APPLICATION OF SYNTHETIC OIL IN TRACTOR HYDRAULIC CIRCUIT

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Abstract: The paper deals with operational application of synthetic oil MOL FARM UTTO Synt in the hydraulic circuit tractor Zetor Forterra 114 41. Synthetic oil is being developed in cooperation with Slovnaft Plc. Operating application followed after the laboratory tests that were carried out according by standard STN 11 9287. Before long operating test was verified temperature and pressure regimes in outlet hydrostatic pump. In verifying these procedures as an additional device was used plow Kverneland LD 100, in which was the hydraulic circuit of maximum stress. The measured values of operating regimes did not show risk of using synthetic oil.

Keywords: TRACTOR, SYNTETIC OIL, HYDRAULIC CIRCUIT

1. Introduction

Protecting of environment is forcing manufacturers of fuels and lubricants as well as manufacturers of agricultural equipment to use liquid produced by plant-based. Almost 50% of all the sold oils in the world finish at present times as forfeits during the operation in nature [Jakob, 2006]. Therefore it is extremely important to replace mineral oils with vegetable oils or synthetic oils of plant-based [Tkáč, 2010 et al.].

At the present time, hydrostatic systems are widely dispersed in the industry. It provides the various types of motions. The power transmission is realized by hydraulic fluid. Hydraulic fluid needs service and observation of operating parameters [Majdan, 2010 et al.].

Operating measurement of temperature and pressure regimes of hydraulic circuit of tractor Zetor Forterra 41 114 was made long before the performance test. In working conditions of agricultural tractors plays a crucial role operating temperature of common transmission-hydraulic oil fill [Majdan, 2010 et al., Cvíčela, 2008 et al.]. The objective of operational test is to verify the possibility of using synthetic oil Mol Farm UTTO Synt in gear and the tractor hydraulic circuit. Temperature and pressure regimes were measured at the exit of hydrostatic pump UD 25.

Zetor Forterra has a common oil reservoir for transmission and hydraulic circuit. Therefore is used universal synthetic oil. Oil Mol Farm UTTO Synt is being developed in cooperation with Slovnaft Plc.. From utilization of hydraulic fluid in a machine point of view there is the most important to know the running properties of fluid i.e. to know the influence of fluid on technical state of parts in the hydraulic system [Tkáč, 2008 et al., Jablonický, 2007 et al.].

2. Prerequisites and means for solving the problem

In order to investigate temperature and pressure regimes output hydraulic pump the tractor worked at the maximum operating load. Tractor assembly was made up of 114 tractors Zetor Forterra 41 and plow Kverneland LD 100 (Fig. 1). It is about 4 plough-share tillage depth was 20 cm

Fig. 1 Zetor Forterra 114 41 and plow Kverneland LD 100

To drive the tractor Zetor Forterra 114 41 uses 4-cylinder engine with a rated output of 81 kW. The type of electrohydraulic system is settled in 23 SS. Working pressure in the hydraulic circuit is 18 MPa. Hydroelectric generator is directly dependent on the engine run, it means if the engine is in operation and is in operation and pump.

Operational measurement lasted 3000 seconds (50 minutes) which was sufficient to stabilize the temperature in the hydraulic and gear circuit of tractor. Before applying synthetic oil was the hydraulic circuit and the transmission cleaned and at the same time were changed oil filters. Tractor was placed on a new hydrostatic pump UD 25. Technical parameters of oil Mol Farm UTTO Synt are listed in Table 1

Tab. 1. Specifications of oil Mol Farm UTTO Synt

Properties	Unit	Valuation
kin. viscosity by 100 °C	mm^2/s	10,22
kin. viscosity by 40 °C	mm^2/s	58,14
viscosity index		165
density by 15 °C	g/cm^3	0,8681
pour point	°C	-42
flash point	°C	232

In measuring of operating modes was set to land two sections measuring 200 m in length, each of which was divided into three sections (50 m + 100 m +50 m). One 100 m section of the pole was divided to 10 equal sections of length 10 m. Compared to the pole after each pass of plough rigs was measured working width shot. The measurements were made with a steel band within ± 5 mm. Similarly, after each passage was measured depth of tillage. The measurement was taken furrow meter with an accuracy of ± 5 mm [Cvíčela, 2008 et al.].

To create pressure in the hydraulic circuit used gear hydrostatic pump UD 25 from firms Jihostroj Aero Technology and Hydraulics. Geometric volume hydraulic pump is 25 cm^3. Nominal outlet pressure is 20 MPa and the nominal speed is 1500 min^{-1}. Hydrostatic pump is equipped with a hydraulic pressure compensating axial float, which is created directly in form-fitting seal bearing bushes.

To measure the pressure on the hydraulic pump output pressure sensor was used HDA 3444-A-250-000 from HYDACs' company with a nominal measuring range of 25 MPa. For temperature measurement was used temperature sensor Pt-100 from MARET, p. r. o. Temperature and pressure sensor was placed at the exit of hydrostatic pump UD 25 (Fig. 2), by coupling flange created for the purpose of measuring the operating modes of output hydrostatic pump UD 25.

