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SOME ASPECTS OF SELECTING ADDITIVES AND OCTANE-LIKE FUEL ADDITIVES

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Annotation. The guarantee of long-term efficient, reliable, and economical operation of a carburetor or injector engine is the detonation resistance of gasoline.

Keywords: octane, benzin, temperature, dehydrocyclization, antidetonation, benzins, alkanes, dehydroisomerization of alkylcyclopentanes

Annotatsiya. Karburator yoki injektor dvigatelining uzoq muddatli samarali, ishonchli va tejamkor ishlashining kafolati benzinning portlash qarshiligidir.

Kalit so'zlar: oktan, benzin, harorat, degidrosiklizatsiya, antidetonatsiya, benzinlar, alkanlar, alkilsiklopentanlarning degidroizomerizatsiyasi

Аннотация. Гарантией длительной эффективной, надежной и экономичной работы карбюраторного или инжекторного двигателя является стойкость бензина к детонации.

Ключевые слова: октановое число, бензин, температура, дегидроциклизация, антидетонирование, бензины, алканы, дегидроизомеризация алкилциклопентанов

INTRODUCTION.

Obtaining high-octane gasoline with octane numbers of 92, 93, 95, and 98 from oil is quite difficult and expensive. There are two methods for increasing the octane number of gasoline: chemical processing - these processes of reforming, platforming, isomerization, destructive hydrogenation, etc., which require enormous capital expenditures. Increasing the octane number of gasoline is achieved by chemical processing of petroleum distillates through reforming, platforming, and hydroforming processes.

To obtain high-octane gasoline components from low-octane oil fractions, the latter are subjected to catalytic reforming, straight-run gasoline or cracking gasoline boiling within 80-1800C is used.

In addition to dehydrogenation and dehydrocyclization reactions, isomerization, destructive hydrogenation, and compaction reactions also occur during catalytic reforming. As reforming catalysts, mainly aluminum-platinum

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catalysts with a content of 0.5 to 0.7% or aluminum-molybdenum catalysts with a MoO3 content of 10.0% and Al2O3 content of 90.0% are used, and the process is carried out at temperatures of 450-5300C, a pressure of 1.4 to 7.0 MPa, and a volumetric rate of 1.0 to 6.0

Based on numerous experimental data, it was established that the anti-knock resistance of motor gasolines depends on which groups of hydrocarbons and in what quantities they contain. Alkanes with a normal structure have the lowest detonation resistance. There is an almost linear relationship between the detonation resistance of normal alkanes and their molecular weight: the smaller the molecular weight, the greater the detonation resistance. Branching of alkanes rarely increases their detonation resistance.

The simplest aromatic hydrocarbons of the benzene series have the highest octane numbers.

The following processes contribute to increasing the octane number of gasolines during catalytic reforming:

1. Formation of aromatic compounds during dehydrogenation of six-membered cycloparaffins and dehydroisomeration of alkylcyclopentanes.

Of all the hydrocarbon classes included in automobile gasolines, normal alkanes have the lowest detonation resistance. With an increase in the number of carbon atoms in the alkane chain, their detonation resistance decreases. The transition from a normal chain to an isomeric structure is always accompanied by an improvement in the antidetonation properties of alkanes. However, for isomeric alkanes, the above dependence persists as the number of carbon atoms in the straight chain increases and the detonation resistance of the isoalkane hydrocarbon molecule decreases. Increasing the degree of branching of the molecule, compact and symmetrical arrangement of methyl groups, and bringing them closer to the center of the molecule contribute to increasing the detonation resistance of isoalkanic hydrocarbons. The table shows the octane numbers of some hydrocarbons.

Table 1.

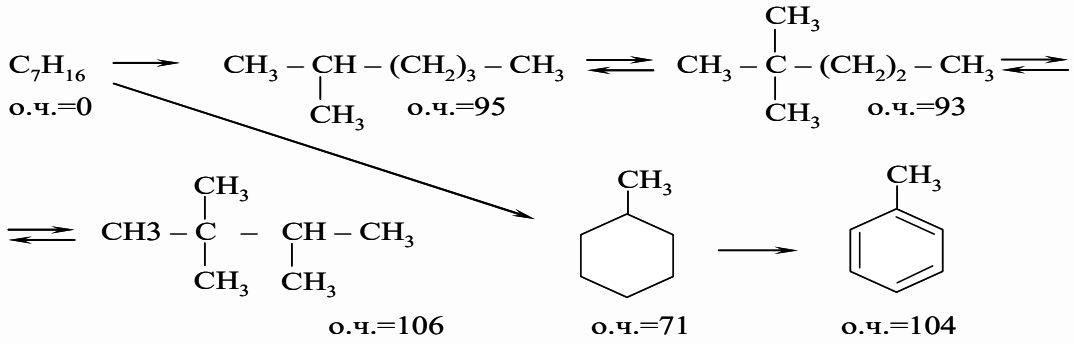
Oxane number of hydrocarbons.

