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FLOW CHARACTERISTICS OF HYDRO-GENERATOR QHD 17 INDEPENDENCE ON THE CHANGE OF PHYSICAL PROPERTIES OF HYDRAULIC FLUID

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Abstract: *The flow characteristics of the hydrogenator QHD 17 were measured in laboratory conditions using hydraulic-transmission liquid MOL farm NH Ultra. Testing of the aforementioned hydraulic-transmission fluid was carried out on a laboratory testing device, which allows to test hydrostatic transducers and transmission-hydraulic fluids. Results of the research include evaluation of flow properties of hydro-generator and flow efficiency, the physical properties of the testing transmission-hydraulic fluid.*

Keywords: Hydrostatic transducers, Hydro-generator flow, Transmission-hydraulic fluid, Taboratory research, Physical properties.

1. Introduction

Changes in the physical properties of the operational fluid significantly affects the flow characteristics of the hydro-generator, regardless of the operating time. There are high demands on fluids, which serve as energy carriers in hydraulic systems (Tulík et al., 2015). We also consider the impact of these fluids on the environment. Due to shortened testing of hydrostatic transducer with different types of operational fluid, we used accelerated fluid testing and simulation of operating load of the hydro-generator in laboratory condition.

2. Methods

Laboratory test equipment allows simulation of operating load of transmission hydro-generator, which was used in hydraulic system of tractor during application of testing hydraulic fluid. The measuring technology, which is part of the hydraulic circuit, consist of a flow sensor, pressure sensor and temperature sensor. This equipment is interconnected with recording unit HMG 3010, which allows flow measurements in the range of 6 to 60 $dm^3.min^{-1}$, 15 to 300 $dm^3.min^{-1}$ and 40 to 600 $dm^3.min^{-1}$ during a pressure of up to 40 MPa and temperature up to 100 °C.

The laboratory test of the oil MOL farm NH Ultra was carried out based on the chosen methodical procedure:

- provision of a reference sample and its analysis of physical-chemical properties,
- the first measurement was performed in the range of 125 hours worked and the signal data from the flow sensor, pressure sensor and temperature sensor were recorded, during hydro-generator rotation 500, 750, 1000, 1250, 1500, 1750, 2000, 2250 and 1750 rpm,
- samples of the test fluid should be taken before the next set of measurements, further sampling of the test fluid are realized after 250, 375 and 500 hours worked,
- the fluid samples, after processing the aforementioned number of hours, were subjected to physical-chemical analysis.

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The methodological procedure for sampling the hydraulic fluid to be tested followed the standard STN 65 6207 (Hydraulic oils and fluids. Sampling for determination of mechanical impurities.). In order to assess the suitability of the tested hydraulic fluid in hydraulic circuits of different machineries, it is necessary to know the input parameters of the system and technical parameters of the hydrogenerator, which will be connected in the hydraulic circuit during testing (Tab. 1).

Tab. 1: Parameters of the hydro-generator QHD 17.

Parameters		Identification	Units	Values
Actual geometric volume		V_g	dm^3	$17.24×10^{-3}$
Torque	nominal	n_n	rpm	1500
Inlet pressure	minimum	p_{1min}	MPa	-0.03
	maximum	p_{1max}	MPa	0.05
Outlet pressure	maximum continuous	p_{2n}	MPa	29
	maximum	p_{2max}	MPa	31
	peak	p_3	MPa	32
Nominal output flow (min.) during n_n and p_{2n}		Q_n	$dm^3.min^{-1}$	23.2
Maximum flow during n_{max} and p_{2max}		Q_{max}	$dm^3.min^{-1}$	54.3
Nominal input (max.) during n_n and p_{2n}		P_n	kW	14.8
Maximum input during n_{max} and p_{2max}		P_{max}	kW	33.6
Weight		m	kg	10.9

Tested operational fluid is MOL Farm NH Ultra, transmission-hydraulic fluid developed for machines by Case New Holland Group, gearboxes, power – shift gearboxes, differentials, wet brakes and hydraulic systems used in high-performance agricultural machinery. Density at 15 °C is 875 $kg.m^{-3}$. Kinematic viscosity at 40 °C is 64.2 $mm^2.s^{-1}$. Kinematic viscosity at 100 °C is 10,9 $mm^2.s^{-1}$. Viscosity index is 162. Pour point is -36 °C. Flash point in open cruicble is 210 °C. The fluid is blue in color, transparent, homogeneous and liquid.

