OPTIMIZATION OF THE COMPOSITION AND PROPERTIES OF GASOLINES TO MEET THE REQUIREMENTS OF EURO-5/6

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ABSTRACT:

The article is devoted to the development of environmentally friendly composite gasolines that meet Euro-5/6 standards. The technologies for obtaining isomerized and oxygenate gasolines from olefins and gas condensates, as well as the processing of petrochemical waste, are considered. The proposed compositions improve the octane number and reduce harmful emissions, ensuring import substitution of additives and environmental efficiency.

INTRODUCTION. The growing requirements for the quality of motor fuels, caused by both the tightening of environmental standards and the need to improve the energy efficiency of internal combustion engines, pose the petrochemical industry with the task of profoundly improving the composition of gasolines. Euro-5 and Euro-6 are not just regulations, but sustainable development guidelines that require minimizing emissions of sulfur compounds, benzene, aromatic hydrocarbons and other toxic substances. Of particular importance is the increase in the oxygen index and octane number without the use of environmentally harmful additives.

The problem is becoming especially relevant for countries with a growing vehicle fleet and limited access to modern oil refining technologies. This requires the development of universal and affordable solutions based on the use of local raw materials, including gas condensate fractions, hydrocarbon waste and polyethylene processing products. Such a strategy combines economic benefits and compliance with global environmental trends.

This study examines the methods for producing gasoline compositions using components produced from gas condensate, unsaturated hydrocarbons and polyethylene waste.

Catalytic processes for obtaining components of environmentally friendly gasoline One of the promising areas in the development of high-octane environmentally friendly fuels is the catalytic trimerization and tetramerization of monoolefins from the homologous series to C_5, including compounds such as ethylene, propylene, butylenes and amylenes. These unsaturated hydrocarbons are by-products of petrochemical processes and gas processing, which makes them an accessible and economically attractive raw material.

The polymerization process is carried out using a boron trifluoride (BF_3) catalyst in an acidic medium. The uniqueness of this method lies in the possibility of carrying out the reaction in relatively mild conditions - a temperature of 160-220 °C and a pressure of 8-10 atm., which reduces energy costs and increases economic efficiency. As a result, a high degree of conversion is achieved - up to 70%, and the resulting product is a gasoline isomerizate with a molecular weight of isohydrocarbons of 150-160 g / mol, possessing high antiknock properties.

These isomerized hydrocarbons are used as important components in gasoline compositions that increase the octane number and improve the environmental characteristics of the fuel. The use of such processes allows for a reduction in the content of aromatic hydrocarbons and an improvement in the flammability of the fuel, which is especially important in the context of Euro 5/6 requirements.

Another important technology is the **production of high-octane gasoline** oxygenate-gasoline based on gas condensates. In this case, a wide fraction of light hydrocarbons is used, which is oxidized by atmospheric oxygen in the presence of an acid catalyst. As a result, complex oxidation processes occur, leading to the formation of oxygen-containing compounds: alcohols, aldehydes, ethers and ketones.

The use of oxygenate gasolines allows to significantly improve the oxygen index of fuel, promoting more complete combustion of gasoline in internal combustion engines. This not only increases energy efficiency, but also significantly reduces emissions of carbon monoxide (CO), hydrocarbons (HC) and solid particles, which makes such gasolines especially valuable in terms of compliance with environmental standards. In addition, this direction plays an important role in the import substitution of traditional additives, such as isoesters, reducing dependence on external supplies.

Use of gas chemical by-products: the example of the Shurtan Gas Chemical Complex

Olefin name	Chemical formula	Output, % in terms of "Green oil"	Gas volume, t/year	Properties of the obtained olefins		
				d_4^{20}, kg/m^3	T boiling point, °C	Bromine number
Ethylene	C_2H_4	4.09	232.0	5.7	-103.7	85.1
Propylene	C_3H_6	28.7	2752,0	5.1	-47.7	79.2
Butylenes	C_4H_8	23.8	488.4	5.95	-6.3	74.0
Butadiene	C_4H_6	41.0	2034.7	5.88	-9.1	42.7

Special attention in modern developments is paid to the secondary use of gas waste. Thus, at the Unitary subsidiary of gas chemical complexes "GKhK" during the production of ethylene, about 8.6 thousand tons of a by-product known as "Green oil" are formed annually. This substance is a complex mixture enriched with valuable olefin components such as ethylene, propylene, butylenes and butadiene.

