7. Vasilchenko V. A. Hydraulic equipment of mobile machines. Handbook, M., "mechanical engineering", 1983, 301 p.

8. Bolgarsky A.V. and others. Thermodynamics and heat transfer. Educational. for universities. M., "Higher school". 1975, 382 p.

9. Koval P. V. Hydraulics and hydraulic drive of mining machines. Moscow: "Mechanical engineering", 1979, 379 p.

10 Mikheev M. A., Mikheeva I. M. Fundamentals of heat transfer. M., "Energy", 1973, 319 p.

11.Safarov M. M. Thermophysical properties of simple esters and aqueous solutions of hydrosine depending on temperature and pressure. Dissertation, Dushanbe, 1994, in 2 volumes, 808 p.

12.Heat and mass transfer. Thermotechnical experiment: Handbook / Ed. V. A. Grigoriev and V. N. Zorin. Moscow: "Energoizdat", 1982, 512 p.

13. Kondakov L. A., Nikitin G. A., Prokofiev V. N. etc. Engineering hydraulic drive. Edited by V. N. Prokofiev, M.: "mechanical engineering", 1978, 495 p.

14. Antonov A. S. Power transmission of wheeled and tracked vehicles. L., "mechanical engineering", 1975, 481 p.

15. Kalinin V. S., Zabegalov G. V. on the thermal mode of operation of the hydraulic drive of single-bucket loaders. - In the book.: Research on mounted machines. Vol. 59, M., Vniistroydormash, 1973, P42-51.

16. Blumin S. V. Investigation of the influence of hydraulic resistances and thermal modes on the parameters of volumetric hydraulic drives of mining machines for open works, dissertation, M., 1980, 179 p.

17. Lazaridi A. p. Investigation of reliability of hydraulic drive of some excavators in the conditions of the Turkmen SSR. Abstract of Cand. Diss., Tashkent, tiiimsh, 1975, 26 p.

18. Gavrilenko B. A., Minin V. A., Rozhdestvensky S. N. Hydraulic drive, M., "Mechanical engineering", 1968, 502p.

19. IR spectroscopic analysis of contamination of hydraulic fluid of hydrofected mining machines. Abduazizov N. A., Aliyev T. B., Zhuraev A. Sh., Kenzhaev Z. Sh. u. Universum: Technical Sciences. 2019. No. 8 (65). P35-39

УДК 621.891+62.192

MECHANISM OF FRAYING OF PRECISION ELEMENTS OF WOOD DISTRIBUTORS TAKING INTO ACCOUNT THE CLASS OF PURITY OF WORKING LIQUIDS

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ANNOTATION

The article discusses the specific features of the hydraulic system of a cotton tractor, as well as the likely mechanism of fraying of the precision elements of the spool valves, taking into account the purity class of the working fluids.

The influence of oscillatory processes on the fraying mechanism of precision spool-housing conjugations during tractor technological operations is analyzed.

The results of studies on the dynamics of the purity class of a hydraulic fluid and recommendations on increasing the life of hydraulic systems for cotton tractors are presented.

Conclusions are formulated on an objective assessment of the hydraulic distributor resource; based on the results of the analysis of the wear of the spool-housing interface. As well as conclusions on the reserve efficiency of operation of distributors and hydraulic systems.

Keywords: hydrodistributor, precision coupling, mechanism of fraying, abrasive particle, resource, cleanliness class, working fluid.

Introduction. Of particular importance is the development of hydraulic drives for cotton tractors that responding to the climatic conditions of Uzbekistan, in particular, the widely used hydraulic equipment facilitating drive control is of particular importance.

Particular attention is paid to increasing the working pressure of tractor hydraulic systems, increasing the speed of actuators and developing tools to ensure the purity of working fluids. Targeted research work is also underway to create the scientific foundations for improving designs, increasing the service life and durability of hydraulic components.

In this direction, scientific research is of particular importance as increasing the resource and reducing the fraying of precision elements of hydraulic systems.

Purpose of the research. Theoretically investigate the fraying mechanism of precision elements of spool valves taking into account the purity class of the working fluids and develop recommendations for increasing the interface life.

Methods and objects of research. It is believed that vibration does not significantly affect the characteristics of a mechanically controlled HS; it can only reduce the force of movement of the spool valve [1]. Let us disagree with this opinion, for which we turn to the diagram presented in Fig. 1.

