ASSESSMENT OF SUITABILITY FOR USE OF BIODEGRADABLE FLUIDS ON THE BASIS OF AN ACCELERATED DURABILITY TEST OF TRACTOR HYDROSTATIC PUMP

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This article deals with evaluation of synthetic biodegradable fluid on the basis of accelerated durability laboratory test of hydrostatic pump UD 25 type. This hydrostatic pump is used in the new tractor Zetor Forterra. The evaluation parameter of laboratory test is hydraulic pump flow efficiency, which characterized the technical state degradation of hydrostatic pump. During the test was used a new synthetic biodegradable fluid, which have usage in agricultural machines as shared hydraulic-gear fill. From results it can be concluded that the fluid has very good properties when working with tractor hydrostatic pump UD 25 by reason that was obtained only 1.03% decrease of flow efficiency and the limit value 20% was not exceed.

Introduction. Fast development and increasing level of technology currently allow wider to deal the question of environmental protection. One answer to this question may be the development of new hydraulic fluids that are environmentally friendly. These fluids have to be before first use thoroughly tested. During the test are detected mainly their properties and impact of fluids on elements of the hydraulic circuit. To advantage are used laboratory tests in which increase a particular nominal parameter we achieve a shortening the test period, resulting in comparison tests in use lower financial burden.

Material and Methods. The accelerated durability test has been carried out with vegetable oil and new developed synthetic biodegradable hydraulic fluid. During the test was evaluated their impact on the technical state of hydrostatic pump used for the test.

Vegetable oil MOL tract ERTTO - it is biodegradable universal tractor oil, which is produced vegetable oil based and special kinds of additives. It is universal tractor hydraulic oil for the lubrication of gearboxes, axle drives, hydraulic circuits and other.

Table 1.

Basic parameters of ERTTO fluid

Parameter	Unit	Value
Kinematic viscosity at 100 °C	$mm^2 . s^{-1}$	10,38
Kinematic viscosity at 40 °C	$mm^2 . s^{-1}$	47,89
Viscosity index *VI*	-	213
Pour point	*°C*	-39

Synthetic biodegradable hydraulic fluid Farm UTTO Synth - the fluid belongs to Universal Gear hydraulic fluids designed for tractors. By reason of this is a newly developed hydraulic fluid, the manufacturer has not provided (Mol Group) closely specifications.

Table 2.

Basic parameters of UTTO fluid

Parameter	Unit	Value
Kinematic viscosity at 100 °C	$mm^2 . s^{-1}$	10,22
Kinematic viscosity at 40 °C	$mm^2 . s^{-1}$	58,14
Viscosity index *VI*	-	165
Pour point	*°C*	-42

Pump UD 25 type - during the durability test was evaluated the impact of selected hydraulic fluids on technical state of hydrostatic pump. For test was selected the hydrostatic pump UD 25 type, which is used in the latest tractors Zetor Forterra.

Hydrostatic pump UD 25 type (fig. 1) is one-way gear pump, it has the possibility of the wide size range of geometrical volume (V_g=5 cm^3 ÷40 cm^3) under nominal pressure up to 30 MPa. The hydrostatic pump is equipped with a hydraulic pressure compensating of axial clearance, which is created with shape sealing in bearing fronts.

Fig. 1. Hydrostatic pump UD 25.

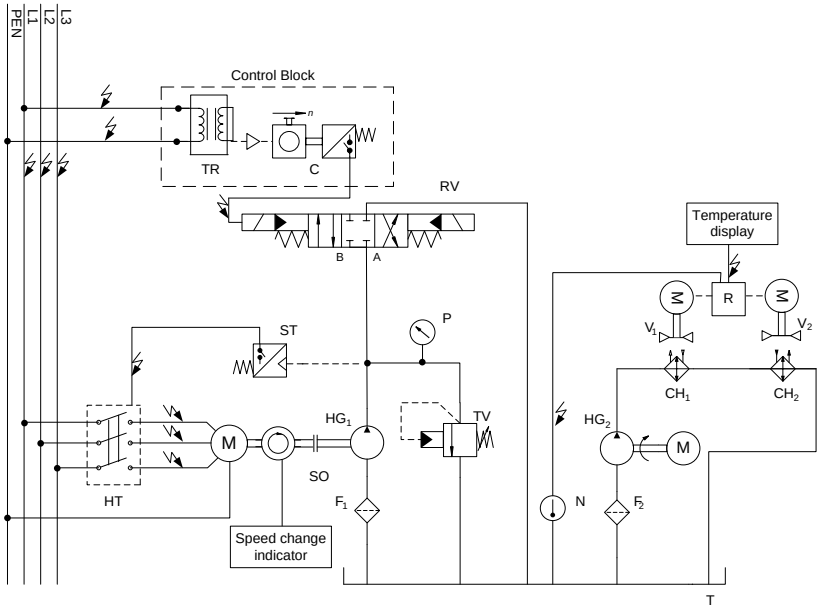

Fig. 2. is the scheme of the test device of hydraulic fluids.

On this test device (fig. 2) were performed the tests of biodegradable hydraulic fluid and mineral oil. The test board consists of a tractor hydraulic pump UD 25 type in the scheme marked as HG_1. The hydraulic pump output is connected to slide valve RV. Hydraulic pump is connected to pressure relief valve TV in parallel, which is set to nominal value pressure of hydraulic pump p = 20 MPa. Slide valve electromagnets are powered from the control block. Flow rate change of fluid results from change of slide valve. The fluid flow through pressure sequence valve (slide valve is in his middle position), or via slide valve directly into the tank (slide valve is in left position). So the cyclic change of pressure stress the tested fluid on output.

