline fraction GTL, GTL process, motor gasoline, compounding, recipe.

I. INTRODUCTION

In the light of the emerging steady trend of continuous growth in the consumption of automotive fuels, as well as the tightening of quality requirements for the resulting motor gasolines, especially their environmental characteristics, promising areas of research are the search for new ways and means of obtaining them and expanding raw materials for the production of motor gasolines. This circumstance causes an ever-increasing worldwide interest in the development of technologies for the production of synthetic liquid hydrocarbons [1, 2].

II. REFERENCE INFORMATION

One of the promising directions for solving the issues of increasing production volumes and improving the quality of motor gasolines obtained is the use of GTL synthetic gasoline fraction as an alternative additional component in their production. However, its peculiarity is the group chemical composition, characterized by a significant content of paraffinic hydrocarbons [3, 4], which causes low antiknock properties of the synthetic gasoline fraction and creates difficulties for the direct production of commercial gasoline from it.

III. SCOPE OF RESEARCH

In this regard, conducting scientific research aimed at studying the possibility of using GTL synthetic gasoline fraction as an additional alternative component for the preparation of commercial motor gasolines based on traditional base gasolines from oil refineries, obtaining such motor gasolines of the optimal composition with the development of criteria for determining the maximum content of gasoline fractions GTL in the composition of gasoline mixtures is relevant and in demand.

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IV. METHODOLOGY

Therefore, for a comprehensive assessment of the studied option of involving the GTL synthetic gasoline fraction in the composition of motor gasoline of petroleum origin, it is necessary to take into account the features of its group chemical composition and the effect of its composition on the quality indicators of commercial gasoline.

To this end, in accordance with ASTM D 6729, a chromatographic analysis of the synthetic gasoline fraction of the Uzbekistan GTL plant was carried out by high-resolution capillary gas chromatography, which, along with the base gasoline of the Bukhara refinery (a mixture of reformate, light and heavy straight-run gasoline fractions), was used in as the objects of this study - the initial components in the preparation of commercial blended motor gasoline brand AI-80.

V. RESEARCH RESULTS

The data obtained on the group hydrocarbon composition of the GTL gasoline fraction in comparison with the petroleum gasoline fraction are given in Table. 1.

Table 1. Group hydrocarbon composition of the gasoline fraction of synthetic and petroleum origin

Gasoline fraction	*n-alkanes*	Isoalkanes	Olefins	Naphthenes	Arenas
Oil	26,0	31,0	4,7	22,1	16,2
Synthetic GTL	71,2	27,6	0,05	0,99	0,21

As can be seen from the table, the composition of the GTL gasoline fraction is significantly different from the petroleum gasoline fraction. The content of paraffinic hydrocarbons is more than 98%, and the content of olefinic, naphthenic and aromatic hydrocarbons is significantly low compared to the petroleum gasoline fraction, while benzene is absent.

Undoubtedly, such a difference in the group hydrocarbon composition of the GTL gasoline fraction is of interest in studying its effect on the properties of synthetic gasoline fractions and the obligatory consideration of the results of such a study in the preparation of blended commercial gasolines involving gasolines of synthetic origin.

With this in mind, studies were carried out to determine the main physicochemical properties of the GTL gasoline fraction (Table 2).

Table 2. Basic physical and chemical properties of GTL gasoline fraction

№	The name of indicators	Values
1	Knock resistance: research octane number	 22
2	Density at 15°C, kg/m3	691,2
3	Fractional composition, °C the beginning of the boil 10% 50% 90% end of boil volume fraction of the residue in the flask, % balance and losses, % (by volume)	 36 64 112 157 178 1,2 4,0
4	Saturated vapor pressure of gasoline, kPa	57,9
5	Volume fraction of benzene, %	0
6	Mass fraction of sulfur, ppm	3
7	Copper plate test	withstands
8	Content of water-soluble acids and alkalis, %	absent
9	Content of mechanical impurities and water, %	absent

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As can be seen from the table, the synthetic gasoline fraction in terms of density, fractional composition, saturated vapor pressure, etc., is similar to the indicators of traditional gasoline, which shows the possibility and promise of using the synthetic gasoline fraction of the GTL process as a blended component of motor gasolines.

It should also be noted that a distinctive feature of the GTL synthetic gasoline fraction is the absence of sulfur and benzene in its composition, the presence of which is strictly limited in the composition of modern motor gasoline. This circumstance is an undoubted advantage of the GTL gasoline fraction over other components of commercial motor gasolines and will contribute to a significant improvement in the environmental characteristics of motor gasolines, bringing them up to the 5th environmental class and above.