Fig. 2 Location of temperature and pressure sensor

To record measured values used digital recording unit HMG 2020 Recorder is designed to measure electrical quantities and resistance in real time and record into memory on a subsequent transfer of information to your computer. The unit contains circuitry to convert analog signals into digital form. HMG digital recording unit 2020 records the measured values in preset intervals.
For digital recording unit was set interval 1 second. When running the measurements were made and additional measurements. And turning and lifting attachment. During measurements the digital recording unit to set the time interval 0.02 seconds, because the greatest possible accuracy.

3. Results and discussion

Description and measurement conditions:
Type tractor: Zetor Forterra 114 41
Measuring point: Marcelová
Type of work equipment: plough Kverneland LD 100
Ambient air temperature: 26,2 °C
Humidity: 36%
Driving position: 4 driving position with reduction
Type regulation: position control
Depth ploughing: 20 cm
Running speed: 8,2 km/h

Fig. 3 Location digital recording unit HMG 2020 tractor during the operational measurement

Operational measurement lasted 3000 seconds (50 minutes) in the autumn plowing. Before measuring, there was located on the outlet hydrostatic pump coupling flange for temperature and pressure sensor. During the operating measurement on tractor was set digital recording unit HMG 2020 (Fig. 3).

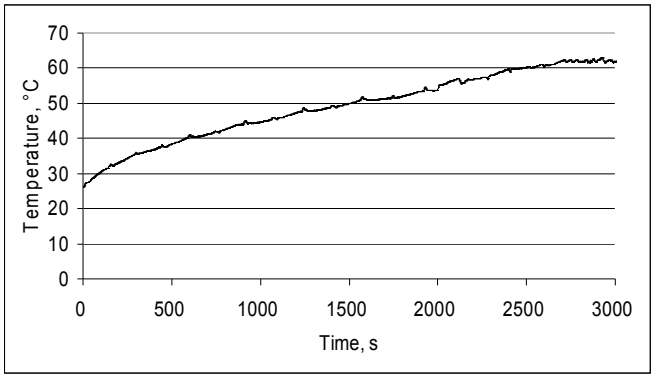

Fig. 4 Outlet Temperature of Hydrostatic Pump

Figure 4 is the temperature on the outlet of hydrostatic pump. Initial temperature synthetic oil and thus the entire tractor was 26.2 °C. The temperature in the hydraulic and gear system has stabilized approximately after 2500 seconds. Oil temperature fluctuated with minimum deviations after stabilization of temperature values around 62 °C.

In the application of mineral oil in PP 80 gear and hydraulic system of tractor Zetor Forterra 114 41 temperature stabilized on outlet of hydraulic pump after approximately 2500 seconds. Tractor assembly was made up of tractors Zetor Forterra 114 41 and combined cultivators B 231. The tractor was put to a reduction of 1 degree. The initial oil temperature of hydraulic pump outlet was 50 °C, oil temperature fluctuated with minimum deviations for temperature stabilization around a value of 66 °C [Kosiba, 2010 et al.].

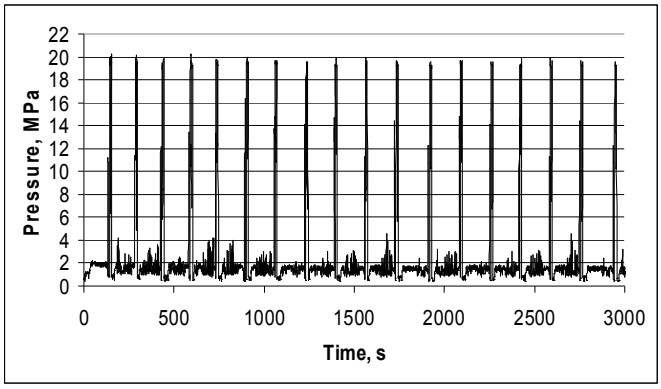

Fig. 5 Outlet Pressure of Hydrostatic Pump

Figure 5 shows the hydrostatic pump pressure output. Working pressure ranged from 1.2 to 2 MPa. Pressures at the tip of the operations reached the 3 to 4.3 MPa and were due to increased soil resistance. When turning the tractor at the headland reached hydraulic pump pressure output value of 20 MPa. Value at a pressure of 20 MPa hit the pressure relief valve to release oil back into the tank. Where caused by lifting and turning plow Kverneland LD 100.

When tractor kit, which consisted of 114 tractors Zetor Forterra 41 and plow 5-PHN 30, working pressure ranged from 1.2 to 1.8 MPa. The hydraulic and gear system was applied to mineral oil PP 80. Plow 5-30 PHN is 5 unilateral plough-shares which means that there is no need to turn on the headland. Therefore, there are pressure peaks when turning at the headland. Average tillage depth was 30 cm [Cvíčela, 2008 et al.].

By our measurement, the outlet pressure of hydrostatic pump with synthetic oil achieves a higher operating pressure of 0.2 MPa. Despite the fact that when measured with mineral oil had a plow blade on one more and an average depth of tillage was 10 cm higher. The measured differences were due to different soil types, while varying soil moisture.

