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WORKING CONDITIONS AND PERFORMANCE INDICATORS OF HYDRAULIC SYSTEM ELEMENTS OF MOBILE MACHINERY

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Construction and road machinery includes motor graders, bulldozers, excavators, scrapers, specialized vehicles, agricultural machinery includes forage harvesters and grain harvesters, etc. In these machines, due to its advantages, hydraulic drive has found wide application. More than 90% of single-bucket excavators produced in the country have a hydraulic drive. The share of construction mechanization equipment with a hydraulic drive exceeds 50%. In mobile agricultural machinery, a hydraulic drive for controlling working equipment has found 100% application, and hydraulic transmission is used in almost all combines of both domestic and foreign production.This is confirmed by the analysis of literary sources [1], which showed that modern combine harvesters DON-1500/1500B/1500M/2600/091, Yenisei-1200/950/960/9, forage harvesters KSK-100, DON-750/680/680M, Polissya-250, mower-conditioners DON-800, KPS-5G, root and shoot harvesters RKM-4, RKM-6, KS-6B, concrete mixer trucks SB-92V/159B/172-1/237, SMB-060, as well as foreign equipment from corporations "John Deere", "Claas", "Case", "Massey Ferguson" and others, are equipped with various hydraulic systems that include a volumetric hydrostatic drive of the transmission (ГСТ).

The developer of the volume hydraulic drive (ГСТ) is the Sauer company, which was founded in 1946 in Germany. Over the years, the company has developed and produced axial piston pumps and hydraulic motors of the 15, 20, 40, 42, 51, 70, 90 series.

ГСТ-90 is an analogue of the 20th series of axial piston pumps and hydraulic motors and is most popular in our country and neighboring countries.

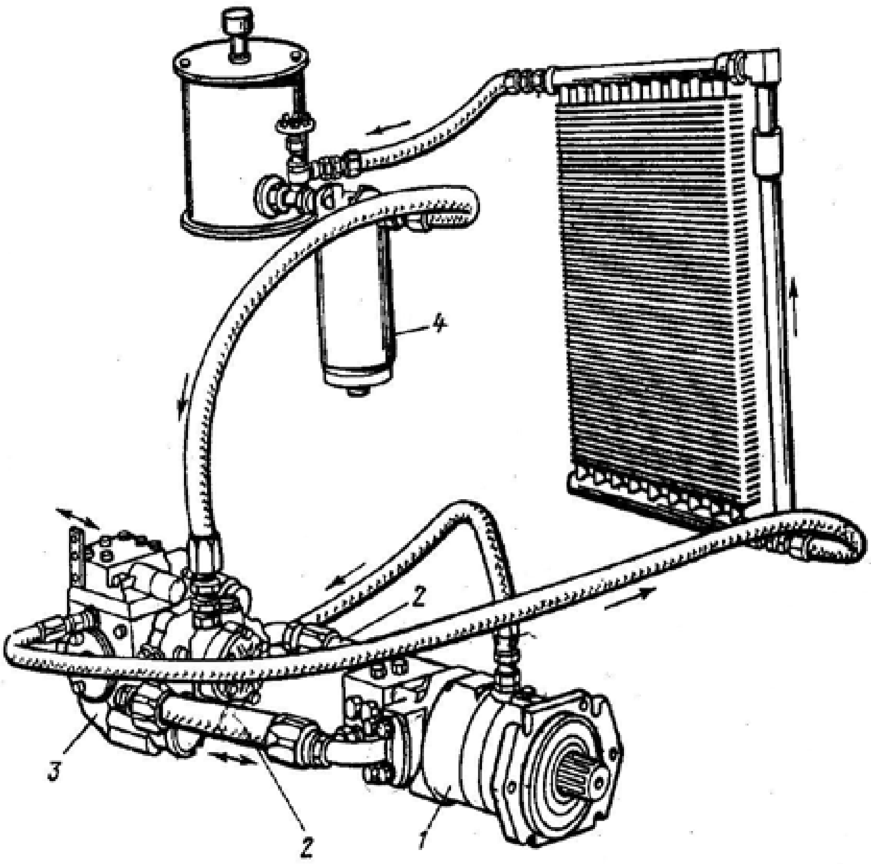
The general view of the hydraulic drive of the ГСТ-90 transmission is shown in Fig. 1.

