СТВОРЕННЯ, ТЕХНІЧНЕ ОБСЛУГОВУВАННЯ, РЕМОНТ ТА НАДІЙНІСТЬ МАШИН

THE LABORATORY TESTING DEVICE DEDICATED TO EVALUATION OF TECHNICAL DURABILITY OF HYDROSTATIC PUMPS

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Annotation

Substitution of mineral oil with biodegradable base oils is a primary objective. Compared to conventional mineral oil based fluids most of vegetable oils exhibit lower thermal, oxidation stability, and even worse low-temperature behavior. Therefore, accelerated laboratory tests are needed before the substitution of mineral oil with vegetable oil. On the basis demands stated by standard was suggested and tried out testing device. In this paper, a design of a testing device for durability tests of hydrostatic pump type UD 25 is presented. The designed testing device serves for a laboratory verification of an influence of biodegradable oils on a durability of hydrostatic pumps. The designed testing device was built and tried out. The review covers thermo vision image too which was measured after construction of testing devices.

Introduction

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. These facts so show on the necessity of usage and improvement of testing methods. There are testing methods centered mainly on hydrostatic pumps, which have fundamental influence on durability, economy and dependability of hydraulic system in a given machine. A long time testing for getting parameters of durability and dependability is demanding on time and energy that's why in this area of research and development there is necessary to realize rapid laboratory tests of hydraulic parts, which enable to shorten the time of an experiment to define the operational durability. The submitted article deals with the design of testing methods of rapid tests for evaluation of hydraulic fluids influence on technical parameters hydrostatic pumps.

Material and methods

Parameters of Hydrostatic Pump UD 25

The hydrostatic pump type UD 25 is one-direction hydraulic gear pump made by the company: Jihostroj Aero Technology and Hydraulics, Fig. 1. This gear pump is equipped with the hydraulic balancing of axial clearance, which is done by sealing in the end face bearings. It has the application in smaller and medium agriculture and forest machines. The hydrostatic pumps types UD used in tractors Zetor, and in commercial car Tatra (Jihostroj a. s., 2007).

Basic parameters of Hydrostatic Pump Type UD 25 are in Tab. I.

Tab. 1. Parameters of Hydrostatic Pump Type UD 25 (Jihostroj a. s., 2007)

Parameter		Unit	Value
Rotation speed	Nominal	min^{-1}	1500
	Maximum		3000
	Minimum		500
Pressure on the outlet	Nominal	MPa	20
	Max. continuous		23
Nominal volume (geometric capacity) V_G		cm^3	25
Nominal outlet flow rate		$dm^3 . min^{-1}$	35.1
Power demand (nominal)		kW	14.2

Fig. 1. Hydrostatic Pump Type UD 25 (Jihostroj a. s., 2007)

Thermographic camera

The thermographic camera type MobIR M3 (Fig. 2) will be used for measurement of surface temperature of hydrostatic pump UD 25. The surface temperature will be measured during the durability test.

Fig. 2. The Thermographic Camera Type MobIR M3

Devices used for the life test of a hydrostatic pump

On the basis of evaluation of life test according to flow characteristics there is necessary to design two testing devices:

- the testing device for realization of a hydrostatic pump laboratory life test,
- the testing device for measurement of a hydrostatic pump characteristics.

Testing Stand for Realization of Laboratory Durability Test

The designed testing device is shown in Fig. 4.This testing device was designed per standard STN 11 9287. Demands according to standard STN 11 9287 (Fig. 3) are stated as follows: "Technical durability must be minimum 10^6 cycles under cyclic pressure loading from zero to the nominal pressure within frequency 0.5 – 1.25 Hz during velocity of pressure increasing 100 – 350 MPa.s^{-1} and in nominal parameters. It this case decreasing of the volumetric efficiency may be maximum 20 percentages".

