

The Influence of Biodegradable Fluids on Deterioration of the Hydraulic Pumps Elements

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Abstract: *This contribution presents the results of measurements of components wear. It has been depending on the roughness measurement and weight components. Roughness of hydraulic pump components has been measured after the test of mineral oil-based liquids type HV and two biodegradable liquids type HETG and HEPR. We measured roughness values of each component using a special device type Mitutoyo Sj 200. The measured roughness results have been graphically compared. We used laboratory scales to weight material and get the results. We noticed the most significant material wear in the bearings and slide plates. There has been the largest weight loss in biodegradable fluid type HETG. We can conclude that the evaluation method based on the wear loss of material is more appropriate. Contribution shows the differences in wear parts of hydraulic pump from the point of view of fluids, as well as the appropriateness of the methods for the evaluation of hydraulic pump wear.*

Key words: Test Bench, Hydraulic Circuits, Pressure Load, External Gear Pump

INTRUODOCTION

Global trend leads that, hydraulic systems are increasingly installed in mechanical engineering. Nowadays, new hydraulic systems have been developing and they are able to work in difficult operating conditions. Hydraulic systems must be able to operate at higher operating pressures and temperatures. This leads to their sophisticated design. The dynamic development of hydraulic systems goes to find new testing strategies of hydraulic fluids. Tests of hydraulic fluids are set in international standards. The new testing strategy of fluid increases the service life of hydraulic systems to ensure their ability in the operating conditions. We can evaluate the properties of hydraulic systems by testing hydraulic fluids. It is important to monitor the technical condition of the hydraulic pump. The quality of the tested fluid depends on the wear of hydraulic components. Analysis of wear metal particles is realized by measuring the weight of hydraulic pump parts and surface quality.

DESCRIPTION OF TRACTOR HYDRAULIC PUMP

When we tested ecological liquids tractor hydraulic pump of type UD-25 was used. It is a one-way gear pump produced by company Jihostroj Aero Technology and Hydraulics, (Česká republika).

Pumps operating at lower pressures used without definition design axial clearance between the gears and the stator. Hydraulic pump of type UD-25 has a bound axial clearance. This type of hydraulic pump is mainly used in tractors of lower power classes. In Fig. 1 are shown the internal parts of hydraulic pump.

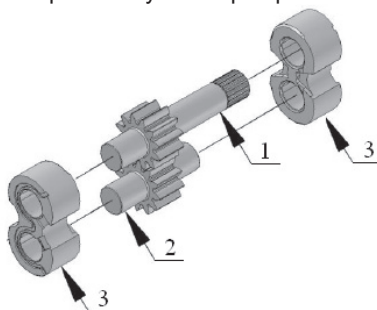


Fig. 1. Internal parts of hydraulic pump UD-25:
1 – drive external gear, 2 – driven external gear, 3 – slide plates

DESCRIPTION OF TEST STAND

Research on the properties of fluids was performed at a test stand (Fig. 2), which was designed and constructed in the framework of research tasks and projects at the Department of Transport and handling. The test stand consists of a hydraulic circuit which used tractor gear pump UD 25. Gear pump is used in the newest tractors Zetor Forterra (Zetor Brno, Czech Republic).

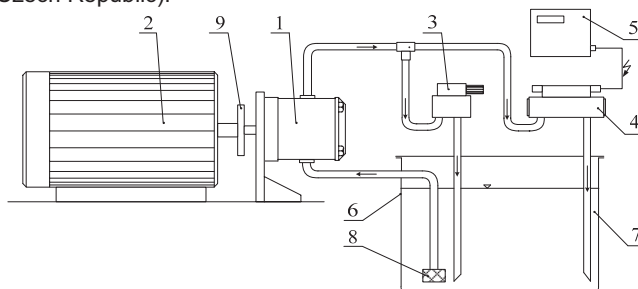


Fig. 2. Laboratory device for loading of biodegradable liquids: 1 – tractor hydraulic pump UD 25, 2 – drive motor, 3 – pressure valve, which is set nominal pressure in the circuit, 4 – hydraulic switch, 5 – control unit, 6 – tank 7 – fluid, 8 – filter, 9 – coupler

The drive motor drives the hydraulic pump. Nominal pressure is set up by pressure valve in the circuit. Cyclic loading of fluid is provided by hydraulic switchgear. Liquid flows through the pressure valve at the nominal pressure of 20 MPa, when the switchgear is in basic position. If the switchgear put to extreme position so the liquid flows directly into the tank. The test stand allows cyclic load of liquid by pressure from 0 MPa to 20 MPa at a frequency of 1.1 Hz. A detailed description of the test stand is shown in the contributions published by: [1], [2], [5], [6], [7]. During the test we used the temperature 65 °C. This temperature was measured in hydraulic circuit of tractor Zetro Forterra 114 41 [3], [4].