3. Conclusions

The measured values of the tested hydraulic fluid are listed in Tab. 2 depending on the number of hours worked. The density of the fluid may be affected by the presence of abrasive metals or environmental impurities.

Tab. 2: The physical properties of the hydraulic fluid under test – MOL Farm NH Ultra.

Method	Parameter	Units	Sampling interval				
			0 h	**125 h**	**250 h**	**375 h**	**500 h**
ASTM D7042	Density at 40 °C	$kg.m^{-3}$	860.70	860.65	860.66	860.60	860.62
	Dynamic viscosity at 40 °C	mPa.s	49.00	47.10	46.50	46.56	46.05
	Kinematic viscosity at 40 °C	$mm^2.s^{-1}$	56.90	54.80	54.00	54.10	53.50
Acid number ASTM D664 A		$mgKOH.g^{-1}$	2.91	3.29	3.36	3.59	3.67
Water content DIN 51777		%	0.07	0.05	0.04	0.05	0.04

The viscosity may incerase or decrease during use. The increase may be caused by oxidtaion products or impurities in the fluid (Helebrant et al., 2001). On the contrary, it is decrease is mainly due to mechanical and thermal degradation of the additive. Flow characteristics of QHD 17 with MOL Farm NH Ultra tested as a function of hours worked fort rotation ranging from 500 rpm to 2750 rpm. The results of the measured data processing are recorded in the Fig. 1 for the nominal hydrogenrator rotation 1500 rpm.

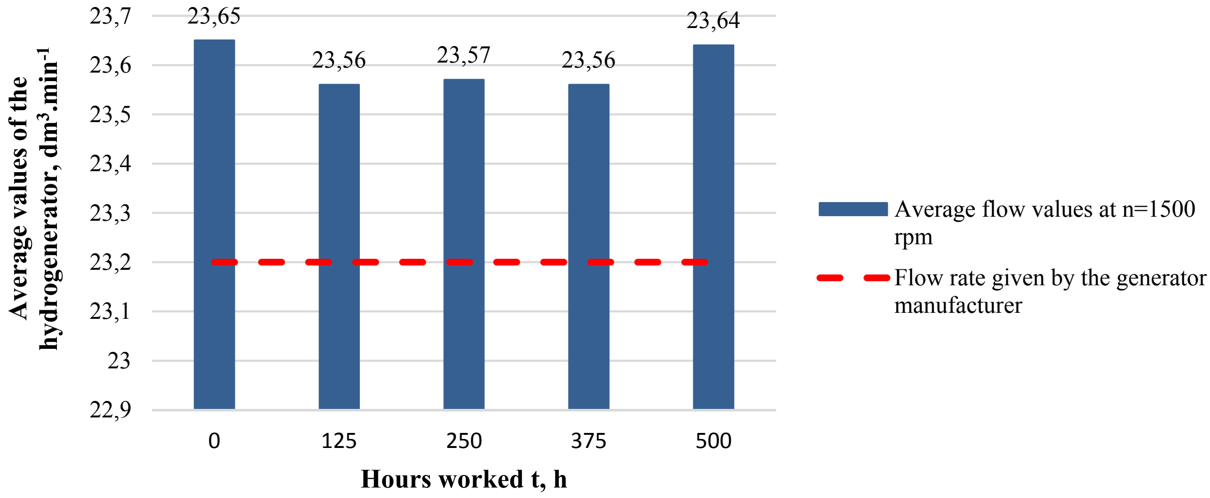

Fig. 1: Dependence of average flow value QHD 17 during test with tested transmission-hydraulic fluid – rotation 1500 rpm.

The maximum decrease in flow efficiency was 0.37 % after 375 hours worked. After 500 hours worked, there was a decrease in flow efficiency compared to 0 hours worked only 0.03 %. The graphical dependencies of Fig. 2 is processed at 1500 rpm, since at the rotation the manufacturer has determined the rated parameters of the hydrogenerator.