Volumetric hydraulic drive ГСТ-90 (Fig. 1) includes an axial-plunger pump 3 with an adjustable working volume, a non-adjustable axial-plunger hydraulic motor 1, a reservoir for the working fluid, a heat exchanger, a fine filter 4 with a vacuum gauge, pipelines and hoses [2].

An axial piston pump converts the mechanical energy of the engine into hydraulic energy, creating a flow of working fluid; an axial piston hydraulic motor, on the contrary, converts the hydraulic energy of the working fluid into mechanical energy.

Axial piston hydraulic machines (pump and hydraulic motor) are interconnected by two hydraulic lines. One of them supplies the working fluid flow from the pump to the hydraulic motor under pressure up to P_h=34,3 MPa, on the second - returns from the hydraulic motor to the pump under pressure P_b=1,17 MPa [2].

Thus, in the "pump-hydromotor" system of the ГСТ-90 hydraulic drive, a closed circulation of the working fluid occurs. The working fluid, which has leaked through the mating parts of the hydraulic units, enters their internal cavity, from there it flows through the drainage pipeline system through the heat exchanger into the tank.



1 – axial-plunger unregulated hydraulic motor; 2 – high-pressure hose; 3 – axial-plunger adjustable pump; 4 – oil filter

Fig. 1. ГСТ-90 positive displacement hydraulic drive [2]

The design features of axial-piston hydraulic machines include the presence of a power supply system, a working volume control system (control hydraulic distributor and servo piston with a cradle) and a hydraulic motor of the valve box [1].

The main parameters of the ГСТ-90 volumetric hydraulic drive are given in table 1.

According to the manufacturer, the criterion for the limit state of the ГСТ-90 volumetric hydraulic drive is a decrease in the volumetric efficiency of the pump at nominal modes by no more than 20% [3].

Table 1

Main parameters of the volumetric hydraulic drive ГСТ-90

№	Parameters	Main working parts	
		Axial piston pump	Axial piston hydraulic motor
1	Working volume, cm3	89,0	89,0
2	Nominal flow, l/min, not less	119,87	-
3	Nominal flow rate, l/min, not less	-	119,87
4	Maximum drainage pressure, MPa	0,35	0,35
5	Feed coefficient, not less	0,949	-
6	Hydromechanical efficiency	-	0,92
7	Coefficient of useful action, not less	0,88	0,89
8	Power, kW (hp), not less	53,86 (73,25)	
9	Temperature in the hydraulic motor drainage, ºC	+80	+80,0
10	Nominal filtration fineness, μm	10,0	10,0
11	Weight without working fluid, kg	78,0	48,0

Gamma-percentage resource ($g = 90\%$)ГСТ-90 before the first major overhaul is $4000_{m\text{-}h}$, and gamma percentage time to failure ($g = 95\%$) is $1800_{m\text{-}h}$. [4].

If we assume that the operating time of the ГСТ-90 before resource failure is distributed according to the Weibull law with a coefficient of variation, then the average resource of axial-piston hydraulic units is equal to [3]:

$$\bar{t} = \frac{l_{0,9}}{W_{0,9}} = \frac{4000}{0{,}5289} = 7563m - h \qquad (1)$$

which is approaching the full resource of the combine.

Operational studies conducted on the Don-1500B combines of 2001 release in [5] showed that in the first year of operation, on average, 363 failures occurred, of which 102 were on hydraulic system units, including 22 failures on hydrotransmission units, i.e. the service life of completely new ГСТ-90s is significantly less than the standard set by the manufacturer (1500 moto-hours (OJSC) "Gidromash" Salavat, and 1800 moto-hours OJSC "Gidrosila" Kirovograd).

