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# Definition of Engine Capacity Losses on Resistance Overcoming in Transmission and a Hydraulic Actuator

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**Abstract**

In article the factors influencing effective work of such responsible systems of mobile cars as transmission and a hydraulic actuator, and in particular under the influence of low temperatures of air are analyzed. The technique and results of the conducted bench researches on identification of influence of the thermal mode of transmission on losses of power in units of transmission and a hydraulic system reveals.

**Keywords**: transmission, hydraulic actuator, working capacity, negative temperatures, viscosity, friction, power, torque

## Introduction

Now in Russia because of cars park wear, new equipment shortage seasonal load of each car sharply has increased. Continuous increase in prices for raw materials, especially for oil, causes requirement to use all opportunities for fuel-lubricants economy.

In farms one of ways to preserve the available cars park and reduction of material inputs is use of progressive resource-saving technologies, including such which are based on tribological recommendations use. [1].

It is known that temperature influence on operability of mobile cars and tractors, including, during operation, has very difficult character and depends on many conditions and factors. So far it isn't founded the quantitative connection between temperature and change of technical and economic indicators in such important car systems, as, for example, transmission or a hydraulic system.

In lubricant system of mechanical transmissions temperature and load-speed operating modes are in difficult interrelation. Thermal processes in such transmission have essential impact on losses of power in these units [1].

In hydraulic systems of cars oils viscosity (temperature) increase breaks spool work and safety devices, as a result operation of executive cylinders is late, breakthroughs appear, the machine operation becomes unsafe. The lag effect of protection devices in hydraulic machines that conducts to emergence of the splashes in pressure exceeding more than twice the nominal increases. Nature of oil friction in pipelines, resistance to the movement through throttles, nozzles, cracks, gaps depends on the size of viscosity. It defines a working liquid consumption on certain system sites, the leaks volume, losses of pressure for oil passing through various sites, efficiency of hydraulic knots, and also loss of power on the hydraulic pump drive [2].

One of the most important directions of ensuring operability of hydraulic actuator units of modern cars and the equipment is increase of wear resistance of their details due to improvement of their greasing mode by use of working liquids rational temperatures under operating conditions.

## Researching methodology

For the purpose of identification of thermal mode influence in tractor transmission on power losses in units of transmission were conducted researches at the brake stand with running reels, the technique and which equipment can be applied and to research of temperature influence on power losses in the drive of units of a hydraulic system.

As object of researches it is possible to consider a hydraulic actuator of times - efficient and modular hinged system of the tractor as it experiences more intensive strain, in comparison with a hydraulic system of the tractor, and, besides, tractors of this brand are widely used when performing power-intensive works, and their hydraulic system is typical for hydraulic systems of the modern cars used in designs.

Researches were conducted with a nominal pressure in tires of tractor wheels on the ninth transfer.

The stand allows to create loading on driving wheels of a tractor, to measure it and to determine the frequency of running drums rotation.

The demanded temperature condition in lubricant system of transmission was supported by means of two electroheating devices installed in the case of tractor transmission. One of them – the tubular electric heater – was connected to a source of a direct current of 36 V. The second – the electric heating element (thermocartridge) – was connected to an tractor onboard network of 12 V [1].

For providing rational temperature condition of a hydraulic system in the tractor it is offered to use the system of working liquid temperature regulation, included in the regular hydraulic system of a tractor and containing the hydraulic pump reported by the pressure head hydraulic line with hydraulic system units and a tank in which two heat exchangers for heating and cooling of working liquid, by means of the drain hydraulic line, the temperature regulator registering temperature in a hydraulic tank, the oil pump of the lubrication system of the engine and a receiver of a tractor pneumatic system connected everyone to one of tank heat exchangers [3,4] are located.

Thus working liquid of a hydraulic system heats up in a tank, executed in the form of the cylindrical capacity limited to two face covers and, cooling of working liquid comes at an air transmission through one of the heat exchangers installed in a tank from a pneumatic system receiver, and the second heat exchanger, is established so that it is included in the delivery hydraulic line parallel to the oil heater of the engine lubrication system, thus, working liquid from a hydraulic system, flowing round heat exchangers in a tractor hydraulic system tank, can heat up or be cooled up to the necessary temperature [3,4].

