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Theoretical study of the accumulation of mechanical mixtures in the engine lubrication system

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Abstract. The work in the field of oil obsolescence, theoretical identification of active additives contained in the oil as a benchmark for evaluating the main operational properties of oil, as well as a theoretical assessment of the properties of oil oxidation resistance and the resource of its active elements, depending on the intensity of the eating of engine details and the amount of elements. The sharply changing climate and high pollination conditions of the republic, a sharp increase in the amount of water and mechanical mixtures, which in turn can lead to a premature departure of motor oils used in it, such as viscosity, corrosion resistance, oxidation resistance, washing and other properties, and acceleration of engine eating. Due to the overload of the tractor, theoretically determined that mechanical mixtures and asphalt products containing oxidation products containing motor oil in the engine maintenance system increased by 1.2%.

1. Introduction

The reliable operation of the engine is incompatible with the quality of the lubrication material. Analysis of the work in the field of oil obsolescence shows that as a criterion for evaluating the main exploitative properties of oil, you can accept the discharge of active additives containing oil and the intensity of the eating of engine details. Mechanical mixtures cause oil switches and filter clogging, changes in the temperature regime of the cylinder-porcelain group, abrasive eating of engine details, and acceleration of the oxidation process.

It is known that the loss of active additives contained in the oil is incompatible with the eating of details. Therefore, a thorough study of the process of losing active additives, in turn, allows you to evaluate the state of the engine. A comprehensive assessment of the properties of oil in the process of use is one of the solutions to the problem [1, 2, 3, 4].

2. Materials and methods

This, in turn, leads to the fact that mechanical compounds do not exceed the composition of the oil. As a result, it accelerates the corrosion eating of details. Having water in motor oil can have the following negative effects:

- cause intensive eating of details and disruption of the oil pump by forming ice during the cold times of the day;

- to have a catalytic effect on the oxidation process and to produce low-temperature sediments, i.e. sleds, in the oil;
- cause corrosion;
- to cause oil to multifunction at high temperatures, resulting in a deterioration in the ability to lubricate and increase friction;
- causes additives to be washed away and sedimented.

The most serious of these reasons is the washing of prisadkas, as a result of which the oil loses its properties.

The resulting embryo was allowed to develop in nutrients and then inserted into her womb, where it was implanted. From the above, we analyze changes in the active elements contained in the oil. [5, 6, 7, 8, 9, 10, 11, 12].

3. Results and discussion

In Manusadjyants O.I. work [13], the discharge of active elements, that is to say, supplements can be evaluated through an unspecified indicator "R" in the process of operation of the engine.

$$‘_t = \frac{S_t}{(C_o - C_t)} * \frac{t}{k} \quad (1)$$

here 't - a dimension indicator that evaluates the discharge of additives in a t-time state;

C_o - the concentration of additives in fresh oil (active elements);

C_t - the concentration of additives contained in t-time oil;

k - coefficient indicating the stage of operation of the oil, moto-hour.

t - the time when the oil works in the engine, moto-hour.

You can determine the amount of supplements added to the oil content used using the following expression.

$$M_m = [M_k\,(100 - K_k) + M_a\,K_k\,]100 \quad (2)$$

here M_M - the amount of active elements contained in the new oil, %;

M_k – the residual amount of active elements in the oil used, %;

K_k - the additional amount to be included in the oil used, %;

M_a - the amount of active elements (Ba, P, Zn, etc) contained in the supplement, %.

According to the residual amount of Ba, the amount of supplements added to the refined oil is determined as follows:

$$K_p^{Ba} = [(C_a^{Ba} - S_{ost}^{Ba})/(S_p^{Ba} - S_{ost}^{Ba})]\ 100 \quad (3)$$

The anti-oxidation supplement added by the residual amount of Zn is determined as follows:

$$K_p^{Zn} = [(C_a^{Zn} - S_{ost}^{Zn})/(S_p^{Zn} - S_{ost}^{Zn})]\ 100. \quad (4)$$

The anti-oxidation supplement to be added by the residual amount of R is determined as follows:

$$K_p^{R} = [(C_a^{R} - S_{ost}^{R})/(S_p^{R} - S_{ost}^{R})]\ 100. \quad (5)$$

To restore the washing and dispergiration of oil, the number of employees (Sh_{ch}) must meet the indicators in the regulatory and technical documents,

$$Sh_{ch} = [Sh_{ost}(100 - K_p) + Sh_pK_p]/100, \tag{6}$$

here Sh_{ost} - the number of workflowers left after purifying oil from water, mechanical mixtures, fuel and organic dirt, mgKON/g;

K_P – the additional amount that must be included in the oil content, %

Shn - the number of included leak liners, mgKON / g.