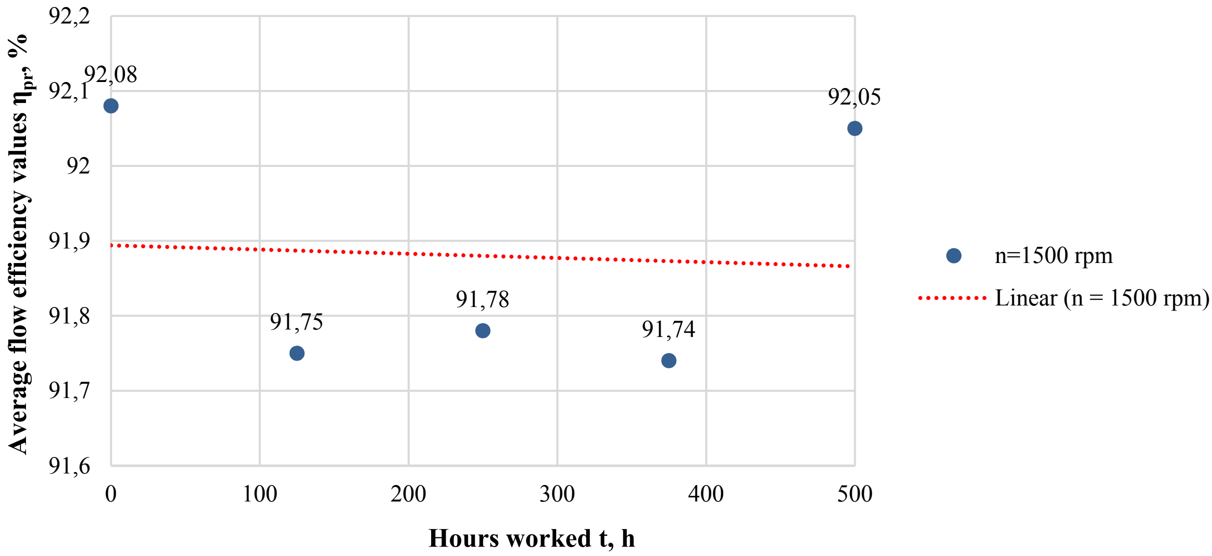

Fig. 2: Dependence of average values of flow efficiency QHD 17 during the test with tested transmission-hydraulic fluid – rotation 1500 rpm.

Aforementioned statement can be confirmed in accordance with ISO 15380: 2011. The operational fluid does not affect the flow properties of the hydro-generator QHD 17 or any other component. Therefore, the flow efficiency did not decrease by more than 20 %.

It can be stated from the relation between the average flow rate of the hydro-generator and the number of hours worked, that the physical-chemical composition of the tested hydraulic oil MOL Farm NH Ultra has no negative effect on the flow properties of the QHD 17 or the other components of the transmission-hydraulic system on the tested equipment. Contamination of the working fluid causes accelerated wear of the hydraulic system, corrosion of steel surfaces, oxidation of fluid and a list of its physical and chemical properties (Čorňák, 2018). Pollution mainly affects ecological fluids, which speeds up their degradation processes (Zastempewski, 2013). Several authors are involved in the evaluation of hydraulic fluid during the operational test with subsequent analysis of contaminants, for example Kučera et al. (2016) and Tulík et al. (2016). As Simikić et al. (2014) says, machines working in agriculture are characterized by demanding operation, often work in dusty and humid environment, which negatively affects the contamination of fluid fillings. The use of environmentally friendly fluids requires a high degree of purity of the fluid filling and a non-measurable concentration of water (Tulík et al., 2015). For this reason, it is important to accurately machine the individual components of the hydraulic circuit, where it is important to monitor the accuracy of CNC machine tools using new methods and trends in product development and planning, where equally important is the multicriterial diagnostics of CNC machines (Košinár and Kuric, 2011 and Kuric et al., 2016). The new QHD17 hydro-generator was also tested during MOL Farm NH Ultra transmission-hydraulic fluid testing. Flow and flow efficiency values are also used to create dynamic flow models in hydrostatic transducers using numerical simulation to protect the environment (Puškár et al., 2015 and Puškár et al., 2019).

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