Hydrocarbons	Octane number (MM).
н– heptane	0
2,2,3 – trimethylbutane	106
2,2– dimethylpentane	93
2,3– dimethylpentane	89
2,4– dimethylpentane	82
3,3– dimethylpentane	84

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2,2,4– trimethylbutane	100
2– methylhexane	95
3– methylhexane	65
cyclocexane	77
methylcyclohexane	71
methylcyclohexane	73
ethylcyclopentane	59
benzene	108
toluene	104

The aromatization reaction of paraffins, discovered by scientists B.A. Kazansky and A.F. Plat, B.A. Moldavskiy, G.D. Kolusher, and others simultaneously and independently in three laboratories, is a major event in petrochemistry and oil refining. According to this reaction, based on normal and iso-structured alkanes, various hydrocarbons can be obtained, the octane number of which is sharply different from the initial one, for example:



The process of aromatization of alkanes has now found wide application in oil refining. (reforming, platforming, isomerization, etc.)

Ethylene hydrocarbons have higher anti-knock properties than normal alkanes with the same number of hydrocarbon atoms. The influence of the structure of ethylene hydrocarbons on their detonation resistance follows approximately the same patterns as in alkanes. The detonation resistance of ethylene hydrocarbons increases as the chain length decreases, the degree of branching increases, and the compactness of the molecule increases.

The best anti-knock properties are possessed by ethyl hydrocarbons, in which the double bond is located closer to the center of the carbon chain.

Among alkadienes, double hydrocarbons with conjugate arrangement have higher detonation resistance.

The detonation resistance of naphthenic hydrocarbons is higher than that of normal hydrocarbons, but lower than that of aromatic hydrocarbons with the same number of carbon atoms in the molecule (table). The decrease in detonation

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resistance of five- and six-membered naphthenic hydrocarbons does not differ significantly. However, the carbohydrates in the molecule differ significantly.

Aromatic hydrocarbons have high detonation stability. Unlike other classes of hydrocarbons, with an increase in the number of carbon atoms, the molecule does not decrease; a decrease in the length of the side chain and an increase in branching improve the detonation resistance of aromatic hydrocarbons.

The appearance of double bonds in the side chains and the symmetrical arrangement of alkyl groups also lead to a similar effect.

Practical aspects of selecting octane-enhancing additives

When selecting additives for commercial gasoline, it is not enough to consider only the numerical increase in the octane rating. The additive must also be compatible with the hydrocarbon composition of the base gasoline, with the operating conditions of the engine, and with environmental and technical requirements. In practice, refinery technologists evaluate the fractional composition, content of aromatic and olefinic hydrocarbons, vapor pressure, sulfur content, gum formation tendency, and oxidation stability. These parameters determine whether the additive will improve fuel quality without creating secondary problems such as deposits, corrosion, increased exhaust toxicity, or instability during storage.

Octane-enhancing components can be conditionally divided into oxygen-containing compounds, aromatic components, organometallic compounds, and multifunctional additive packages. Oxygen-containing compounds, including alcohols and ethers, usually increase the octane number because oxygen in the molecule promotes more complete combustion and changes the rate of flame propagation. However, their use requires control of water solubility, phase stability, volatility, and material compatibility. For example, fuels containing alcohols may absorb moisture from the atmosphere, and this may cause phase separation under unfavorable storage conditions. Therefore, the selection of such components must be accompanied by laboratory tests that simulate transportation and storage.

Aromatic hydrocarbons have high octane numbers, and for this reason they are important components of high-octane gasoline fractions. At the same time, excessive aromatics content is undesirable because it can increase soot formation, deposit accumulation in the combustion chamber, and the concentration of toxic compounds in exhaust gases. Thus, the technological task is not simply to increase the amount of aromatic hydrocarbons, but to find a balanced composition in which detonation resistance, engine cleanliness, fuel economy, and environmental indicators are maintained within acceptable limits. In this regard, catalytic

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reforming remains one of the main industrial methods for obtaining high-octane components, but the final fuel formulation requires careful blending.