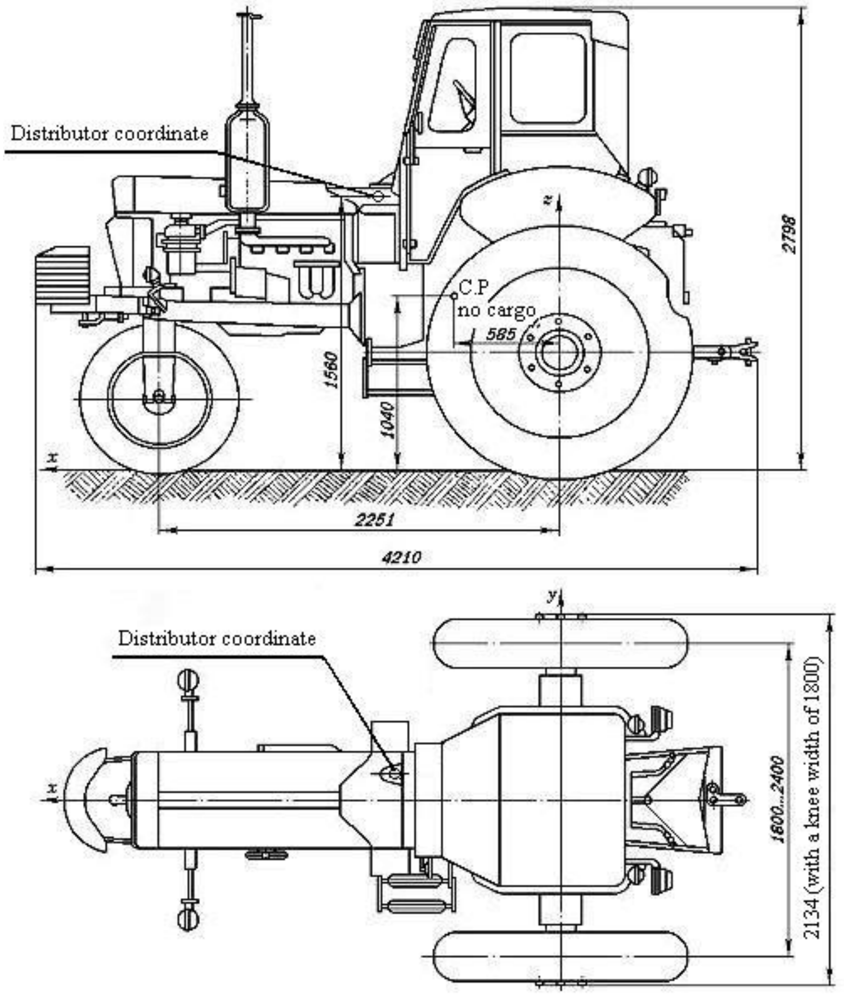

Fig. 1. Functional diagram of the inertial spool system of a sectional control valve during tractor movement.

During cultivation of cotton, the movement of a row cultivating tractor is accompanied by vibration in the frequency range of 30 ... 60 Hz and amplitudes of 0.10 ... 350 mm. These vibrations are due to the stochastic nature of the longitudinal and transverse profiles of the furrow, the speed of the tractor, the density of the soil, tire pressure and a number of other reasons.

The row crop tractor is three-wheeled; therefore, various types of vibration are possible in all six degrees of freedom. When the front wheel hits an obstacle, the vibrations are directed around the axis, and the disturbing force is represented by the torque. Here, the radius of rotation or the shoulder is equal to the distance from the contact point of the tire with the obstacle to the coordinate of the distributor.

When hitting an obstacle of one of the driving wheels, the tire senses and transmits a disturbance impulse to the frame in the form of a torque relative to the axis. In this case, the radius of rotation (oscillation) will be determined by the distance from the drive wheel to the coordinate of the location of the distributor. This moment (let's call it overturning), upon reaching the acceleration of unity, becomes equal to the reactive moment, which returns the system to its original state. Thus an oscillatory system is formed, similar to a physical pendulum.

If all three wheels experience disturbances of equal magnitude, then a pulse will act on the tractor, the vector of which is directed along the axis.

Forced tractor vibrations cause a change in the clearance in the spool-housing interface, as shown in Fig. 2.