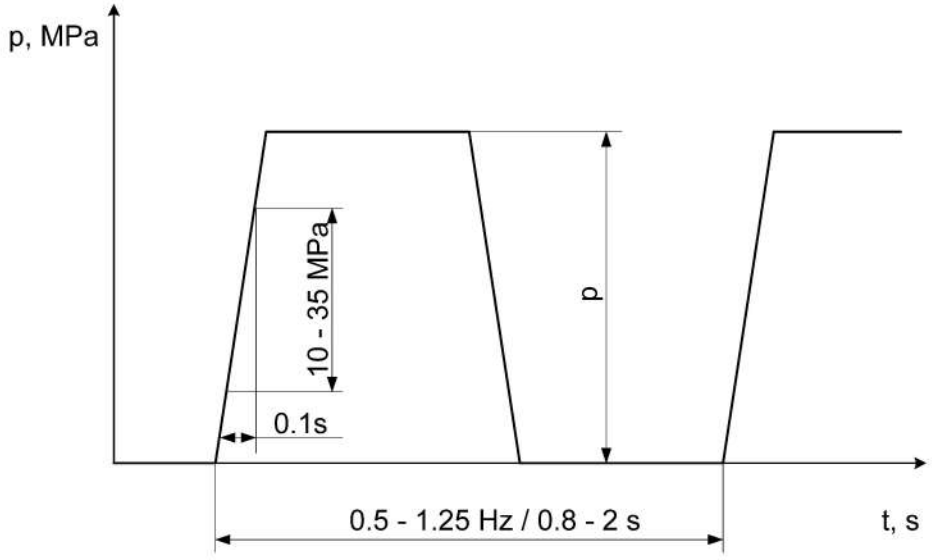


Fig. 3. The course of cycling compression stress according to standard STN 11 9287

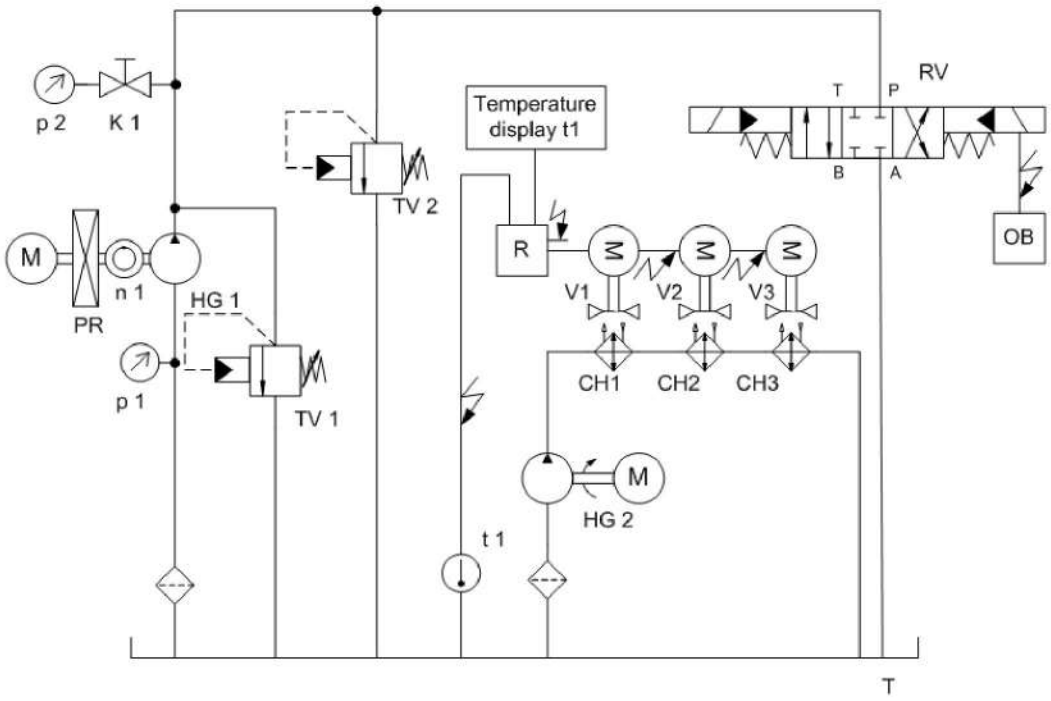


Fig. 4. The testing device for realization of a hydrostatic pump life test

The hydrostatic gear pump UD 25 is marked in scheme (Fig. 4) by symbol **HG 1**. The hydrostatic pump **HG 1** is driven by the electric motor **M.** The gearbox **PR** is placed between the electric motor and the hydrostatic pump to rotation speed change of the hydrostatic pump (the hydrostatic pump with rotation speed n = 1500 min^{-1} does not require gear box but it is directly connected to electric motor **M**.) The adjustment of pressure gradient in the circuit is accomplished by the two-stage sequence valve **TV 2**. The **TV 1** is two-stage pressure relief valve, which limits maximum pressure in circuit by exhausting fluid when the required pressure is reached. By reason of designation of the pressure gradient in circuit the pressure is measured by two pressure gauges, of which one is placed in the suction pipe **p 1** and second one in the pressure pipe **p 2**. The spherical plug valve **K 1** protects pressure gauge **p 2** against pressure dynamic loading during the durability test. The spherical plug valve is only open during the adjusting of the nominal pressure.

