Performance improvement methods of hydroficated machine under refrigeration

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Abstract. In this paper, the problem of the influence of climatic conditions on the performance of a Hydraulic gear is considered. The importance of the work is due to the fact that the methods for solving the problem are proposed, namely, the use of preheating for a Hydraulic gear and an internal combustion engine under refrigeration. The use of hydrofected self-propelled vehicles in the northern regions in winter is considered. The factors determining the technical and economic indicators of hydrofected machines are revealed. The influence of negative temperature on the physical and mechanical properties of hydraulic equipment materials is also considered. Three main directions have been identified in which temperature affects the hydraulic drive. An experiment was conducted in which the dependence of the performance of the machine was revealed using a preheating device for the working fluid and without the device.

1. Introduction
A hydraulic gear is a set of devices designed to drive machines and mechanisms using hydraulic energy. In a hydraulic gear, the power fluid is an energy carrier, thanks to which the connection between the pump and the hydraulic motor is established. In addition, the power fluid provides lubrication of the moving parts of the hydraulic gear elements [1].

Mineral oils, water-oil emulsions, mixtures and synthetic liquids are used as power fluids in the hydraulic gear. The choice of the type and brand of power fluid is determined by the purpose, degree of reliability and operating conditions of hydraulic gears of machines.

The economic indicators of a hydraulic gear are mainly determined by its purchase price (price) and operating costs. The first includes the costs of development, manufacture, purchase of components and components, as well as installation and commissioning. Operational costs include energy consumption, as well as maintenance and repair costs.

2. The influence of temperature on the performance of hydroficated machines
The use of hydroficated self-propelled machines in the northern regions is hindered by the exceptionally low efficiency of the Hydraulic gear in winter. For example, a bulldozer could not plan snow at an air temperature of minus 24 °C, even an hour after the start of the machine. The reasons for this were the uncontrolled movement of the blade under the action of an external load and insufficient cutting force. A similar pattern is observed when other machines are working. In practice, in Eastern Siberia, Yakutia in the Far East, often to maintain the performance of the Hydraulic gear at a certain level in harsh climatic conditions, the engines of cars are not turned off from November to March. This leads to fuel overspending, premature wear of the engine and hydraulic pump, and environmental pollution. Of all
the factors that determine climatic conditions, the temperature has the greatest influence on technical and economic indicators. Other factors affect indirectly through temperature. For example, when the wind speed increases, the conditions of heat exchange of the Hydraulic gear with the environment change significantly and the temperature of the power fluid decreases. With an increase in the strength of the developed soil, a deterioration in the condition of roads or an increase in the depth of snow cover, the operating mode of the Hydraulic gear worsens, since the loads on the hydraulic motor increase, which in turn leads to an increase in the pressure in the hydraulic system and an increase in the temperature of the power fluid [2-3].

Thus, the temperature of the environment and the power fluid is the main factor determining the technical and economic indicators of hydroficated machines.

We have identified three main directions in which the temperature affects the Hydraulic gear. Under the influence of temperature (in the range from -50 °C to +80 °C), the state of the power fluid changes significantly: the viscosity increases hundreds and thousands of times, the density increases, the contamination and moisture content increase. Due to the saturation of the liquid with the gas-air phase, the volume elasticity modulus and the pulse propagation velocity decrease, the dynamic compliance and the volume expansion coefficient increase. When the temperature changes, there is a change in the size of the gaps in the movable joints and the tension in the stationary ones. Due to the deformation and size changes of the parts, the friction forces or pinching of the moving elements in the guide and regulating hydraulic equipment increase, air is sucked into the suction hydraulic line and the power fluid is saturated with air. All this causes deterioration of the dynamics of the Hydraulic gear and metal structures, jamming of hydraulic equipment, destruction of hydraulic equipment [4-6].

The temperature change has a negative effect on the physical and mechanical properties of hydraulic equipment materials, especially polymers. The nature of the contact of the friction surfaces changes, the friction force increases and the wear of hydraulic equipment parts increases.