The magnitude of the diametrical clearance s is determining the size, number of abrasive particles and the depth of their penetration into the mate. It is believed that the initial clearance in the interface does not exceed 8 micrometer, therefore, the fray mechanism is interpreted as multi-stage [2].

In the first stage, pinching of particles larger than 15 micrometer between the edges of the mating occurs. In this case, deformation of the surfaces and destruction of particles occurs.

In the second stage, an abrasive that has penetrated into the body of a soft material (body) scratches or cuts the surface of the moving spool. At the same time, dulling and chipping of particles occurs, after which their effect on conjugation ceases.

It is noteworthy that in this interpretation of the fraying mechanism, the presence of vibration is ignored, that is, an active change in the clearance in the interface and impact loads on the friction surface through an abrasive. In addition, the limitation of the fluid purity class is carried out from traditional ideas that friction surfaces have a roughness, in the hollows of which abrasive particles less than 15 micrometer in size are immersed.

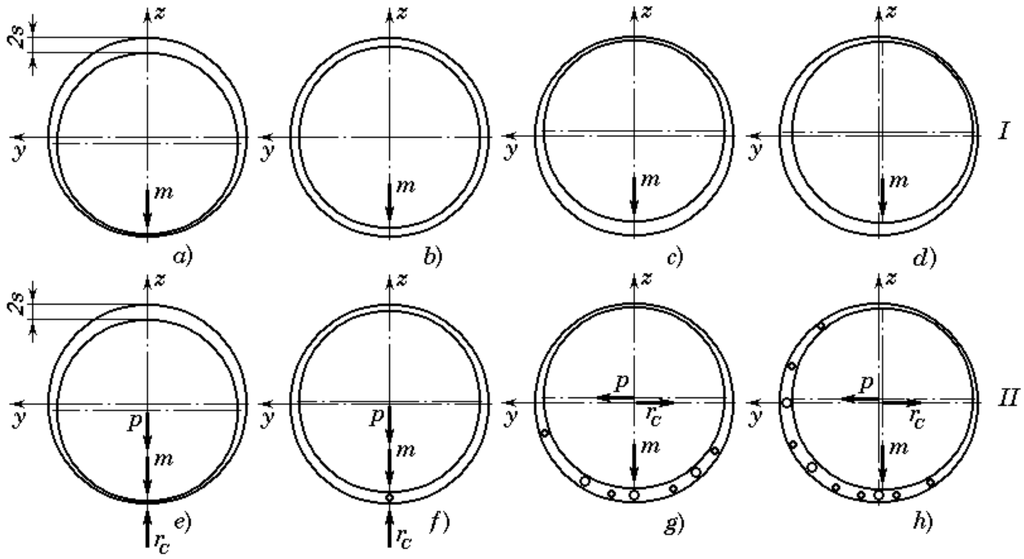

Fig. 2. Probable patterns of interaction of the surfaces of the spool mechanism in the absence of flow and various classes of fluid purity.

The fallacy of this postulate lies in the fact that the surfaces of this pair are polished and lapped, and therefore their $R_a = 0{,}25$ micrometer.

In our opinion, the amount of fraying of the mating parts is determined not only by the displacement (stroke) of the spool along the axis, but also by the changing diametrical clearance s facilitating the penetration of the abrasive into it. Moreover, the sizes of abrasive grains do not play a decisive role. The appearance of ovality and cut, apparently, is due to the prevailing interface vibration vector and the location of the hydraulic fluid supply.

It should also be noted that in this conjugation, the laws of the hydrodynamic theory do not work, since there is no fluid flow here.

The above interpretation of the fraying mechanism is new, since it allows us to consider the liquid purity class from the position of activity of the entire spectrum of the abrasive fractional composition [2]. The only weak point in it is the impossibility of taking into account the shape (faceting, presence and sharpness of the ribs), the orientation of the faces at the moment the particles enter the gap, and the strength and hardness of the grains. All this is stochastic in nature and relates to uncertainties of the first kind, and therefore should be taken into account from the point of view of probability theory.

Attempts to revise the requirements of GOST 17216-2001 were previously undertaken by specialists of the “Rostselmash” plant. Their studies found that the industry’s most common method for determining the mass of liquid polluting particles according to GOST 6370-2018 does not meet the requirements, since its sensitivity is limited to the 13th class of purity [3]. Therefore, its use to control the purity of the working fluids of the hydraulic drives of the Don combine is not possible.