The cyclic pressure loading is accomplished by the tree-positions, four-port slide valve with closed center **RV,** which is operated electro-hydraulically. The three positions, four-port valve **RV** is connected to the output pipe of the hydrostatic pump **HG 1**. The change of flow direction is realized by the position change of the three positions, four-port valve **RV.** When this valve is in the mid-position the fluid passes through the sequence valve **TV 2.** When three position, four-port valve **RV** is in the left extreme position the fluid passes in the tank. Thereby, the pressure loading conditions in the outlet of the hydrostatic pump **HG 1** is changed. The view of testing device is in Fig. 5.

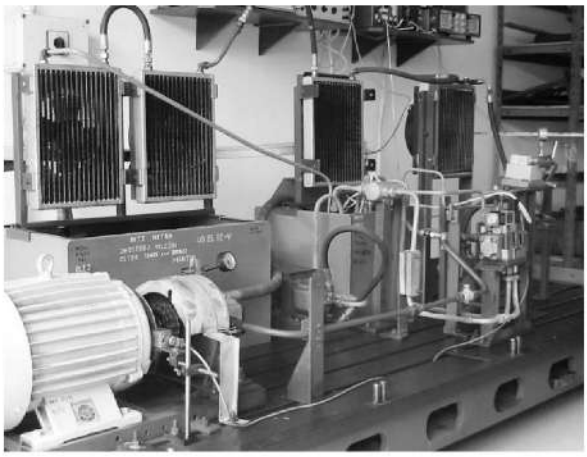


Fig. 5. Designed testing device for realization of a hydrostatic pump life tests

The Testing Stand for Measurement of Characteristics

The design of a testing device (Fig. 6) comes from experience and research work realized in the Department of motor vehicles and heat devices, SPU in Nitra (Radhakrishanan, 2003, Drabant et al., 2005). It is given for measurement of hydrostatic pump

characteristics, which is marked as **HG 2**. The testing stand consists of two hydraulic circuits. The hydraulic circuit, which uses the tank **T 1**, serves for a drive of the measured hydrostatic pump **HG 2** supplied by the tank **T 2**. The outlet pipe from the variable axial piston pump **HG 1** is direct connected to the inlet pipe of angled piston motor **HM 1**. The **TV 1** is two-stage pressure relief valve, which limits maximum pressure in circuit by exhausting fluid when the required pressure is reached.

The tested hydrostatic pump **HG 2** is connected to the circuit with the tank **T 2**. **TV 2** is the two-stage pressure relief valve. The two stage sequence valve **TV 3** is dedicated for adjustment various values of pressure by which is measured flow rate for characteristic Q = f $(p)_n$. The view of testing device is in Fig. 7.