At the same time, a high content of paraffins and a relatively low content of aromatic hydrocarbons determine the low octane characteristics of the synthetic gasoline fraction. Its octane number, determined by the research method, is up to 25 points. This circumstance limits the content of the GTL gasoline fraction in the composition of blended motor gasolines and should be taken into account as the main criterion in calculations to determine the limiting share of the GTL synthetic gasoline fraction in the composition of blended motor gasolines.

Therefore, the octane index is limiting or restricting the maximum allowable content of synthetic gasoline fraction in blended gasoline. At the same time, the limiting maximum content of the GTL synthetic gasoline fraction in the composition of the base gasoline can be calculated based on the effective or maximum possible octane number of the base gasoline. Based on this, the calculated limiting content of the GTL synthetic gasoline fraction in the composition of the studied base gasoline equal to 95-96 points will be within no more than 20% wt. to base gasoline.

With this in mind, a sample of blended automotive gasoline AI-80 was prepared based on the base gasoline of the Bukhara Oil Refinery and the synthetic gasoline fraction of the Uzbekistan GTL plant, including 64% wt. reformate, 22% light and 4% heavy gasoline fraction, and 10% wt. synthetic gasoline fraction GTL. For the prepared sample, a complete analysis of the physicochemical properties was carried out in accordance with the requirements of the state standard O'zDSt 3031:2015. The research results are presented in Table 3.

Table 3. Physical and chemical properties of AI-80 blended motor gasoline containing GTL synthetic gasoline fraction

№	The name of indicators	O'zDSt 3031:2015 requirements for AI-80 gasoline	Blended gasoline
1.	Detonation resistance: Octane number: according to the research method according to the motor method	 at least 80.0 at least 76.0	 82,2 76,2
2	Density at 15°C, kg/m^3	at least 725	750,8
3	Fractional composition,^{0}C the beginning of the boil, not below 10%, not higher 50%, not higher 90%, not higher end of boil, not higher volume fraction of the residue in the flask, % balance and losses, % (by volume)	 35 75 120 190 215 2,0 4,0	 37 56 95 151 179 1,4 4,0
4	Pressure of saturated vapors of gasoline, kPa, no more	66,7	59,1
5	Volume fraction of benzene, %, no more	5	4,9
6	Mass concentration of resins washed with solvent, mg/kg, not more	5	1
7	Induction period, min.,		

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	at least	450	1021
8	Mass fraction of sulfur, mg/kg, no more	500	0,012
9	Copper plate test (3 hours at 50°C)	Class I	1a
10	Content of water-soluble acids and alkalis, %	absent	absent
11	Content of mechanical impurities and water, %	absent	absent
12	Appearance	Pure transparent	Pure transparent
13	Mass concentration of manganese. mg/dm3, no more	absent	absent
14	Mass concentration of iron, g/dm3, no more	absent	absent
15	Mass concentration of lead, mg/dm3, no more	10	absent

VI. CONCLUSION

As can be seen from the table, the resulting sample of blended gasoline fully meets the requirements of the state standard O'zDSt 3031:2015 for AI-80 motor gasoline and has improved environmental characteristics due to a significantly lower sulfur content - its content is 0.012 ppm, against no more than 500 ppm according to the standard, or 600 times less than the values of the standard, and also due to the absence of benzene in the composition of the GTL synthetic gasoline fraction involved in the base gasoline of petroleum origin. Along with this, blended gasoline has improved indicators, for example, antioxidant stability - the induction period of gasoline is almost 3 times less compared to the requirement of the current standard.

To find the amount of an additional component involved in the composition of blended gasoline in the form of a synthetic gasoline fraction GTL, you can use the calculated ratio in terms of octane numbers:

$$G_{mg} = (O_{cg} G_{cg} – O_{bg} G_{bg}) / O_{sg}$$

where G_{mg} is the amount of GTL synthetic gasoline fraction in blended motor gasoline, G_{cg} and G_{bg} are the amount of commercial and base gasoline, O_{cg}, O_{bg} and O_{sg} are the values of octane numbers of commercial, base gasoline and GTL synthetic gasoline fraction, respectively.

VII. RECOMMENDATION

Consequently, the synthetic gasoline fraction of LTL is a valuable component of commercial motor gasoline, which has improved environmental performance due to the almost absence of sulfur and aromatic hydrocarbons in its composition. At the same time, the permissible limiting amount of the GTL synthetic gasoline fraction involved in the base gasoline can be determined by calculation in terms of the octane characteristics of the base gasoline and synthetic gasoline fraction

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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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- 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.