According to the authors in [4,5], the range of resource failures of the ГСТ-90 combines equipped with the ГСТ-90 is in the range of 178...1023m-h, with an average value of T = 616,3 m-h, і середньоквадратичному відхиленні σ = 243 m-h.

Fig. 2 shows the results of statistical processing of the average seasonal operating time of KSK-100 combines depending on the service life [5].

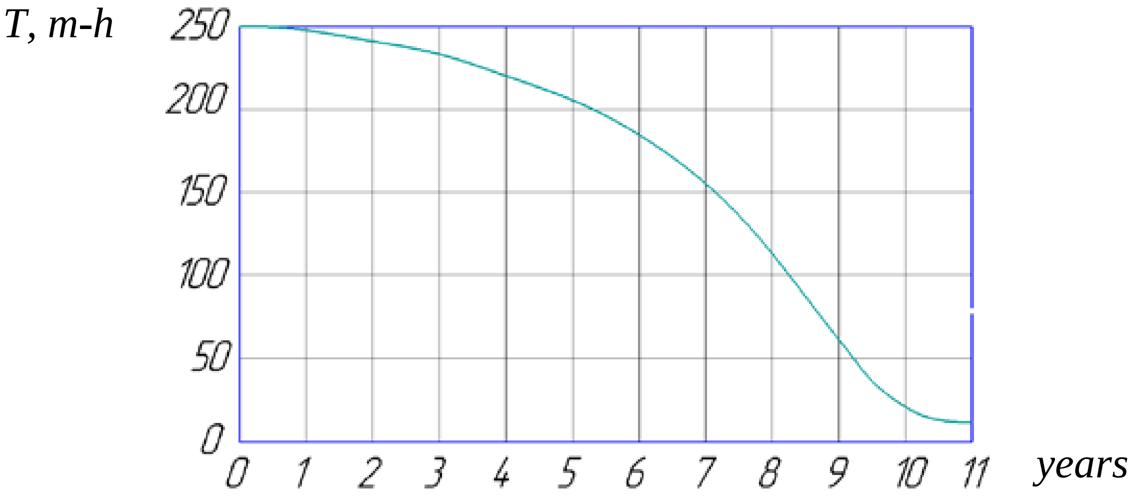


Fig. 2. Curve of decrease in working hours before failure of the combineKSK-100 from the service life

From Fig. 2 it follows that the seasonal operating time of the combine is in the range T_c=47…253 m-h, with average seasonal operation T_{av} = 170,6 m-h. Thus, failures of the second and third groups of complexity occur after 3...4 years of operation of the machine.

A detailed analysis of the reliability indicators of axial-piston hydraulic machines shows that a significant share (44%) of all malfunctions falls on the pumping units of the pump and motor. Judging by the type and nature of wear of the parts of the pumping unit, we can say that they are mainly due to hydroabrasive and cavitation wear, which are caused by the content of mechanical particles and dissolved air in the working fluid [5].

The purpose of further research is to experimentally determine the effect of wear of parts in the plunger pair of the pumping unit of the axial-piston hydraulic pump on its volumetric and mechanical losses.

References.

1. Збірник методичних материалів з будови, обслуговування та ремонту ГСТ 33/90/112. Кіровоград : ОАО «Гідросила», 2005. 176 с.

2. Аврулін Г.А., Подригало М.А., Мороз І.І., Коваль О.Д.Аналіз технічного рівня об’ємних гідроприводів з мотор-колесами.Mechanics and Advanced Technologies. Vol. 7, No. 2, 2023 р. 185 – 192.

3. Гидропривод объемный ГСТ-90. Техническое описание и инструкция по эксплуатации. Кировоград, 1994. 12 с.

4. Гидронасос НПА-90Р. Технический паспорт. ОАО «Гидросила», 2006. 20 с.

5. Баликов Н.М. Забезпечення роботоздатності та підвищення ресурсу гідроприводів сільськогосподарської та меліоративної техніки із застосуванням комплексних покриттів: автореф, дис. канд. техн. наук. Вінниця: ВПІ 2002. 6 с.