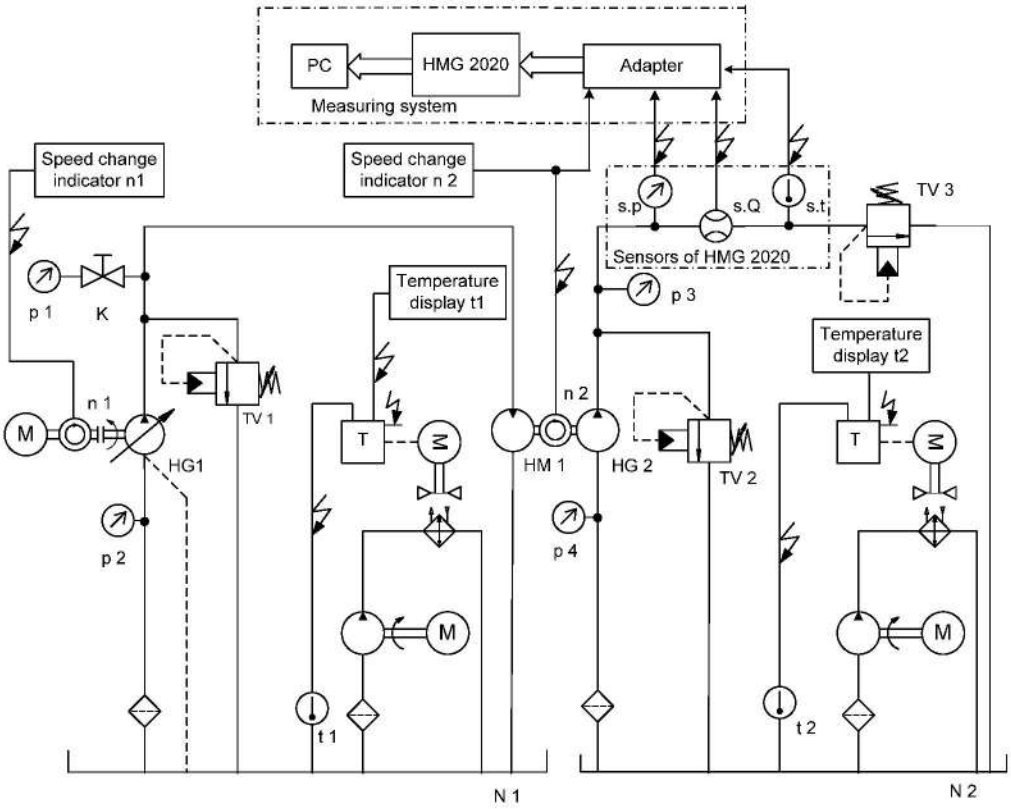


Fig. 6. The testing device for measurement of characteristics in the testing hydrostatic pump

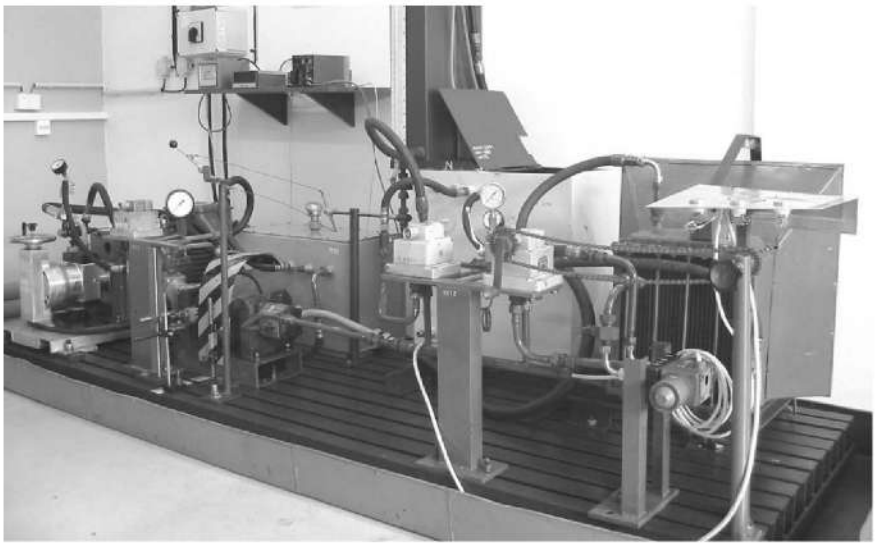


Fig. 7. Designed testing device for measurement of hydrostatic pump characteristics.

Measurement of characteristics

The measurement of characteristics is necessary to realize at constant oil temperature $t = 50\ °C \pm 2\ °C$. By this condition there are canceled the error of measurement caused by the change of hydraulic fluid viscosity by the change of temperature because between fluid viscosity and temperature there is physical dependency.

Before the measurement of characteristic $Q = f(p)_n$ there is necessary to set up rating value of revolutions **n 2** (measured on the hydrostatic pump **HG 2**) by the change of flow in the hydrostatic pump **HG 1**. The measurement of characteristics is realized by gradual increasing of pressure throughout the pressure valve **TV 3** by getting the rating value of pressure in the measured hydrostatic pump **HG 2**. On the basis of data registered in measuring system there is possible to make the flow characteristics $Q = f(p)_n$.

