Measurement of pressure in hydraulics system of the ZTS 160 45 tractor

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ABSTRACT: This contribution is oriented on the field of dynamic loading analysis of three-point hitch of tractor hydraulic pump. The hydraulic pump is placed in circuit of three-point hitch of the tractor ZTS 160 45. Obtained data from operation experiments will be applied for simulation of dynamic loading of the tested hydraulic pump. The measurements were realized during position control with ploughing sets: tractor ZTS 160 45 + plough 5-PN-30 and tractor ZTS 160 45 + plough 7-PHX-35. During the test physical and mechanical properties of soil and operating parameters of ploughing sets were investigated. Pressures of hydraulic system were in range from 3.2 to 7 MPa at aggregation with plough 5-PN-30 and hydraulic pump was loaded. Pressures of hydraulic system during ploughing with ploughing set tractor ZTS 160 45 + plough 7-PHX-35 were in range from 1.8 to 14 MPa and two times hydraulic pump was unloading in time 2 seconds.

Keywords: tractor; ploughing set; pressure; hydraulic pump; three-point hitch

The tractors are most often connected with mounted, semimounted and semi trailer tools. In using of mounted and semi trailer tools is inevitable to equip the tractor with hydraulic control. Hydraulic control enables the three point hitch control thus the control of operating depth of mounted and semi trailer tools (Bauer 2000; Petranský et al. 1999).

We lay stress on life-time, operating reliability and dynamical facilities of hydrostatic converters in this development. The fact has many requirements on method of testing. We needed the model hydraulic pump to come close to really operating conditions. We must measure, record and evaluate the operating processes in this way. We achieve objective information about input of action environs, which will be function of the machines from proposed equipments. Credibility of results of testing in laboratory conditions is very dependent on the real simulation of operating conditions (Petranský et al. 2003). Greater part of this process has coincidental character as timing measure intervals are very long. For this reason it is necessary to device a measuring, directing and technical system which provides for reliability scanning of processing and their record for reason of the next elaboration (Drabant, Petranský 2000).

MATERIAL AND METHODS

The knowledge of operating conditions for example external environment and internal system action is inevitable for proposal and evaluation of functional properties which are directly or indirectly conditional and influenced by operation loading, pressures, temperatures etc. (Pokorný et al. 2003). The test was realized for the purpose of examination and impact loading analyse of the tractor's hydraulic pump in stochastic operating conditions. Obtained data from operating conditions will by applied for simulation of dynamic loading of the tested hydraulic pump (Petranský, Drabant 1989).

To measure the pressures in hydraulic system of the tractor we used two ploughing sets:
– tractor ZTS 160 45 + plough 5-PN-30,
– tractor ZTS 160 45 + plough 7-PHX-35.

The tests were realized during position control (Žikla, Drabant 1987).

Following physical and mechanical properties of soil were investigated:
– volume mass of soil,
– soil moisture,
– penetrometric resistance of soil,
– shear strength of soil.

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Samples of soil were taken by means of Kopecký's rollers and after drying them at temperature 105°C during the time of 6 hours volume mass and soil moisture were determined. Penetrometric resistance of soil was measured by means of registration penetrometer. For measurement of the shear soil strength handle screwed device PILCON- EDECO with direct readout of values was used. The measurement was accomplished in three values of depth with diameter of the propeller 19 mm. Measurement method and evaluation of the measured values was realized according to the standard STN 71 1026 *Laboratory determination of soil shear strength by propeller test*.

Following parameters were measured to determinate operation parameter of the ploughing set:

– operating width of set,
– ploughing depth,
– operating speed of set,
– fuel consumption.

By measuring working parameters the track length was set to be 200 m, being split into two parts of 100 m. One-hundred-meters track has been divided by means of poles into ten the same 10 m tracks. The measurement of working width of set stroke has been done opposite site of each pole. The measuring device used was measuring steel strip of ± 5 mm accuracy. In a similar manner, at the end every track, the depth of soil processed has been measured. The measurement was done by furrow meter of ± 5 mm accuracy.

Fig. 1. Placement of pressure transducers in tractor

Fig. 2. Transmission of measuring data to PC

Operating speed of the equipment we calculated from the length of each track and the time each assigned track.

