CURRENT PROBLEMS

IMPROVING THE ENVIRONMENTAL AND PERFORMANCE PROPERTIES OF AUTOMOTIVE GASOLINES. Detergent Additives

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The environmental characteristics of the automobile and their conservation during use are directly dependent on the quality of the motor fuels used. For this reason, auto and fuel manufacturers use joint programs to solve environmental problems. Stiffening of the environmental requirements for automobile engines is forcing auto manufacturers world-wide to search for new technical solutions which ensure that the approved standards are satisfied. The composition of the exhaust gases is more rigorously regulated with the complicated design of vehicles and the increase in their power. Conserving fuel has become an important goal.

The development of neutralization systems became the most effective measure for reducing the toxicity of exhaust gases. The catalytic converter allows “detoxifying” up to 90% of the toxic substances [1]. However, for efficient operation of the system, the automobile must have a fuel injection system, since an ordinary carburetor does not ensure the stable, optimum composition of the mixture. The use of a fuel injection and distribution system in gasoline engines was an unconditional advance by auto manufacturers: improving fuel combustion increased the power of the vehicle while simultaneously reducing fuel consumption and the exhaust gas toxicity [2].

Autos with fuel injection began to be manufactured in 1980. Since 1990, more than 70% of auto engines abroad have been equipped with fuel injectors.

Approval of the emissions toxicity standards – Euro-3 and Euro-4 – required manufacturers to further improve the designs of automobile engines. The technical innovations included the preheating neutralizer, exhaust gas recirculation systems, etc. Beginning in 2000, use of on-board systems for diagnosis of gasoline engines became mandatory. Such systems can control emissions from a motor vehicle during its entire lifetime.

The progress in building auto engines constantly dictates new fuel quality requirements. In the entire world, the laws on environmental protection are providing for conversion to use of environmentally clean motor vehicles requiring the corresponding fuels.

Under the plan for developing domestic auto manufacture approved by the RF government, auto plants began manufacturing automobiles that satisfy the requirements of Euro-2 and Euro-3 in 2004. However, even after the new environmental requirements took force, the constant “exceptions from the rules” allow them to continue manufacturing obsolete products (Euro-0).

The Russian passenger auto fleet consists of 24 million units, and the annual increase is 0.9-1 million units. Despite such high growth rates, 50% of the vehicles are more than 10 years “old”, 31% are 5-10 years, and 19% are less than 5 years old. The proportion of passenger autos that satisfy the environmental characteristics is thus 90% for Euro-0, 5% for Euro-1, 4% for Euro-2, and only 1% for Euro-3.

The new requirements for fuel quality defined by the European Directive were introduced in two stages: in 2000 and in 2005. The basic indexes for the toxic properties of gasolines are: lead, sulfur, aromatics (including benzene), and olefin content and evaporability. The main gasoline quality requirement is the absence of alkyl lead antiknocks, since catalytic converters are incompatible with leaded gasolines, and without the converters, it is impossible to satisfy the environmental requirements [3].

In EU countries, leaded gasolines have not been used since 2000. In Russia, after GOST R 51105–97 came into effect in 1997, almost all oil refineries have manufactured gasolines that satisfy Euro-2 standards.

On July 1, 2002, GOST R 51866–2002, which is an authentic translation of EN 228:1999 and the corresponding Euro-3 standards, took force in the territory of Russia. Production of gasolines according to this standard has been implemented at Novo-Ufa and Moscow Oil Refineries, Surgutsk FBC, and Slavneft’–Yaroslavnefteorgsintez Co. Production of these gasolines at Ryazan’, Novokuibyshev, and other oil refineries is planned.


The necessary standards and technical and manufacturing base for manufacture of commercial gasolines that satisfy current European requirements have thus been created in Russia. However, production of gasolines that satisfy the Euro-3 and Euro-4 standards implies an important change in the technology and high costs, while the use of such gasolines is only justified in modern autos of the corresponding class.

At the same time, harmful atmospheric emissions can be reduced significantly and consequently the environmental situation can be improved if detergent additives are incorporated in automotive gasolines. This is due to the correlation of the cleanness of the carburetor, starting system, and combustion chamber with engine operating efficiency and exhaust gas composition.

Many changes in engine design to boost power and reduce fuel consumption and toxicity (closed crankcase ventilation system, recirculation of exhaust gases, use of fuel injection) have strengthened the tendency toward formation of deposits on engine parts [4]. This process is most intensive in the jets, in the carburetor strangler, and in the injectors and intake valves. Formation of deposits on these parts perturbs initial engine control, increases fuel consumption, reduces power, and increases exhaust gas toxicity.

According to European Directive 98/70/EC, the automobile should remain “clean” during its entire “lifetime,” and its environmental characteristics should be stable for 100,000 km. This can only be attained during use by using special additives, in particular, detergents and multifunctional additives, since the existing technologies for production of automotive gasolines do not allow obtaining the required level of properties that would ensure a clean fuel system.

Modern engines are increasingly more sensitive to formation of deposits. Even a small amount of deposits in the fuel supply system or combustion chamber can perturb operation of the engine and make it inefficient [5].