Organometallic antiknock additives historically played an important role in increasing gasoline octane number. Tetraethyl lead was especially effective, but its high toxicity and negative influence on exhaust gas treatment systems led to severe restrictions and a gradual transition to lead-free gasoline. Modern practice therefore gives preference to less hazardous octane improvers and to technological processes that increase octane number through changes in hydrocarbon structure. This trend is important because the quality of motor fuel is now assessed not only by engine performance, but also by its influence on human health, urban air quality, and the service life of catalytic converters and oxygen sensors.

The effectiveness of any additive is usually evaluated through comparative tests. First, the octane number of the base gasoline is determined by standard research and motor methods. Then several trial blends are prepared with different concentrations of the additive. Each blend is analyzed for octane number, density, fractional composition, vapor pressure, corrosion effect on copper plate, gum content, sulfur content, and oxidation stability. If the additive provides a high octane response but worsens storage stability or increases corrosion activity, its practical value becomes limited. Therefore, the best additive is not necessarily the strongest one, but the one that provides a stable and economically justified improvement of the whole fuel quality system.

Economic and technological efficiency of additive use

From an economic point of view, additives are used when the increase in fuel quality compensates for the cost of the additive and the technological operations connected with its dosing, mixing, quality control, and storage. In refinery conditions, the decision is usually based on the comparison of several alternatives: deeper catalytic reforming, isomerization of light fractions, use of high-octane blending components, or direct introduction of an additive. Chemical processing methods may require large capital investments and energy costs, but they provide stable high-quality components. Additives, in contrast, may give a faster result and allow flexible correction of fuel properties, especially when the quality of the available gasoline pool changes during production.

The technological efficiency of additives is also connected with their dosage accuracy. Small deviations in concentration can lead either to insufficient octane improvement or to unnecessary cost increases. For this reason, modern blending systems use controlled dosing equipment, automatic mixers, and laboratory feedback. After blending, the finished gasoline must be homogenized, because uneven distribution of the additive may cause differences in quality

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between separate batches. In addition, safety rules must be strictly observed during storage and handling, since many additives are flammable, volatile, or chemically active substances.

A separate issue is the interaction between additives and engine fuel systems. Fuel injectors, filters, pumps, seals, and combustion chamber surfaces are sensitive to fuel composition. Some additives may improve cleanliness by reducing deposits, while others may increase the formation of insoluble products during long-term storage. Therefore, multifunctional additive packages are widely used. They may include detergent, antioxidant, anticorrosion, demulsifying, and anti-icing components. Such packages do not only increase detonation resistance, but also support stable fuel operation in different seasonal and climatic conditions.

For the conditions of Uzbekistan, including regions with hot summers and significant temperature differences during transportation and storage, the stability of gasoline blends is especially important. High ambient temperature can increase evaporation losses and change vapor pressure characteristics. Therefore, additives and blending components must be selected with regard to climatic factors, storage tank conditions, and the expected duration of fuel storage. A properly selected additive package helps preserve octane properties, prevents gum formation, reduces corrosion risk, and ensures more reliable engine operation in real exploitation conditions.

Recommendations for improving fuel quality control

To improve the reliability of high-octane gasoline production, it is advisable to introduce a systematic quality-control algorithm. At the first stage, the composition and properties of the base gasoline fraction are determined. At the second stage, possible additives are selected according to their octane response, compatibility, availability, environmental acceptability, and cost. At the third stage, experimental blends are prepared and tested under laboratory conditions. At the fourth stage, the most effective composition is checked during pilot blending and storage. Only after these stages can the additive be recommended for regular production use.

In addition, fuel quality monitoring should not be limited to the determination of octane number alone. The final gasoline must meet a complex set of indicators that characterize combustion quality, volatility, stability, safety, and ecological influence. Such an integrated approach allows refineries and fuel suppliers to reduce technological risks, increase product competitiveness, and provide consumers with gasoline that ensures efficient and reliable engine operation. Thus, the scientific and practical selection of octane-enhancing additives is an important direction in modern oil refining and petrochemical technology.

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