Results and Discussion. In literary sources states that a minimum service life of hydrostatic pump has to be 10^6 cycles and decrease flow efficiency should not exceed 20%. Flow values were measured with digital recording unit HMG 2020 and after that processed in graphic form of flow characteristics. From statistical processing flow values were calculated the flow decreases of efficiency, which in our case is characterized by the degradation of the technical state of hydrostatic pump. In order to prevent measurement errors due to the change of viscosity, during the measurement was the temperature of fluid kept in constant level.

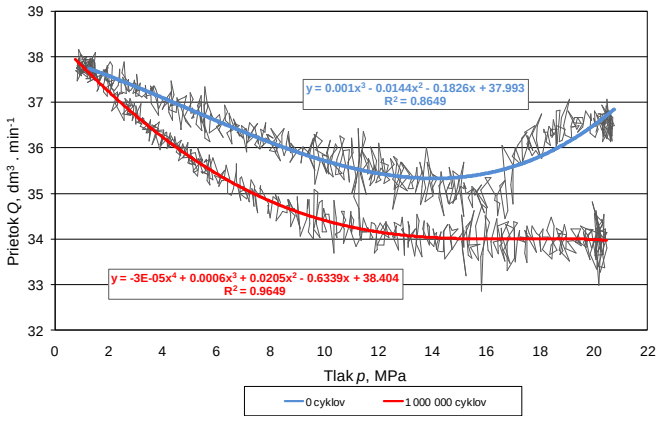

Figure 3. Flow characteristics of hydrostatic pump with vegetable oil ERTTO type.

Wear of hydrostatic pump accompanied by a decrease of leakage resistance, which is the maximum for a new hydrostatic pump and during operation there is its decrease, and therefore will decrease the flow values flow rate.

In Fig. 3 and 4 are flow characteristics of the hydrostatic pump which worked with tested hydraulic fluids. Characteristics were measured every 250 000 cycles. For greater clarity we are presenting the characteristics only at 0 cycles (new pump) and at 10^6 cycles (pump after the test end of test). On the basis of the flow, which are measured at the nominal parameters of hydrostatic pump, that is n = 1500 min^{-1}, P = 20 MPa and the liquid temperature t = 50 ° C ± 2 ° C and its statistical processing, we calculated the decreasing of flow efficiencies, fig.5.

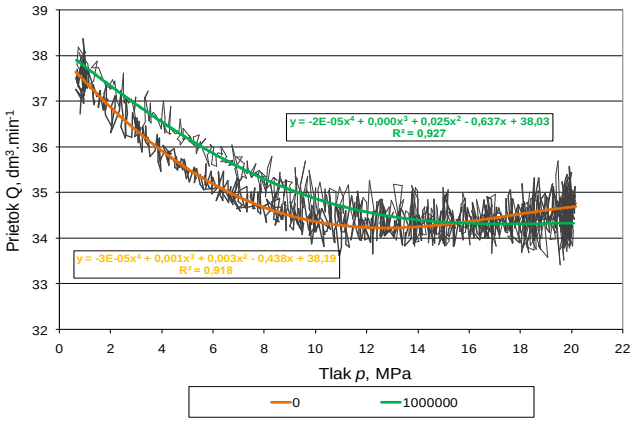

Fig. 4. Flow characteristics of hydrostatic pump with synthetic fluid UTTO type.

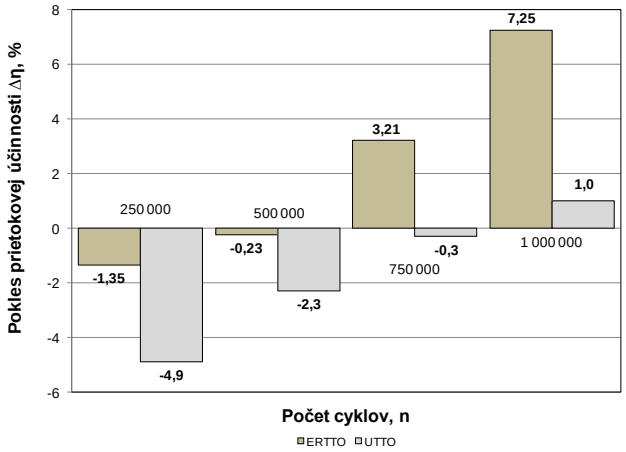

Fig. 5. Comparison of hydraulic fluids on the basis of the decrease of flow efficiency.

From the decrease of flow efficiencies of the working media is seems (fig. 5) that the new developed hydraulic fluid UTTO type, the hydrostatic pump improve its operating parameters, up to 750 000 cycles, which we attribute to the running-in process and it presents a negative numbers of decrease of flow efficiencies values.

After the end of test was measured 1,03 % decrease of flow efficiency. When vegetable oil type ERTTO was observed the running-in process was to 500,000 cycles and from that moment began operation wear, what we presented with positive values of decrease of flow efficiencies.

Conclusion. This article presents the accelerated laboratory test of hydraulic fluids and then their comparison. As a working medium were selected on the test, the vegetable oil ERTTO type and the newly developed synthetic biodegradable fluid UTTO type. Fluids were evaluated on the basis of the technical state of tractor hydrostatic pump UD 25 type, which was determined by the decrease of flow efficiency. This decreases was calculated by statistical processing flow values , which were measured every 250 000 cycles.

From the comparison of both fluids can be concluded that the newly developed synthetic fluid was during accelerated durability test better operating properties, because was observed 1.03% decrease of flow efficiency of hydrostatic pump, while by vegetable oil this value was 7.3%. Hydrostatic pump in both cases showed good operational parameters, because in any case the limit value 20 % of decrease of flow efficiency was not exceeded.

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