Pressures measurement in hydraulic system of the tractor. Pressure was measured in output of the pump.

To measure the pressures we used sensors HDA 3444-A-400-009 with nominal measuring range of 40 MPa. The next measuring means used to measure of the pressures were strain gauge transducer TT 320 (ZAP Jinovce, Czech Republic) and pressure gauge with measuring range from 0 to 40 MPa (Chirana Stará Turá) (Fig. 1). The pressures in output of the pump of the hydraulic motor were measured by ploughing – 50 m, by lifting and lowering of plough and by turning of equipment at the end of track, by putting the plough into the soil and con-

Table 1. Physical and mechanical properties of soil

Ploughing set	Volume mass of soil (g/cm^3)		Soil moisture (%)		Shear strength in depth (kPa)		
	wet	dried	volume	mass	10 cm	20 cm	30 cm
ZTS 160 45	1.4	1.15	24.1	14.2	77.4	118.4	124.5

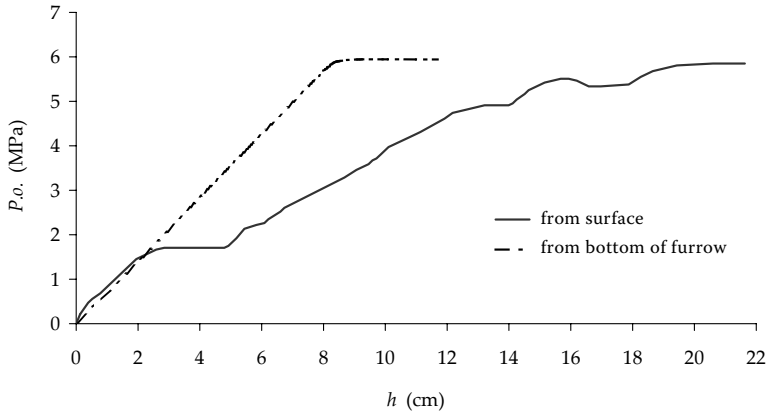

Fig. 3. Penetrometric record during tests of ploughing sets with ZTS 160 45 tractor

P. o. – penetrometric resistance of soil
h – depth

tinuing in ploughing (Žikla 1997). To record the measured values we used hand measuring device HMG 2020 (Hydac Ltd., Martin, Slovak Republic). Measuring data were recorded to PC to the next processing (Fig. 2).

RESULTS AND DISCUSSION

Testing conditions

The determination of characteristics and conditions of tests with focus on physical and mechanical features of soil was coming from measurements and calculations of volumetric weight and humidity of soil, penetrometric measurement of soil resistance and soil slipping stiffness. The average attributes of presented parameters are shown in Table 1.

The penetrometric record in the track and out of the track of tractor ZTS 160 45 is shown in Fig. 3.

Operating indications of ploughing set

The measured and calculated operation parameters of ploughing sets are presented in Table 2.

Load characteristics

Load characteristics of the hydraulic pump for ploughing set which consists of tractor ZTS 160 45 + plough 5-PN-30 is shown in Fig. 4 and for

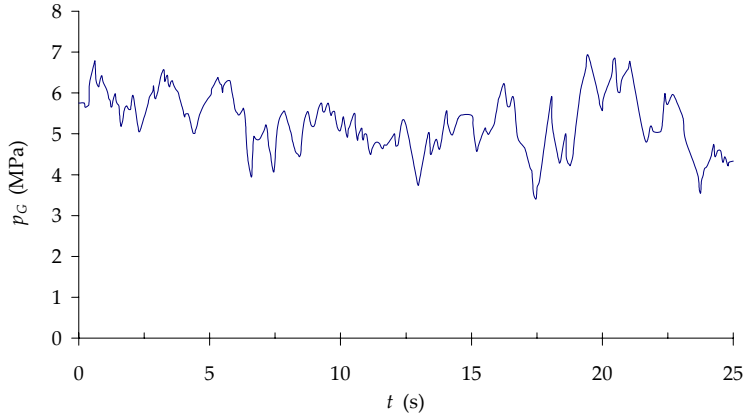

Fig. 4. Time dependent state of output pressure of hydraulic pump of tractor ZTS 160 45 with plough 5-PN-30 – position control