3. Efficiency improvement methods of the hydraulic gear under refrigeration

The problem of increasing the efficiency of a Hydraulic gear is solved at the stage of its design, manufacture and operation [7-9].

The use of high-strength materials for the manufacture of critical parts of hydraulic equipment. As an example of this direction of improving efficiency, we can note the use of more resistant metals in pumps, regulating and guiding hydraulic equipment for the manufacture of parts subject to cavitation erosion. The use of cold-resistant steels for the manufacture of rods and eyelets of hydraulic cylinders, pump shafts and hydraulic motors, the use of durable and frost-resistant polyurethane and rubber-fabric seals of hydraulic equipment, which have high strength, retain sufficient elasticity in a wide temperature range and are not subject to intensive aging and vulcanization.

The use of new, more advanced designs of hydraulic equipment.

Even small changes in the design of existing hydraulic equipment can improve their performance at extreme temperatures. For example, the use of elastic gaskets and changing the fit in the connection of the fitting-distributor housing allows you to reduce the low-temperature destruction of the latter. Reducing the stress concentrators on the shaft of pumps and hydraulic motors also reduces their breakdowns during the start-up period with precision connections of the guide and control equipment. The use of appropriate landings in hydraulic equipment eliminates cases of low-temperature pinching of moving elements in the gaps and thereby prevents possible emergency situations.

Development of modern hydraulic systems. The use of rational wiring of the hydraulic system, reducing the length and bends of the suction, pressure and drain hydraulic lines due to the rational arrangement of hydraulic equipment on the machine, the use of an electrohydraulic control method and combining the functions of two or three hydraulic devices in one allows you to reduce energy losses in hydraulic lines and increase the useful forces on hydraulic motors at low ambient temperatures and power fluid [10]. This method should include, for example, the use of hydraulic locks or chokes with check valves designed to prevent rapid spontaneous lowering of working equipment, the use of secondary safety valves, as well as valves with various logical functions. In addition, it is possible to
significantly improve the performance of hydrosificated machines by using adjustable axial-piston pumps with a so-called zero-setter, which automatically reduces the angle of inclination of the cylinder block when the pump is started and thereby ensures minimal fluid supply. This allows you to reduce the typical pressure during the start-up period and, as a result, the torque on the shaft, which ultimately eliminates bullying and jamming in the piston group of the pump.

After conducting the experiment, the dependence of the machine performance was revealed with the use of a preheating device for the power fluid and without the device. The analysis of the graph showed that without the use of the device, the unit reaches its calculated performance only after 2.5 hours of operation.

Figure 1. A graph of the dependence of the machine's performance on the operating time:

1 - operation of the Hydraulic gear and internal combustion engine without a preheating device for the power fluid, 2 - operation of the Hydraulic gear and internal combustion engine using a preheating device for the power fluid.

Preheating of an internal combustion engine at low temperatures with a high efficiency, high speed, and at the same time the simplicity and low cost of the device that performs preheating.

Goremje process must be kept under control, for which the device has sensors [11-13]:

- a temperature sensor or a flame indicator that turns off the glow plug in a timely manner, igniting the fuel at first;
- sensor for air temperature or coolant temperature;
- an overheating sensor that stops the operation of the pre-heater in emergency situations, somehow muffled exhaust gas output, etc.
- Thus, the use of the heater leads to:
• an increase in the engine life (cold start, as is known, is equivalent to 600 km of a normal summer run, the pre-start heater thoroughly prepares the engine for starting and working "on cold");
• ecology (from the point of view of environmental protection, antifreeze heaters are positioned as the right equipment, the engine is warmed up, and harmful emissions are minimal).

4. Conclusion
After conducting the experiment, the dependence of the machine performance with the use of a preheating device for the Hydraulic gear power fluid and an internal combustion engine without a device was revealed. Thus, the heating of the internal combustion engine and the heating of the power fluid in the hydraulic system are one of the main factors for increasing the productivity of the machine.

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