The applied fuel and oil in the engine corresponded to requirements of specifications. Oil temperature was maintained in the engine at the level 90±5°C. Service of the diesel was made according to the maintenance manual. The engine at tests worked before measurements at each set mode not less than 5 min. at the position of governing bodies of the rotation frequency regulator corresponding to full fuel supply. In the case of transmission and in a hydraulic system of a tractor recommended by manufacturer were used oils and motor oil, respectively. Their temperature was controlled by the help of the thermocouples installed in the case of transmission and a a hydraulic system tank and was registered a twelve-dot potentiometer which ate from an tractor onboard electric network. Researches were conducted at a fuel temperature of 25±2°C with triple frequency. The loading brought to driving wheels of a tractor at researches was close to maximum operational and was established at the level of 3300±50 N. Rotation frequency of an engine cranked shaft was controlled by the special device and corresponded to 2200 $min^{-1}$. [1, 5, 8].

## Algorithm of researches results processing

Losses of power on the drive of hydraulic system units can be calculated by the following technique. Power ($N_e$) which will be spent by the stand electric motor for scrolling of wheels of a tractor when the coupling is switched off, equivalent to the sum of power losses in the drive of running drums ($N_{dr}$), in tractor transmission ($N_{tr}$) and in a hydraulic system ($N_{ha}$), on condition of lack of slipping of wheels concerning the stand drums [6, 7]:

$$N_e = N_{dr} + N_{tr} + N_{ha}, \qquad (1)$$

The power spent by the stand electromachine is determined by a formula:

$$N_e = \frac{M_{rot} \cdot n_{rot}}{9554}, \qquad (2)$$

$M_d$ - an electromachine rotor torque, N·m; $n_{rot}$ - frequency of rotation of a rotor, $min^{-1}$.

The rotor torque of the electromachine is determined by a formula:

$$M_{rot} = \frac{M_d}{\iota_{red} \cdot \eta_{dr}}, \tag{3}$$

$M_d$ - an electromachine rotor torque, N·m; $\eta_{dr}$ - efficiency of the drive of running the stand drums.

The torque of running drums of the stand is determined by a formula:

$$M_d = P_{td} \cdot r_d, \tag{4}$$

$P_{td}$ - the tangent force of draft on running drums, N; $r_d$ - radius of running drums, $r_d$ = 0,3 m.

Then:

$$M_{rot} = \frac{P_{td} \cdot r_d}{\iota_{red} \cdot \eta_{dr}}, \tag{5}$$

$$N_e = \frac{P_{td} \cdot r_d \cdot n_{rot}}{9554 \cdot \iota_{red} \cdot \eta_{dr}}, \tag{6}$$

Losses of power at the switched-on mechanism of the tractor hydraulic pump drive are in transmission on a formula:

$$N_{tr} + N_{\text{ha}} = N_e - N_{dr}, \tag{7}$$

where

$$N_{dr} = N_e \cdot (1 - \eta_{dr}), \tag{8}$$

Then:

$$N_{tr} + N_{\text{ha}} = N_e - N_e \cdot (1 - \eta_{dr}) = N_e \cdot \eta_{dr}, \tag{9}$$

Having substituted the power of the electromachine determined by a formula (6) and, having expressed losses of power in a hydraulic system, we will receive:

$$N_{ha} = \frac{P_{td} \cdot r_d \cdot n_{rot}}{9554 \cdot \iota_{red}} - N_{\text{tr}}. \tag{10}$$

## Conclusion

For definition of power losses in transmission $N_{tr}$ it is necessary to make experiment at the fixed temperature of transmission oil and the disconnected hydraulic pump. The received value will be constant on condition of working loading and oil temperature preservation. Thus, having measured the tangent force of draft on running drums, and knowing the frequency of the electromachine rotor rotation which was supported by a constant ($n_{rot}$ = 700 $min^{-1}$.), and also at known value of power losses in transmission $N_{tr}$ it is possible to define power losses in a $N_{ha}$ tractor hydraulic system.

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