p_G – output pressure of hydraulic pump
t – time

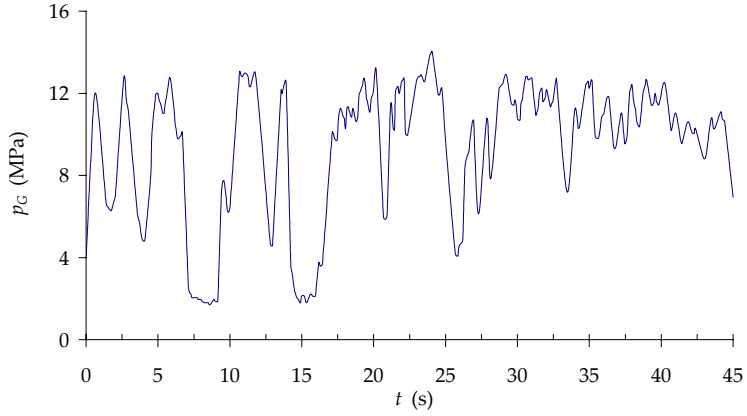

Fig. 5. Time dependent state of output pressure of hydraulic pump of tractor ZTS 160 45 with plough 7-PHX-35 – position control

p_G – output pressure of hydraulic pump
t – time

Table 2. Operating parameters of ploughing sets with ZTS 160 45 tractor

Parameter		Symbol	Unit	5-PN-30	7-PHX-35
Average ploughing depth		h	cm	25	30
Average speed of ploughing set		v_p	m/s	1.44	1.00
			km/h	5.2	3.6
Performance	area	W_p	m^2/s	1.935	1.985
			ha/h	0.696	0.714
	volume	W_o	m^3/s	0.483	0.595
			m^3/h	1,738.8	2,142.0
	mass	W_G	t/s	0.6762	0.8330
			t/h	2,434.3	2,998.8

ploughing set which consists of tractor ZTS 160 45 + plough 7-PHX-35 is the load characteristic shown in Fig. 5.

CONCLUSION

During measuring were obtained data of time dependent states of pressures in the hydraulic system of tractor ZTS 160 45 with ploughs 5-PN-30 and 7-PHX-35. Obtained data from operation experiments can be applied for simulation of dynamic loading of the tested hydraulic pump. The measurements were realized during position control with ploughing sets: tractor ZTS 160 45 + plough 5-PN-30 and tractor ZTS 160 45 + plough 7-PHX-35. During the test physical and mechanical properties of soil and operating parameters of ploughing sets were investigated. Pressures of hydraulic system were in range from 3.2 to 7 MPa at aggregation with plough 5-PN-30 and when hydraulic pump was loaded. Pressures of hydraulic system during ploughing with ploughing set tractor ZTS 160 45 + plough 7-PHX-35 were in range from 1.8 to 14 MPa and two times hydraulic pump was unloading at a time of 2 seconds.

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Meranie tlakov v hydraulickom systéme traktora ZTS 160 45

ABSTRAKT: Príspevok je orientovaný do oblasti analyzovania dynamického zaťaženia traktorového hydrogenerátora hydraulického obvodu trojbodového závesu traktora ZTS 160 45 s cieľom získané údaje z prevádzkových experimentov využiť pre simulovanie dynamického zaťaženia skúšaného hydrogenerátora. Merania boli uskutočnené pri polohovej regulácii

s nasledovnými traktorovými orbovými súpravami: traktor ZTS 160 45 + nesený pluh 5-PN-30 a traktor ZTS 160 45 + návesný pluh 7-PHX-35. Počas merania dynamického tlakového zaťaženia boli sledované fyzikálno-mechanické vlastnosti pôdy spracovávaných pozemkov a prevádzkové ukazovatele orbových súprav. Pri agregácii s neseným pluhom 5-PN-30 sa tlaky pri orbe a zaradenej polohovej regulácii pohybujú od 3,2 do 7 MPa bez odľahčenia hydrogenerátora. Pri návesnom pluhu 7-PHX-35 a zaradenej polohovej regulácii sa tlaky pohybujú od 1,8 do 14 MPa, pričom odľahčenie hydrogenerátora nastalo dvakrát, a to maximálne 2 s.

Kľúčové slová: traktor; orbová súprava; tlak; hydrogenerátor; trojbodový záves

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