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Influence of Increased Temperatures on Operability of The Hydraulic Drive

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In articles the issue of improvement of quality and efficiency of operability of hydraulically operated cars is investigated at influence of increased temperatures of working liquid and environment. The problem ensuring operability of a hydraulic actuator of the cars operated in wide temperature range, and increase of their efficiency is one of the most actual in domestic mechanical engineering.

Keywords: hydraulic actuator, means of cooling of working liquid, multiple-pass heater, experimental stand.

In hydraulic systems of self-propelled cars temperature of working liquid and environment changes over a wide range: from -50 °C to +90 °C and above. The bottom limit of temperatures is defined minimum temperature and a climatic zone in which the car works. The top limit of temperature of working liquid depends on the maximum ambient temperature, speed of a wind, level of solar radiation, duration of light day, design features of a hydraulic actuator and a mode of its work [1, 2].

To design features carry the capacity and standard sizes of pumps, quantity and types of hydraulic resistance, throttles and valves, capacity and the area of a heat transfer of hydraulic tanks. Regime characteristics are an efficiency of nominal pressure and period of operation of a hydraulic actuator under loading, the frequency of switching of the managing director and the regulating equipment. Constructive and regime characteristics can become the reasons of emergence of the increased temperature in a hydraulic actuator that has a great impact on viscosity of working liquid, physical and mechanical properties of materials, from which the hydraulic equipment is made, on deformation of units hydraulic actuator, changing gaps and interferences in interfaced details.

Operating experience of hydraulically operated cars and results of stand tests of hydraulic actuators show that temperature increase of working liquid more than + 50 °C causes the following undesirable phenomena.

1. The increase of friction in the hydraulic equipment due to weakening of protective properties of oils and formation of details of zones of dry friction on the surface of contact of details. Therefore there is big contact tension and temperature, bringing to increase in intensity of wear of rubbing

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details of the hydraulic equipment (in particular linear wear of plunger of axial and piston pumps [1, 3]), to a gripping of metals in axial and piston pumps and a fatigue spalling (pitting) of teeth in gear pumps.

In research [1, 47] when studying dependence of friction force and friction force of sliding of consolidations of hydraulic cylinders, slide valves of distributors from temperature, the increase in friction forces was shown at temperature increase higher than + 200 °C. It is also noted that artificial support of temperature (viscosity) of working liquid in the optimum range in which energy losses on friction are minimum, it is possible to reduce significantly losses on friction in the hydraulic equipment [1].

2. Reduction of volume efficiency of hydraulic pumps and dispenser owing to increase in internal leakages of working liquid. It leads to decline in production of cars.

Temperature increase of working liquid from +300 ° to +800 ° C leads to decline in production of shovels to 35 % due to increase in time of a running cycle. At an overheat of working liquid to 1000 ° C decrease in working speeds of rods of hydraulic cylinders, increase by 2-3 times of time of a running cycle, forcing pressure drop with 75 to 60 kgfs/cm2, reduction of hour technical productivity more than in two [8, 9] is caused. The raised thermal mode of a hydraulic actuator influences time of continuous operation of hydraulically operated cars. The general losses of productivity for change because of the compelled idle time of the excavator, in this case are reached by 15-18 %.

The volume efficiency of the pump affects productivity during all work of a hydraulic system both at low, and at high temperatures. In work [10] when studying change of duration of a running cycle of the excavator of the Excavator of the fourth dimensional group it was shown that at decrease in volume efficiency of the pump 223.25 twice productivity of the car decreases four times. Dependence of volume efficiency of pumps on temperature (viscosity) of working liquid is presented also in researches [11]. Both raised, and the lowered temperature reduce volume efficiency of various pumps. However axial and piston pumps possess higher and stable volume efficiency at positive temperatures. At increased temperatures reduction of efficiency is caused by internal leakages of the pressure head line in soaking up, through face, radial and axial gaps [12]. In this case except direct link – influence of reduction of efficiency on increase in working temperatures, exists also feedback owing to which high temperature of working liquid causes decrease in efficiency of a hydraulic actuator.

3. The increase in external leakages of working liquid through mobile and demountable connections contradicts ecological safety of the hydraulically operated self-propelled car, reduces volume efficiency, worsens appearance of cars as in places of leaks the dust sticks.

The increase in intensity of oxidation of working liquid (oil aging) and its chemical decomposition results from oxidation by its oxygen of air, temperature, not dissolved air in liquids and abrasive particles thus have catalytic effect. Therefore corrosion wear of hydraulic units is caused. Temperature increase on everyone 8... 10 °C is doubled by oxidation of working liquid.

4. The increase in intensity of relaxation processes, is irreversible reduces working capacity polymeric details of hydraulic equipment.

Temperature change from +200 C to 800 C causes intensity of volume destruction of rubber consolidations that is caused by reduction of hardness of rubber, easing of protective properties of oils and formation of zones of dry friction So, excessive ware of lip seals increases by 1,5 times, rings of round cross section – by 1,4 times [1,13, 14].

5. Owing to thermal expansion at influence of ambient temperature the linear sizes of heated elements and a deviation in system of admissions that can lead to violation of kinematic communications of system change. There is a danger of jamming of details of precision execution.

Three above mentioned factors – viscosity of liquid, physical and mechanical properties of materials and gaps (interferences) in the interfaced details, changing under the influence of increased temperatures, lead to deterioration of a condition of the hydraulic equipment. That in turn conducts to reduction of operational productivity of hydraulically operated self-propelled cars (at temperature more than + 50 °C the hydraulic actuator becomes inefficient, and at further change of temperature (it is above +70 °C) non operable.

Thus, there is a problem of increase of efficiency of operability of hydraulically operated cars at influence of increased temperatures of working liquid and environment. The solution is conducted now in four main directions. First, new materials and designs of details of the hydraulic equipment are applied. Secondly, working liquids of the summer grades are used. They are characterized with raised index of viscosity .Thirdly, level of maintenance of hydraulically operated cars raises. Fourthly, regulation of temperature of actuating liquid in a hydraulic actuator is applied.

It is necessary to remember that all four specified ways of increasing of efficiency of operability of hydraulically operated cars don't exclude and don't replace each other, and are organically combined among themselves and supplement each other. Therefore at design of hydraulic actuators of the cars intended for operation in areas with sharp continental climate, it is necessary to consider possibility of a combination of all ways.

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Влияние повышенных температур на работоспособность гидравлического привода

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В статье исследуется проблема повышения качества и эффективности работоспособности гидрофицированных машин при воздействии повышенных температур рабочей жидкости и окружающей среды.

Ключевые слова: гидроусилитель, средства охлаждения рабочей жидкости, частотный обогреватель, экспериментальный стенд.