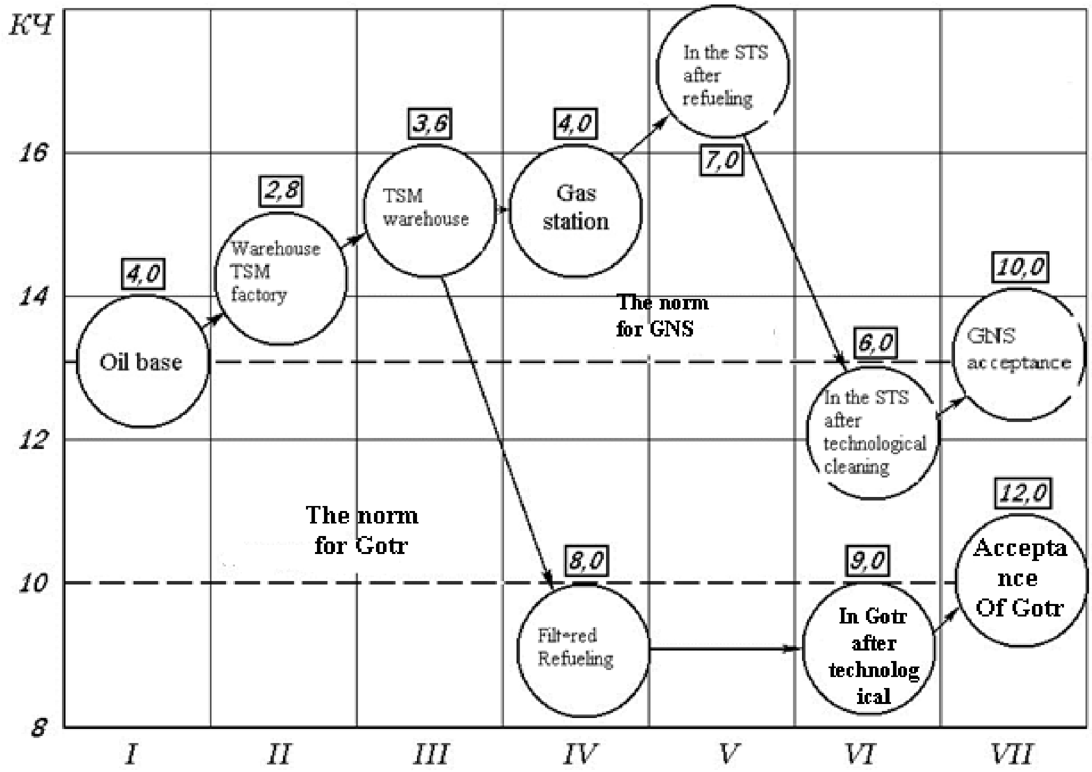

Fig. 3. Diagrams of the dynamics of a change in the hydraulic fluid purity class during the production of "Don 1500" grain combines.

Based on the low values of grinding coefficients during cleaning, working fluids with filters with a nominal filtration fineness of 25 micrometer, as well as filters together with the SOG-904A stand, they came to the following conclusions:

- during the entire period of the factory run-in of the hydraulic drives of the "Don" combines, particles of mechanical impurities of 10 micrometer or more in size are generated in the working fluid generated by the hydraulic drive, and therefore it is advisable to extend the duration of the controlled run-in, including at the beginning of the operation of the combine;

- as technological, it is advisable to use filters with a nominal filtration fineness of 10 micrometer and below.

The substantial part of these conclusions is justified by the diagrams presented in Fig. 3, characterizing the dynamics of the accumulation of mechanical impurities in the working fluid at seven stages of production. In rectangular frames relative to each stage, the grinding coefficient is indicated.

From the presented diagrams it can be seen that, while still at the tank farm, the oil already has a 13th grade of purity, which is recognized as the norm for a hydraulic system (HSS) [4]. Therefore, to ensure this norm, when manufacturing finished products, additional technological oil purification is recommended.

For hydrostatic transmission (HT), the 10th grade of purity is normalized, and more thorough refueling with filtration is recommended here, followed by technological oil cleaning. Note that when accepting finished products it is proposed to provide a grinding coefficient of 10 ... 12.

