The durability test of tractor hydrostatic pump type UD 25 under operating load

Š. Drabant, J. Kosiba, J. Jablonický, J. Tulík

Department of Transport and Handling, Faculty of Agriculture Engineering, Slovak University of Agriculture in Nitra, Nitra, Slovak Republic

Abstract


The results of the UD 25 hydrostatic pump durability test are presented; they were obtained in the laboratory under operating load. The test of operating load was a continuation of the hydrostatic pump durability test with a cyclic pressure loading according to the norm STN 11 9287. It lasted 300 hours, with 70°C ± 2°C of hydraulic fluid temperature. The aim of the test was to simulate the operation of the hydrostatic pump under load in laboratory and to find out its deterioration and the influence of a biodegradable fluid on its qualities. The achieved results confirmed that flow efficiency of the UD 25 hydrostatic pump decreased only to 3.6% which points to its good technical state even after the test performance. Meanwhile we can state that the used ecological hydraulic fluid on the basis of a vegetable oil "Environmentally responsible tractor transmission oil", produced by the Slovnaft company, Inc., is characterised by very good qualities.

Keywords: hydrostatic pump; operation load test; simulation; flow characteristics; ecological fluid

MATERIAL AND METHODS

To simulate the operating load it was necessary to suggest and realize a testing device to be used in laboratory. For this purpose it was first necessary to achieve time courses of pressures on the output of tested UD 25 hydrostatic pump. The time courses of loading pressures were achieved by the measurement in a hydraulic system of the Zetor Forterra 114 41 tractor while plowing in a set with a 5-PHN 30 plough within a strength regulation (Tkáč et al. 2006). The measured time courses of the pressure loading were exposed to the analysis from both amplitude and frequency view. On the basis of the performed analysis it was possible to judge the adequacy of the suggested and realised testing device for the simulation of the operating load in laboratory. In Fig. 1 a scheme of a

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The testing device was suggested with reference to works by Drabant et al. (2005), Tkáč et al. (2008a), and Kročko et al. (2008).

The durability test with the operating load was realised at the Department of Motor Vehicles and Heat Devices, Technical Faculty of the Slovak University of Agricultural in Nitra. Fig. 2 depicts a view of a testing device in laboratory.

On the testing device the time courses were simulated; they were achieved on the output of the hydraulic hydrostatic pump under the operation conditions while plowing. The chosen time course is depicted in Fig. 3.

Time changes of course pressures in hydraulic system in output hydrostatic pump are exemplified in Fig. 3. By ploughing with Zetor Forterra 114 41 tractor with 5–PHN 30 plough (Fig. 4), output hydraulic pressures oscillate from 1 to 6.5 MPa. Measured courses of pressures demonstrate that hydraulics used in the tractor with 5–PHN 30 plough is sufficient. Tkáč et al. (2004) measured the amplitudes of pressure in output hydrostatic pump; ZTS 164 45 tractor with 5–PHX 35 plough at ploughing gave the values from 1 to 8 MPa, whereas ploughing with KUHN plough resulted in amplitudes of pressure from 1.5 to 9 MPa. ZTS 164 45 tractor has bigger amplitude pressure because ploughs have one ploughshare more and the tractor has bigger delivery. Yet, we can establish that our results are comparable to the results with the ZTS 164 45 tractor (Tkáč et al. 2004; Cvíčela et al. 2008).

The testing device was operated and run by a computer control system. The block scheme of the control system is depicted in Fig. 5.

The basic blocks of the control system were the personal computer with the D/A converter off-set and an ERJ electronic control unit. The operation alone of the...
electrohydraulic proportional pressure EHTV valve was realised with a digital-analogical converter D/A and an ERJ electronic running unit. The converter D/A converted digital signal of computer into analogue signal, the pressure running $U_R$ was a time function. The analogue signal $U_R = f(t)$ was subsequently amplified in an ERJ electronic control unit and transported on a EHTV proportional pressure valve.

As a filling, the MOL Tractol ERTTO oil, a biologically degradable hydraulic fluid, was used; it was produced by the Slovnaft company, Inc. The technical data of the oil are depicted in Table 1 (Slovnaft company, Inc. 2007).