Device Used for Measurement of Characteristics

The measuring system consists of the adapter, measuring device **Hydac HMG 2020** and computer for the evaluation of measured values. It is possible to record simultaneously four analog signals (with input voltage from 0 to10 V or current input from 4 to 20 mA with possibility of switching) and one a frequency signal from 0.3 Hz to 30 kHz by means of measuring device HMG 2020. The analog signals were obtained from the sensors of pressure **s.p**, flow rate **s.Q** and temperature **s.t** by means of adapter (Fig. 5). The frequency input was used for the record of rotation speed **n 2**. The measuring device was connected to the notebook and by this manner all measurement process was controlled.

Thermographic measurement

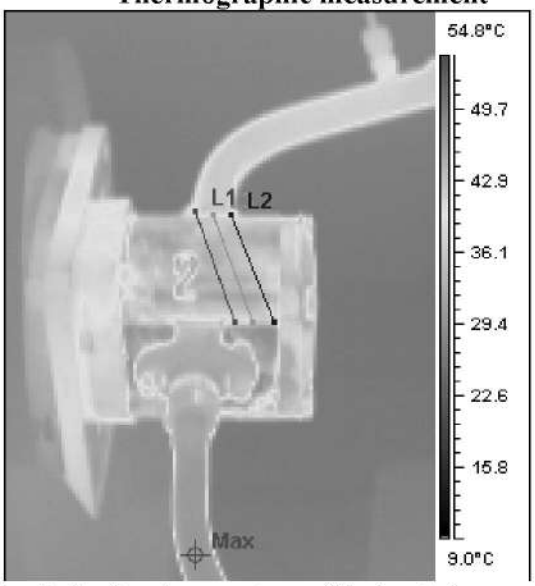
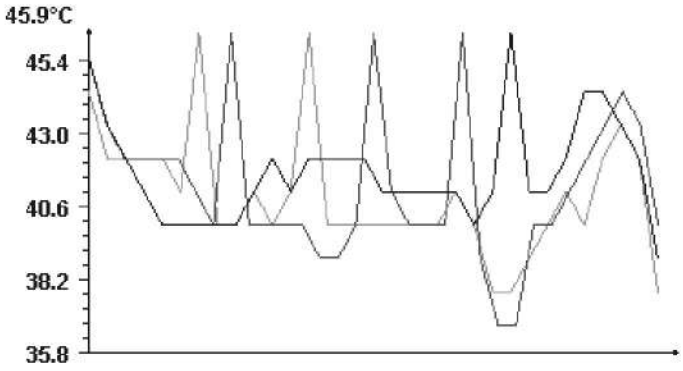


Fig. 8. Surface temperature of hydrostatic pump UD 25

Fig. 8. shows surface temperature of hydrostatic pump UD 25



Object Parameter	Value
Max	53.5°C
L3:AvgTemp	40.9°C
L3:MaxTemp	44.0°C
L3:MinTemp	37.7°C
L1:AvgTemp	40.9°C
L1:MaxTemp	45.1°C
L1:MinTemp	36.7°C
L2:AvgTemp	41.9°C
L2:MaxTemp	45.1°C
L2:MinTemp	38.8°C

Fig. 9. The surface temperature across the selected lines.
The temperatures across selected lines are shown in Fig. 9.

Conclusion

It was need to suggest two testing stands for the measurement of the hydrostatic pumps. The durability test of the hydrostatic pumps is realize by one stand (the testing stand for realization of laboratory durability test of the hydrostatic pumps, Fig. 4) and the second one serves for the evaluation of results of the test (the testing stand for the measurement of the characteristics of the hydrostatic pumps, Fig. 6).

The aim of the presented paper is to design testing stands for durability tests of hydrostatic

pumps. The demands for design of testing stands issue from parameters of hypothetic tested hydrostatic pumps and the loading process of hydrostatic pump during durability test (STN 11 9287).

The designed testing stands which are presented in this paper have technically solutions as follow: loading of hydrostatic pumps is realized by the tree-positions, four-port valve and sequence valve. Therefore, the characteristic of cyclic pressure loading is realized by tree-positions, four-port valve and sequence valve. The testing stand for the realization of the laboratory durability tests was designed so that the time characteristic of the cyclic pressure loading corresponds with the valid standard (Fig. 3).

The testing stand for the measurement of the characteristics (Fig. 6) is designed so as to enable the adjustment of a wide range of working parameters. The influence of a biodegradable hydraulic fluid on the durability of the hydrostatic pump UD 25 will be stated by a comparison between the characteristics mentioned above.

The surface temperatures of hydrostatic pump type UD 25 was measured after design of testing stands by reason of wearing process monitoring.

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