Operational measurement of temperature and pressure regimes of hydro output confirms that the use of biodegradable synthetic oil does not risk the use of synthetic oil in the hydraulic transfer system

and the tractor Zetor Forterra 114 41 Maximum temperature of the hydraulic pump output was 62.8 °C and maximum pressure was 20.19 MPa. For more accurate assessment of the characteristics of the load measurements were taken when lifting (Fig. 5) and to rotate (Fig. 6) work equipment. These measurements were made at 50 times the reduction in the time interval for recording measured values compared to the operating modes of measurement. Measurement of load characteristics for lifting equipment and rotate the work lasted 40 seconds. This time was sufficient to determine the load characteristics.

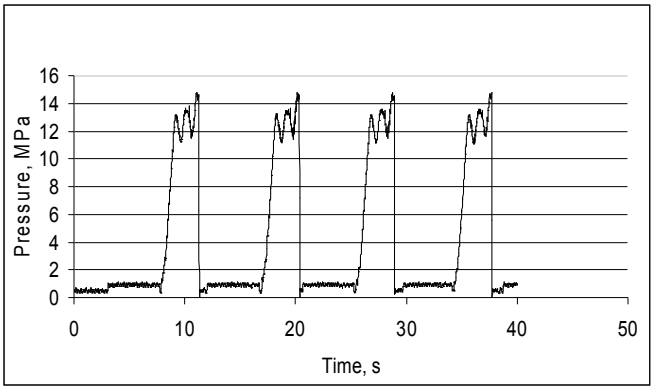

Fig. 6 Time course of outlet pressure hydrostatic pump for lifting the working tools

Figure 6 is the timing of the hydrostatic pump outlet pressure when lifting plow Kverneland LD 100. During the measurements were made 4 strokes. The maximum value of outlet pressure hydraulic pump was 14, 62 MPa.

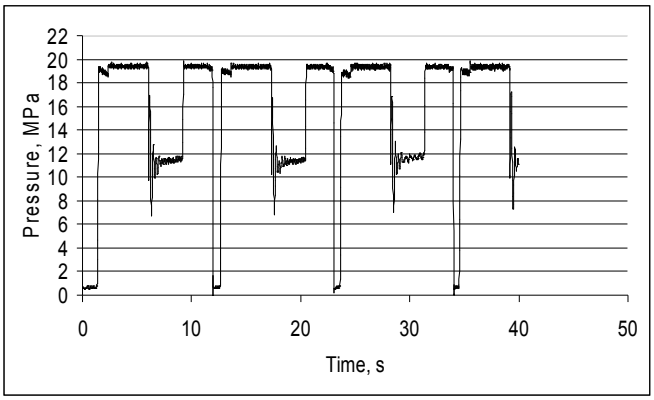

Fig. 7 Time course of outlet pressure hydrostatic pump to rotate the work tool.

Time course of pressure at the exit of the hydrostatic pump to rotate the work tool is in Figure 7. The chart is visible that during the measurements were made 3 complete conversions. Conversion of working tools consisted of two phases. In the first phase there is rotation of the working tools in the transport position. When rotating the pressure reaches the output hydraulic pump almost 20 MPa, the value is affected pressure valve. When remaining in the transport position, the pressure on the hydraulic pump output to approximately 12 MPa. Subsequently it comes to the completion of rotation of work tools, where the pressure is on again hydro output of almost 20 MPa, the value is affected pressure valve.

4. Conclusion

Hydraulic systems of tractors and their level of computerization ensure greater efficiency, accuracy and reliability when working with farm tools [Tkáč, 2010 et al.]. Operational measurements were found of temperatures and pressures in the hydraulic circuit in a set of tractor with a plow Kverneland LD 100. Operational application of synthetic oil developed by Mol Farm UTTO Synt used to verify the possibility of its use. Operational measurement followed the laboratory, which were carried out according to standard STN 11 9287. Readings of temperatures and pressures pose a risk of biodegradable synthetic gear oil in the tractor and hydraulic circuits.

During operational tests are monitored and recorded all work activities carried out by tractor. At regular intervals (450 Mh) will be sampled from tractor oil. These samples are then subjected to analysis in the company Slovnaft Plc. At intervals of 450 Mh will be removed from the tractor pump flow and remeasured its effectiveness. After the overall evaluation of laboratory and operational tests will be evaluated the possibility of further utilization respectively production of synthetic oil Mol Farm UTTO Synt.

The biggest obstacle to the use of synthetic oils in the Slovak agriculture is mainly the price. Since the estimated value of newly developed by the synthetic oil will be approximately double that of mineral oil. It is therefore extremely important legislative and financial support for the use or synthetic biodegradable oils in agricultural enterprises.

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Supported by the Ministry of Education of the Slovak Republic, Project VEGA N° 1/0462/09 The Elimination of Negative Operation Impacts of Machines on Agricultural Land, Water and Atmosphere.