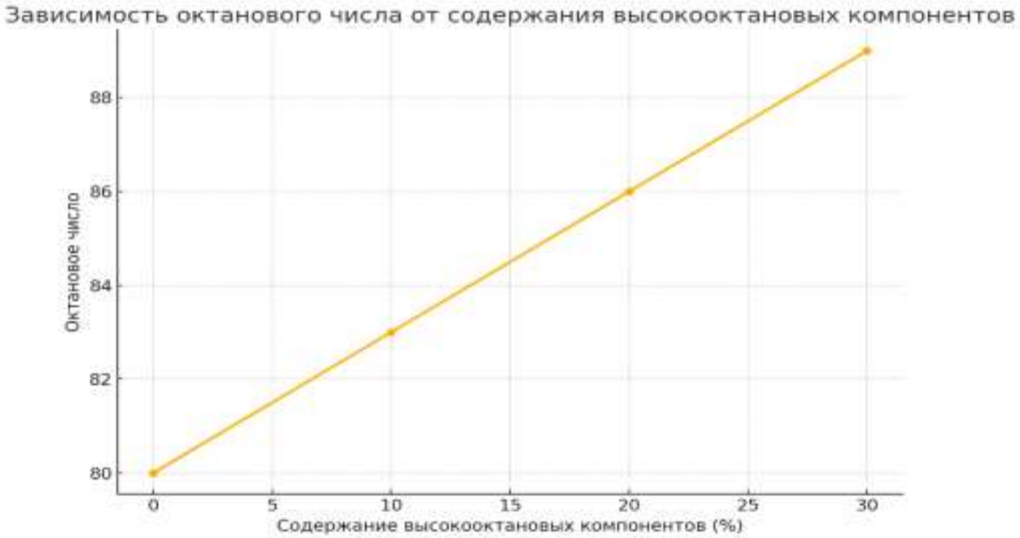
Name of fractions	Properties					
	Gross composition	Wed. g/mol.	Output, % wt.	Physicochemical parameters		
				d_4^{20}, кг/м^3	n_D^{20}	O.C.
Alkylate (gas) gasoline	From $_4$ to $_8$	116	26-28	710-720	1,13884	88.6 ÷94.0
Polymer gasoline	From $_6$ to $_{12}$	164	34-38	770-771	1,4125	83.6 ÷88.4
Low molecular weight polyethylene	From $_{12}$ and up	220-5000	34-37	895-920	Viscous white solution	—

These components are not only potential feedstocks for the synthesis of motor fuels, but are also key semi-finished products in the chemical industry, including the production of plastics, resins, synthetic rubbers, solvents and other organic compounds. Their processing allows:

- effectively dispose of industrial waste;
- reduce emissions into the atmosphere;

- reduce the cost of obtaining fuel components;
- ensure sustainable development of petrochemical complexes.

Thus, the integration of such catalytic and processing processes into petrochemical production not only solves environmental problems, but also contributes to the creation of highly efficient fuels that fully comply with the requirements of Euro-5 and Euro-6.



Chemical processes and raw material sources Trimerization and tetramerization of olefins (C_2-C_5) on a BF3 catalyst in an acidic medium at a temperature of 160-220 °C and a pressure of 8-10 atm. lead to the production of high-octane isomerizate. Similarly, alkylate gasoline was synthesized from "green oil" - a by-product of ethylene production at the Shurtan Gas Chemical Complex. The obtained fractions, including C_4-C_8 and C_6-C_{12}, were characterized by a high octane number (up to 94) and appropriate physicochemical properties.

Polyethylene waste, also generated at this enterprise, is a valuable resource for obtaining polymer gasoline. The use of such waste allows not only to improve the properties of the final product, but also to solve the problems of recycling secondary raw materials.

Formation of composite gasoline compositions Based on the above-described components, various gasoline composites were made, corresponding to the A-76, AI-80 and AI-93 grades. Their composition included:

- straight-run gasoline from gas condensate (25-35%),
- reformed gasoline from the Bukhara Oil Refinery (35-50%),
- isomerized and alkylated gasolines (15-25%),
- oxygenate-gasoline (5-10%).

Such compositions demonstrate improved viscosity, density, refractive index and surface tension, and also comply with Euro 5/6 standards. It is especially important that these mixtures can be adapted to the existing production capacities of oil refineries, which simplifies their industrial implementation.

Applied value and industrial implementation The results of the work performed have a pronounced applied focus. The obtained gasoline compositions were tested in a pilot plant, which allowed us to evaluate their behavior during real operation in ICEs (internal combustion engines). In particular, composites with the addition of oxygenates and alkylates demonstrate stability during combustion, reduced NOx and CO emissions, and improved ignition in cold conditions.

In addition, the technology allows for the efficient processing of low-molecular polyethylene waste, which is relevant in the context of environmental sustainability and closed cycles of raw material processing. This solution opens up prospects for the integration of polymer processing into regional fuel clusters.

Physicochemical characteristics of composites As a result of the tests, the following characteristics were obtained:

Name of the indicator	Gasoline condensate compound		
	A -76	AI-80	AI-93
Specific gravity,	775	765	760
Refractive index	1.4885	1.4825	1.4690
Viscosity, cPs	43.7	36.2	34.5
Surface tension	36.2	31.5	32.0
Color	Yellow	Light	Light

Conclusions. The use of technological solutions based on the use of domestic raw materials and petrochemical waste allows obtaining gasolines that fully comply with the requirements of Euro-5/6. The resulting gasoline composites provide not only environmental friendliness, but also high operational efficiency, making them promising for wide industrial implementation.

References:

1. **GOST R 51866-2002** . Automotive fuel. Unleaded gasolines. Technical conditions. — M.: Standartinform, 2003.
2. Efremov A.A., Kozlov A.N. *Modern components of motor gasolines* . - M.: Chemistry, 2012.
3. Dyakonov A.L., Nefedov A.V. *Catalytic processes for processing hydrocarbon raw materials* . - St. Petersburg: Nedra, 2010.

4. Alimov A.A. *Development and study of environmentally friendly gasoline compositions* . // Bulletin of the chemical industry of Uzbekistan. - 2020. - No. 4. - P. 35-41.
5. Isaev A.N., Shirokov V.A. *Catalysis in petrochemistry: theory and practice* . - M.: LKI, 2016.
6. Directive 2009/30/EC of the European Parliament and of the Council of 23 April 2009. *Quality of petrol and diesel fuels and the introduction of a mechanism to monitor and reduce greenhouse gas emissions* .
7. Technical Regulations of the Customs Union TR CU 013/2011. *On requirements for automobile and aviation gasoline, diesel and marine fuel, jet fuel and fuel oil* .