The attitude to the HSS, hydrostatic steering (HS) and HT in operation is surprising. The normalized complexity of their oil refueling during scheduled maintenance is 6...13 times less than the engines (see Fig. 4) [1], although the capacities of both systems are almost equal.

An analysis of previous studies shows that the rate of accumulation of mechanical impurities in hydraulic fluid is higher than in motor oils, and the frequency of their

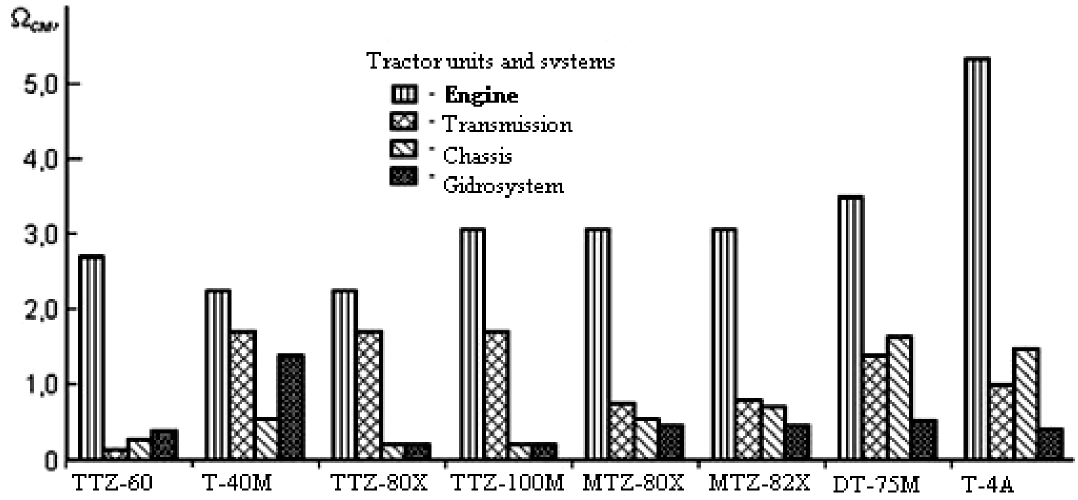

Fig. 4. The complexity of refueling tractor systems during maintenance.

replacement is 960 and 240 hours, respectively.

On this basis, we believe that the rules for tractor maintenance regulated by GOST 20793-2009 require adjustment based on the results of our research [5].

Conclusion. Based on the results of the studies, the following conclusions can be formulated:

1.An objective assessment of the life of the hydraulic distributor should be the pairing with the least operating time to the limit state, the resource of the distributor should be estimated by the indicator with the least operating time.

2.An analysis of the fraying mechanisms of the spool-housing mates shows that the mobility of the spool-housing mates is caused not only by control actions, but also by the presence of vibrations during tractor movement.

3.The effect of the impulse of the interaction force is enhanced when abrasive particles enter the conjugation gap. The presence of abrasive in the oil reduces the mating resource by 28.8%.

4.A huge reserve of operating efficiency of distributors and hydraulic systems is generally seen in an increase in the oil purity class (for example, up to 400G), but this requires improved filtration and limited communication with the environment [6].

At the same time, it should be noted that the ISO 4406-99 standard regulates only the particle size distribution of impurities larger than 15 micrometer, while our studies indicate the influence of abrasive material even with a diameter of less than 5 micrometer.

Глава из книги

Abramov S.I., Khazarov A.M., Sokolov A.V. “Техническая диагностика одноковшовых экскаваторов с гидроприводом”. М.: Стройиздат, 1998. 100 с.

Статья из журнала (печатный)

Aliboev B.A. «Performance characteristics and wear pattern of precision parts of cotton tractor hydraulics» - Journal of Friction and Wear, 2016, Vol. 37, No. 1, pp. 83–85. © Allerton Press, Inc., USA.

ГОСТ из Стандартинформ

GOST 6370-2018. Oil, oil products and additives. Method for determination of solids. М.: Стандартинформ, 2018. 7 с.

GOST 17216-2001. Industrial cleanliness. Liquid Purity Classes. М.: Стандартинформ, 2008. 11 с.

GOST 20793-2009. Tractors and agricultural machinery. Technical maintenance. М.: Стандартинформ, 2011. 19 с.

ISO 4406-99. The hydraulic drive is volumetric. Working fluids. Particle Contamination Method. М.: Стандартинформ, 2001. 12 с.