CHEMMOTOLOGY

RESPONSE OF HYDROCARBON FUELS TO LITHIUM-CONTAINING ANTIKNOCK COMPOUNDS


Organolithium compounds were investigated as chemical controllers of hydrocarbon combustion. The response of individual hydrocarbons of different classes, reference mixtures, naphtha cuts, and base compositions of commercial gasolines was investigated as a function of the concentration of lithium in them. The mechanism of action of lithium-containing antiknock compounds is proposed.

The use of antiknock additives is usually the simplest and least expensive way to increase the octane number of automotive gasolines [1, 2]. The effect of chemical combustion controllers of motor fuels on the processes that take place in internal combustion engines is a function of the group hydrocarbon composition of the fuel. The response of naphtha cuts (mixtures of hydrocarbons) from different industrial processes and individual hydrocarbons to the entire spectrum of existing antiknock compounds has been investigated in many studies, in [1-6] in particular.

The effect of organoelemental antiknock compounds on the antiknock rating of hydrocarbons of different classes was investigated in detail in [4-6]. It was found that the greatest response was exhibited by paraffins, a smaller response was exhibited by naphthenes, and olefins and aromatics had the smallest response.

A trend was detected for chemical combustion controllers of gasolines based on metals of variable valence: the lower the octane number (ON) of the gasoline or its basic component, the higher the antiknock effect of the additive. The results of the tests on a single-cylinder standard engine with variable compression (Vokesh method) and in full-scale engines in highway conditions show that the greatest increase in the ON is characteristic

Fig. 1. Effect of the concentration $c$ of lithium on the increase in the research octane number $\Delta RON$ of base compositions of automotive gasolines: 1) Regular-92 (AI-92); 2) Normal-80 (AI-80).
of straight-run naphthene–paraffin-base gasolines, a lower ON is characteristic of catalytic reforming and cracking gasolines, and the lowest ON is characteristic of gasolines with a high aromatic hydrocarbon content.

Organic derivatives of alkali metals are a new class of organoelemental combustion controllers for automotive gasolines [7]. It was found that lithium compounds exhibited the highest activity in testing on an UIT-85 in standard conditions. The response of naphtha cuts of different genesis, individual hydrocarbons, and commercial compositions to lithium-containing antiknock compounds is not known.

We investigated the effect of organic lithium compounds on the antiknock rating of base hydrocarbon compositions of the commercial gasolines Normal-80 (AI-80) and Regular-92 (AI-92) produced according to GOST R 51105 by Surgut Condensate Stabilization Refinery (CSR) on a standard UIT-85 setup according to GOST 511 and GOST 8826. These compositions, which have a RON of 77.1 and 88.2, respectively, contain reforming catalyzate, an isopentane cut, and IBP-70 and IBP-140°C straight-run naphtha cuts.

It was found that on addition of additives containing organolithium compounds to these base compositions, the antiknock rating of the compositions increased (Fig. 1). The required level was attained for an additive concentration of 0.0044 wt. % in terms of lithium.

Further studies were conducted with a concentration of antiknock compounds in the range of 0.002-0.004 wt. % (20-40 ppm), optimum both with respect to the real efficiency and with respect to the requirements of GOST R 51105.

The tests for the antiknock rating of a standard reference mixture of isooctane (90%) with n-heptane (10%) with ON = 90 (MON and RON) with different concentrations of lithium in them showed that the motor method is more sensitive to compounds of this metal in fuel than the research method (Fig. 2).

The data on the response of individual hydrocarbons and C₅-C₉ cuts, the most common in commercial gasolines, to lithium combustion controllers are shown in Table 1 and Fig. 3. The antiknock rating of paraffinic hydrocarbons increased most significantly, and the antiknock rating of aromatics increased the least. The

![Fig. 2. Effect of the concentration c of lithium on the increase in the octane number ΔON of a standard mixture of isooctane (90%) and n-heptane (10%): 1) MON; 2) RON.](image)

![Fig. 3. Effect of the concentration c of lithium on the increase in the octane number of individual hydrocarbons: 1) isoparaffins; 2) olefins or normal and isomeric structure; 3) naphthenes; 4) aromatics.](image)