DESCRIPTION OF FLUIDS

We evaluated properties of two biodegradable liquids and mineral oil. Fluids were produced by Slovnaft a.s. (Slovak Republic). All fluids are UTTO type (Universal Tractor Transmission Oil) and they are classified as SAE 80W API GL 4. There were tested two biodegradable liquids. One of them based on vegetable oil rape (HETG according to VDMA 24 568) and the other made of the base oil based on poly-alpha-olefins. Mineral oil (HV according to VDMA 24568) terms the NH Farm Ultra Mol. Technical parameters of the test liquids are shown in Table. 1.

Tab. 1. Characteristics the tested liquids

Parameter	value	Liquid type		
		HV	HETG	HEPR
Kinematics viscosity at 100 °C	mm ² . s ⁻¹	10.7	10.38	10.22
Kinematics viscosity at 40 °C	mm ² . s ⁻¹	60	47.89	58.14
Viscosity Index	-	160	213	165
Specific weight at 15°C	g . cm ⁻³	0.888	-	0.8681
Pour point	°C	-39	-39	-42

MITUTOYO SJ 201 DEVICE FOR MEASURING OF SURFACE ROUGHNESS

Mitutoyo S_j 201 device was used to measure the roughness of components hydraulic pump. The device consists of a measuring device, scanning device and connecting cable.

Using the device Mitutoyo we were performed to roughness measuring for bolts, gear tooth surface and sliding bearings.

LABORATORY SCALES

To measure the weight of pump components were used laboratory scales type Kern EWB. Fixing the value of the weighing occurs within 2 seconds. Output device scales is composed of a LCD screen that displays weights weighed in digital form. In measuring weight of gear we did not weigh to the drive gear pump, because during the drive shaft operation its wear in outside part is occurred.

RESULTS AND DISCUSSION

We performed measurements of surface roughness gears pins, gear teeth, and sliding bearings by using the Mitutio SJ 201 device. Each measurement was performed in the biodegradable liquid type HRTG, HERP and mineral oil HV. Roughness measurements results for the components are represented graphically in Fig. 3. The graphical representation of the results shows that the surface roughness of teeth of gears and pins does not show significant differences. Surface roughness of sliding bearings is different depending on the type of fluid. The most striking is the roughness of sliding bearings with fluid type HETG and the lowest fluid type HV. The results roughness of bearings is comparable to the evaluation of fluid properties on the flow characteristics presented in papers [8], [9].

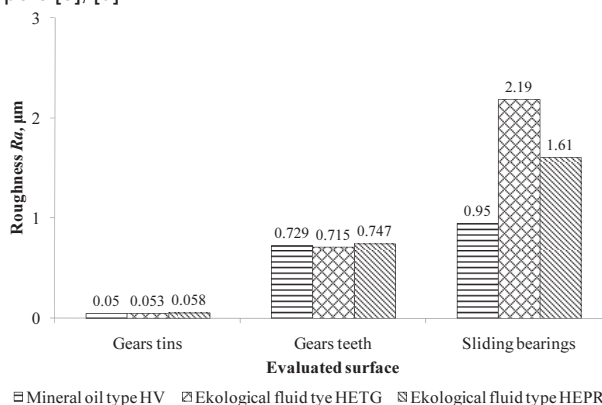


Fig. 3. Comparison of surface roughness R_a for selected components of hydraulic pump

We performed measurements of material loss of slide plates and driven gears using a laboratory scales. The differences in material loss of the pump parts, which are loaded with the individual fluids is shown in Fig.4. The graphical representation of the measurements shows that when measuring weight of slide plates and gears to material loss was the highest for oil type HETG.

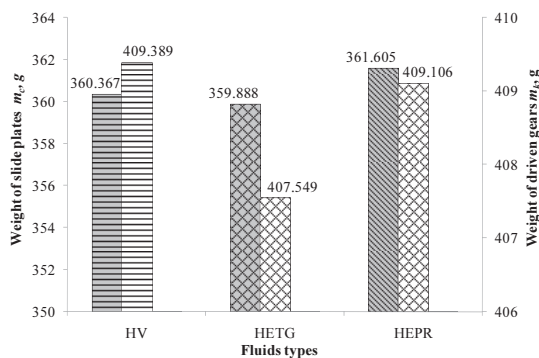


Fig. 4. Comparison of material loss for lead bearing by the weight

CONCLUSIONS AND FUTURE WORK

In this contribution is presented the evaluation of lubricating properties for hydraulic fluids based on wear parts of tractor hydraulic pump. For the tests we used biodegradable fluids of type HETG, HEPR and for comparison mineral oil type HV. We measured surface roughness after the removing components of hydraulic pump, using the device Mitutoyo SJ 201. We performed measurements on the roughness of the pins, gears and sliding bearings of hydraulic pump. For measured values of roughness components show excellent lubricating properties of fluids. The graphical comparison of the wear and tear parts that will wear on most reflected in the slide plates and bearings. In the second case, we measured the loss of material for the weight. We used laboratory scales to measure the weight of the selected components. It was practically a quick method to check the wear of the material by weight. The graphical comparison of the weight of selected components that say the greatest loss of material occurred at the biodegradable fluid type HETG. Contrast, the smallest decline of material was in fluids HV and HEPR

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