The additional amount to be included in the oil is determined as follows:

$$K_p = [(Sh_{ch} - Sh_{ost})/(Sh_p - Sh_{ost})]\ 100. \tag{7}$$

In restoring the composition characteristics of the oil, its cinematic composition at 100ºC (V_k) must meet the figure in the regulatory and technical document:

$$V_k = [V_{ost}(100 - K_v) + V_pK_v]/100, \tag{8}$$

here V_{ost} - kinematic, mm^2/s after purifying oil from mechanical mixtures, water, fuel and organic dirt;

V_k - kinematic friction of fresh oil at 100ºS, mm^2/c;

K_v - the amount of the additive to be entered, %;

V_p - cinematic composition of the included additive, mm^2/s.

The amount of the additive to be entered can be determined as follows:

$$K_v = [(V_k - V_{ost})/(V_p - V_{ost})]\ 100. \tag{9}$$

The process of accumulating mechanical mixtures in the engine lubrication system is fixed using the following expression proposed by Polotarov S.P.

$$X_{nb} = X_0\left(\frac{G_0 - Q_y\tau_g}{G_0}\right)^{n\left(\frac{Q_\phi\varphi}{Q_y}+2\right)-1} + \frac{100\alpha}{Q_\phi\varphi + Q_y}\left[1 - \left(\frac{G_0 + Q_y\tau_g}{G_0}\right)\frac{Q_\phi\varphi}{Q_y} + 1\right]x$$
$$x\frac{1-\left(\frac{G_0 - Q_y\tau_g}{G_0}\right)^{n\left(\frac{Q_\phi\varphi}{Q_y}+2\right)}}{1-\left(\frac{G_0 - Q_y\tau_g}{G_0}\right)^{\left(\frac{Q_\phi\varphi}{Q_y}+2\right)}}; \tag{10}$$

$$X_{nн} = \left(\frac{G_0 - Q_y\tau_g}{G_0}\right)X_{nb}; \tag{11}$$

here X_{nb}, $X_{nн}$ - the amount of mechanical mixtures in the cases after adding oil on the carter and n - n - the th time the oil is added;

Q_Y - oil pumping speed, kg/h;

Q_f - conductivity of the filter, kg/h;

α- the rate of contamination with mechanical mixtures, kg/h;

τ_q - the cavity until the oil is added, hours

G_o - the first mass of the oil , kg.

X_0 - the original pollution of the oil, %

And the dirt that remains in the filter is determined by the following expression:

$$X = X_0 \exp\left(-\frac{Q_у}{G_0}t\right) + \frac{100\alpha}{Q_у}\left[1-\exp\left(-\frac{Q_у}{G_0}t\right) - \frac{200B_ф G_0}{Q_у^2}\right] \left[\frac{Q_у}{G_0}t\exp\left(-\frac{Q_у}{G_0}t\right)-1\right]; \tag{12}$$

And the dynamics of the change in the number of alkalis of oil can be determined by the following expression.

$$C = C_0 \exp\left(-\frac{K_c+Q_у}{G_0}\right) + \frac{Q_у C_0 - 0{,}35yG_т S - Q_ф^c}{K_c+Q_у} x \; x\left[1-\exp\left(-\frac{K_c+Q_у}{G_0}\right)\right] \tag{13}$$

From the above expressions, you can analyze the dependence of X= f(t) and c=f(t) and determine the laws governing their change in accordance with the requirements imposed on the oil.

The amount of mechanical compounds contained in the oil can be determined as follows

$$T_М^x = \frac{G_0}{Q_у + Q_ф\varphi_ф}\ln\frac{1}{1-\frac{X_{бр}\left(Q_у+Q_ф\varphi_ф\right)}{100\alpha}}; \tag{14}$$

Depending on the number of active additives contained in the oil, its boundary duration is as follows:

$$T_М^c = \frac{G_0}{K_c+Q_у}\ln\frac{C_0 - \frac{Q_у C_0 - 0{,}35yG_т S - Q_ф^k}{K_c+Q_у}}{C_{бр} - \frac{Q_у C_0 - 0{,}35G_т S - Q_ф^c}{K_c+Q_у}}; \tag{15}$$

To compare the results of theoretical expressions obtained with the results of experiments, the dependence of C=f(t), X=f(t) will be checked, and the experiment will continue until the conditions of $T_m^x \leq T^x_{m.ch}$, $T^s_m \leq T^s_{m.ch}$ are met ($T^x_{m.ch}$, $T^s_{m.ch}$ mechanical mixtures, and the limit amount for the number of workpers).

4. Conclusions

The sharply changing climate and high pollination conditions of the republic, a sharp increase in the amount of water and mechanical mixtures, which in turn can lead to a premature departure of motor oils used in it, such as viscosity, corrosion resistance, oxidation resistance, washing and other properties, and acceleration of engine eating.

Based on theoretical formulas, you can look at the oxidation resistance properties of oil and the resource of its active elements, depending on the number of elements contained in the oil, such as barium, dream, calcium, and phosphorus.

Due to the overload of the tractor, theoretically determined that mechanical mixtures and asphalt products containing oxidation products containing motor oil in the engine maintenance system increased by 1.2%.

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