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About the Effect of Magnetic Field on the Quality of Combustion of Liquid Organic Fuel

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Abstract—The fundamentals of the influence of the shape of molecules of liquid organic fuel on the quality of the process of its combustion are described. The change in the shape of these molecules due to their diamagnetic properties at working up the fuel stream with magnetostatic field explains the discovered previously empirical regularities, which have the wide practical application in the devices with the fuel combustion.

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Empirical laws governing the effect of magnetic field on the quality of the combustion of liquid organic fuel have been described earlier [1–3]. Below is described the fundamental mechanism of the influence of magnetic field on the properties of fuels, which explains the regularities revealed previously. The function which describes the reaction rate of the fuel combustion (as a fraction of having reacted fuel) is determined, obviously, by many factors, including pressure of mixture $P(t)$, temperature $T(t)$, concentration of the oxidizer $v_{ox}(t)$, the fuel concentration $v_{fuel}(t)$, the probability of collision of the molecules of oxidizer and fuel $p_c(\ldots)$, which are in turn the functions of time, therewith the probability depends on the same factors.

$$f(t) = (P(t), T(t), v_{ox}(t), v_{fuel}(t), p_c(P, T, v_{ox}, v_{fuel}, (\text{geometrical parameters of molecules}))(t)) \tag{1}$$

The first factors, $P(t)$ and $T(t)$, define the rate of motion of the molecules. The second factors, concentrations $v_{ox}(t)$ and $v_{fuel}(t)$ (t) are statistical parameters of the measure of collision probability. However, other conditions being equal, the change in the measure of the collision probability $p_c(\ldots)$ is determined by the change in the area of the fuel molecules, S: the greater the area of molecules (concentration and composition are the same), the greater the probability of collision, at least at the moment of the reaction beginning. It is obvious that the dependence of the reaction rate on the measure of the collision probability is linear at the moment of the reaction beginning:

$$\left.\frac{\partial f}{\partial p_c}\right|_{t=0} = k_1 p_c\,. \tag{2}$$

The dependence of the measure of the molecules collision probability on the area of the fuel molecules at the initial moment is also linear ($p_c = h(S)$, where h is linear), so that:

$$\left.\frac{\partial f}{\partial S}\right|_{t=0} = k_2 S \tag{3}$$

the function of the measure of the area of molecules is also the boundary condition for function (3), which describes the process of combustion. Therefore, without considering the detailed and bulky modeling, we conclude about the linear influence of the area of molecules on the function describing the rate of the combustion process at the initial moment:

$$\left.\frac{\partial f}{\partial S}\right|_{t=0} = k_3 S \tag{4}$$

and during the process progress ($g(t)$ is implicit function):

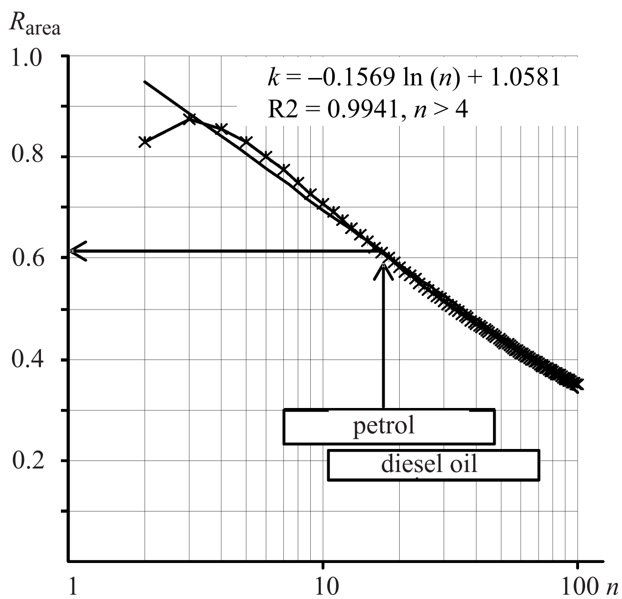
$$\left.\frac{\partial f}{\partial S}\right|_{t\in[t_0,t_1]} = g(t)S. \quad (5)$$

A simple model is created, which describes the effect of the molecular shape (elongated or maximally compact, energetically advantageous [8]), on the contact area of molecule with the oxidizer in the process of combustion [1] (see figure). The ratio of the areas of the molecular conformations of the elongated $S_1(n)$ and convoluted (spherical) $S_2(n)$ forms, in the first approximation, under the assumption of the thread-like molecules, without branching, is such:

$$k(n) = S_2(n)/S_1(n)$$
$$= \frac{\{1.5\,[d(n)]^2 l(n)\}^{2/3}}{[d(n)^2]/2 + d(n)\,l(n)}, \quad (6)$$

where n (units) is the number of carbon atoms in the molecule ($n > 4$), $d(n)$ is the diameter of the elongated molecule, $l(n)$ is the length of the molecule (in the arbitrary units – number of carbon atoms).

Taking into account probabilistic laws governing the distribution of lengths and states of molecules, the forecasts are obtained of the effectiveness of improvement in the quality of combustion with the change in the shape of molecules to elongated: 6% for the diesel fuel and 3% for the high-knock rating gasolines, that made it possible to explain observed previously in practice effect of fuel economy at the working up the fuel streams by magnetostatic field [1], that leads to the change in the shape of molecules to elongated (close to the cylindrical), due to the use of diamagnetic properties of the organic molecules of fuels [7, vol. 1, p. 614]. Thus, the forecasts, which coincide with the effect observed in practice, explain the physicochemical mechanism of the effectiveness of working up liquid organic fuel by magnetostatic field directly before combustion. In the magnetic field a molecule, due to its "ejection" from the region of strong magnetic field into the region of weak magnetic field, is "straighten," that is, becomes more elongated.



Function of the ratio of the area of the compact form of molecule to the area of the elongated cylindrical form, as dependence on the length of molecule. (R_{area}) area ratio of maximally compact and elongated molecule forms.

Validation of the described model by another method, that is, attempt of the analysis of the of molecular conformations using a measuring equipment is impossible, in view of the fact that any attempt to conduct measurement introduces additional energy into the examined [2], hence, it affects the conformational-structural features of the investigated liquid. That is, the only method of testing the reality of model is the experiment on the combustion of the worked up with magnetic field fuel in engines or other installations.

The analogous effect of the action of electromagnetic field, namely the influence of working up by electromagnetic field of the complex organic molecules, leading to an increase in reactivity of the carbon C=C double bonds and the restructuring of molecules with the oxidation of these double bonds (by sulfuric acid) to the single at the change in the geometry of molecules (stretching the formed dipoles) is discovered in somewhat different area at the study of the sludge (aqueous emulsions, which contain 20–30% of organic residues and 10–30% of sulfuric acid) [4]. But here again impossible to estimate the degree of the influence of electromagnetic field on the geometry of molecules for the same reasons, and the model of this effect remains the theoretically described and eventually confirmed experimentally [5, 6].

The presence of the description of the general physicochemical mechanism of the effect of improvement in the quality of the combustion of liquid organic fuel at the working it up by magnetic field makes it possible to speak about the wide practical and industrial significance of the discovered effect also in other (besides the previously experimentally investigated) fields of application of liquid organic fuel, including in the aerospace devices, which use liquid organic propellants (kerosene).

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