In order to find out the influence of the hydraulic fluid on the qualities of the hydrostatic pump, it was necessary to measure the flow characteristics.
With application of the Ekouniverzal oil, ZTS 8011 tractor with hydrostatic pump type PZ 2–18 KS was in operation from 0 to 2,242 Mh; from output pressure of the hydrostatic pump of 16 MPa and nominal speed of hydrostatic pump of 2,200 rpm at 0 Mh, flow rate was measured as 22.80 dm$^3$/rpm. After 2,242 Mh, flow rate was measured as 19.05 dm$^3$/rpm. Durability of hydrostatic pump, type PZ 2–18 KS, is 2,000 Mh. On the basis of the measurements a decision was made that the hydrostatic pump has to be changed because the measured flow rate (19.05 dm$^3$/rpm) was close to the minimal value 19 dm$^3$/rpm (Tkáč, Škulec 2002; Tkáč et al. 2003).

**RESULTS AND DISCUSSION**

The flow characteristics were measured during the durability test with the operating load (300 h) in intervals of 60 and 120 h. The characteristics were measured at the stated rotations of 800 rpm, 1,200 rpm and at nominal rotations of 1,500 rpm. Each measurement was repeated several times on the basis of calculation of the needed number of measurements.

Table 1. Technical data of the MOL Tractol ERTTO vegetable oil

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kinematic viscosity under 100°C (mm$^2$/s)</td>
<td>10.38</td>
</tr>
<tr>
<td>Kinematic viscosity under 40°C (mm$^2$/s)</td>
<td>47.89</td>
</tr>
<tr>
<td>Viscosity index VI (–)</td>
<td>213</td>
</tr>
<tr>
<td>Pour point (°C)</td>
<td>–39</td>
</tr>
</tbody>
</table>

In Fig. 6 the single measured points are depicted, with the flow characteristic of $n_G = 1,500$ rpm, after 60 h of the UD 25 hydrostatic pump durability test with the operating load in laboratory. For more transparency and facilitation of comparison of the achieved results, only the curves without the measured points will be further depicted. These curves, so called trend lines, were reached with a regression analysis using the polynomial model of the 3rd grade in the MS Excel program.

In Figs 7 and 9 the flow characteristics of the UD 25 hydrostatic pump are depicted; they were determined for the evaluation of the influence of the ERTTO (Environmentally responsible tractor transmission oil) hydraulic fluid on its durability during the operating load test. These figures also present flow characteristics of the new hydrogenator at 0 cycles and after performing $10^6$ cycles according to the norm STN 11 9287, which were achieved before the UD 25 hydrostatic pump durability test with the operating load.

Tkáč et al. (2008b) introduces description of testing equipment according to the norm STN 11 9287, which was implemented in the test.

Revolution of 1,500 rpm and pressure of 20 MPa at 0 Mh result in the flow rate of 34 dm$^3$/rpm and of 33.15 dm$^3$/rpm at 300 Mh. The flow rate decrease is 2.5%. Škulec et al. (2001), using the PZ 2–19 KS hydrostatic pump with Ekouniverzal oil, obtained a decrease of flow rate of 1.25% at revolution of 1,500 rpm and pressure of 16 MPa after 300 Mh. Test of hydrostatic pump, type UD 25, under operating conditions followed after laboratory test. The flow rate decrease of hydrostatic pump type PZ 2–19 KS (Škulec et al. 2001) was two times higher compared with the UD 25 hydrostatic pump that we tested.
CONCLUSION

The UD 25 tractor hydrostatic pump durability test with the operating load lasted 300 h in laboratory and followed after the test of the $10^6$ cycles according to the norm STN 11 9287. The operating load test was performed with the MOL Tractol ERTTO biodegradable oil produced by the Slovnaft company, Inc. After 60, 180, and 300 h of performance the flow characteristics were measured at above-stated rotations (800, 1,200, 1,500 rpm) of the UD 25 hydrostatic pump.

On the basis of the achieved results we found out that the measured flow characteristics of the UD 25 hydrostatic pump have only a minimal decreasing tendency from 0 to 300 h. After the end of the durability test with the operating load in laboratory, the flow efficiency of the UD 25 hydrostatic pump decreased by 3.6%, which points at a good technical state, and is a proof of high quality of the used ecological hydraulic fluid on the basis of the ERTTO vegetable oil produced by the Slovnaft company, Inc.

References


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Corresponding author:
Ing. Ján Kosiba, Slovak University of Agriculture in Nitra, Faculty of Agriculture Engineering, Department of Transport and Handling, Tr. A. Hlinku 2, Nitra 949 76, Slovak Republic
phone: + 421 0908 305 389, e-mail: jan.kosiba@gmail.com