SERVICE PROPERTIES OF FUELS AND OILS

CHARACTERISTICS OF THE EFFECT OF MANGANESE CYCLOPENTADIENYL TRICARBONYL (TsTM) ANTIKNOCK AGENT ON THE PRODETONANT PROPERTIES OF COMBUSTION-CHAMBER DEPOSITS

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From operating experience with gasoline engines, it is well known that the fuel octane number requirement will increase as the engine service period is extended, as a consequence of the formation of combustion chamber deposits.

The magnitude of the additional prodetonant effect of the deposits, which is governed by the addition of tetraethyllead to the fuel, depends on the condition under which the deposits are built up. In some cases, this effect is small or even indetectable [1]; in other cases it is very evident, amounting to 6 to 8 octane numbers [2].

In contrast, the use of an antiknock agent based on manganese not only eliminates this increase in the prodetonant effect of the deposits, but in a number of tests has been accompanied by a decrease in the fuel octane number requirement [3, 4].

The mechanism by which the metal compounds of an antiknock agent effect a change in the prodetonant properties of deposits is still completely unknown. The effect of antiknock agents on deposit formation is not limited to increasing the amount of deposits. The presence of salts and oxides of the antiknock agent in the deposits will lead to a lowering of the temperature required to initiate the process of glow-combustion of the carbonaceous deposits, and will increase the intensity of this process. This favors the burnoff of part of the deposit; however, it also increases the danger of the appearance of surface ignition. In contrast to the bulk and insulating effects of the deposits, which cause only a prodetonant effect, the appearance of surface ignition may cause either an increase or a decrease in the octane number requirement.

Premature ignition, acting in a manner similar to that of increasing the spark advance angle, favors the appearance of knock. At the same time, the generation of additional flame fronts, caused by contact with incandescent particles of the deposits after spark-ignition of the mixture, may favor the suppression of knock [5]. There are indications in the literature that the tendency of the deposit particles to cause premature ignition is less pronounced for the smaller particles [6]. Small particles, on the order of tens of microns, do not cause premature ignition and may decrease the octane number requirement.

We have investigated the feasibility of suppressing knock by means of finely dispersed particles of certain compounds, primarily oxides, that are formed during the combustion of metal-containing antiknocks. This study was performed with a unit assembled on the basis of a single-cylinder four-cycle internal combustion engine (CFR—Army method) with additional equipment needed to feed powder and to determine its effect on knock intensity. The powder-feed attachment was designed so that the powder could be introduced into the combustion chamber uniformly and in synchronization with the cycle. The intensity of the knock vibrations was determined as described in [8].

The effect of finely dispersed powders on knock was determined while the engine was operating under the following conditions: Engine speed 900 rpm, spark 10° BTDC, crankcase oil temperature 50-75° C, coolant tem-
Fig. 1. Antiknock effect of fine particles: 1) Manganese dioxide; 2) lead oxide; 3) activated charcoal; 4) manganic oxide; 5) manganous oxide; 6) aluminum; 7) deposits.

Fig. 2. Effect of particle size on antiknock effect of powder (aluminum, feed rate 1.5 g/min).

On the basis of the results that were obtained, along with literature data, it can be concluded that particles of combustion products from TEL and TsTM do have an antiknock effect. However, a necessary condition for the manifestation of this effect is the presence of oxides of the antiknock metal in the combustion chamber in the form of fine particles with highly developed surfaces.

The aerosols that are formed in the bulk condensation of the decomposition products of an antiknock are highly mobile and will coagulate rapidly. The processes of particle enlargement (aggregation and sintering) of the particles that are not swept out with the exhaust gases are also continued on the surface of the combustion chamber. The growth rate is greater for lower melting materials [9]. Low-melting halogen compounds of lead are rapidly sintered to large aggregates, thus losing their antiknock properties, regardless of whether they are in the chamber space or on the surface. Hence, the antiknock effect that we have found for fine particles is not present when lead compounds accumulate in the combustion chamber, and increases in the amount of deposits and increases in the deposits' tendency to preignition will usually lead to an additional increase in the engine octane number requirement.

For a layer of high-melting manganese oxides, fine particles are typically present; these are capable of giving an antiknock effect. This is manifested not only in the form of a weakening of the prodetonant effect of...