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Analysis of Available Methods for Detecting Failures of Transmission Units During Operation

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Annotation: In this article, the concentration of abrasive particles accumulated in the crankcase of the transmission block under high ambient temperature conditions in the transmission blocks depends on the crankcase sealing and the recorded refueling frequency.

Key words: Transmission, operation, malfunctions, abrasive particles, oil, concentration, crankcase.

We know that the main parts of a car or tractor transmission include a clutch, cardan transmission, gearbox or hydromechanical transmission, gearbox and drive shaft (main gear and differential). Vehicle and tractor transmission blocks account for 10-15% of all failures and 40% of total labor and material consumption for maintenance.

Defects in the transmission blocks occur during the operation of cars and tractors, as well as as a result of failure, wear or breakage of the adjustment of some parts. It is important to be able to predict transmission block failures during operation so that failures do not occur and productivity is reduced.

The high ambient temperature reduces the viscosity of the lubricating oil, as a result of which some of the oil, along with the abrasive particles, flows out of the non-dense areas of the crankcase sealing elements, which in turn reduces the oil level in the transmission unit. Therefore, in order to ensure good lubrication of the parts during operation, the transmission unit crankcase is periodically refilled with fresh oil, which reduces the concentration of abrasive particles in the oil after each refill, and the degree of concentration depends on the new oil mass being refilled. will be [1-3].

Let's look at the dynamics of the accumulation of abrasive particles in the oil of transmission units under the conditions of operation of the machine. We assume that the level of dust during operation, the ambient temperature and the tightness of the crankcases of the transmission units do not change, and that the increase in the concentration of abrasive particles is constant during the refueling process. In this case, the mass of abrasive particles removed from the crankcase as a result of oil leakage before the first refill is:

$$m_1 = G_v \cdot \Delta U_{iz} \qquad (1)$$

this is Gv - the mass of oil leaving the transmission unit crankcase between two new oil refills, kg; ΔU_{iz} –is the increase in the concentration of abrasive particles between two new oils[4].

The increase in the concentration of abrasive particles is determined experimentally by the results of operational tests using the method described above.

After the first filling with oil, the residual mass of the abrasive particles in the crankcase of the transmission unit is as follows:

$$M_1 = M_o - m_1 = G_t \Delta U_{iz} - G_v \Delta U_{iz} = G_t \Delta U_{iz}(1 - \frac{G_v}{G_t}) \quad (2)$$

where Mo- is the mass of abrasive particles that fill up with the first oil when no oil leakage is observed; G_t – the amount of oil when filling the transmission unit with the first oil according to the technical conditions, kg. We end it with the following,

$$k = \frac{G_v}{G_t} \qquad (3)$$

here G_t is the mass fraction of oil leaking from the transmission crankcase, resulting in:

$$M_1 = G_t \cdot \Delta U_{iz}(1 - k) \qquad (4)$$

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where the coefficient k indicates the degree of tightness of the transmission crankcase.

The mass of abrasive particles lost from the transmission crankcase as a result of oil leakage during the period of refueling twice, taking into account the residual mass of abrasive particles in the transmission crankcase after the first oiling, is as follows:

$$m_2 = G_t \cdot \Delta U_{iz}[(1-k)+1] \qquad (5)$$

Taking into account the mass of abrasive particles removed from the crankcase of the transmission unit as a result of oil leakage between the new oil and the first and second filling, the mass of the abrasive particles in the transmission unit oil after the second filling is:

$$M_2 = G_t \cdot \Delta U_{iz}(1-k)[(1-k)+1] \quad (6)$$

The mass of abrasive particles removed from the crankcase of the transmission unit as a result of oil leakage from the last filling to the oil change is determined as follows:

$$m_n = G_t \cdot \Delta U_{iz}(1-k)^{n-1} + (1-k)^{n-2} + \cdots + (1-k)^2 + [(1-k)+1] \quad (7)$$

The mass of abrasive particles in the transmission unit crankcase during the oil change period, taking into account the mass of abrasive particles removed from the transmission unit crankcase as a result of oil leakage from the last filling to the oil change

$$M_n = G_t \cdot \Delta U_{iz}(1-k)\{(1-k)^{n-1} + (1-k)^{n-2} + \cdots + (1-k)^2 + [(1-k)+1]\} \qquad (8)$$

(7) After simplifying the calculated expressions mn in formula and Mn in formula (8), we obtain:

$$m_n = G_t \cdot \Delta U_{iz}(1-(1-k)^n)\frac{1}{k} \qquad (9)$$

$$M_n = G_t \cdot \Delta U_{iz}(1-k)(1-(1-k)^n)\frac{1}{k} \qquad (10)$$

To calculate the mass of abrasive particles in the transmission unit crankcase during the oil change period, both parts of the equation are added to the additional mass of the transmission unit, and we obtain the analytical relationship to calculate the product concentration in the transmission unit crankcase:

$$\varepsilon_{iz} = \Delta U_{iz}(1-k)(1-(1-k)^n)\frac{1}{k} \quad (11)$$

The change in the concentration of abrasive particles during the operation of the machine is linear. Therefore, the increase in the concentration of abrasive particles in the oil during periodic pouring can be expressed as:

$$\Delta U_{iz} = a \cdot t \quad (12)$$

where a-is the change in the concentration of the abrasive particles per unit time; t – the frequency of refueling during the operation of the transmission unit[4-5].

In this case, the expression for calculating the concentration of products in the crankcase of the transmission unit is as follows:

$$\varepsilon_{iz} = a \cdot t(1-k)(1-(1-k)^n)\frac{1}{k} \quad (13)$$

Thus, under high ambient temperatures, the concentration of abrasive particles that accumulate in the crankcase of the transmission unit depends on the crankcase tightness and the frequency of refueling. Using the last expression (13) it is possible to estimate the degree of contamination of the oil with abrasive particles at any time of use [6-8].

The above formula makes it possible to predict the quality of the oil and extend the service life of the units by changing the oil in a timely manner.

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