ТЕХНИЧЕСКИЕ НАУКИ

ИССЛЕДОВАНИЕ СИСТЕМ "ГИДРОБАНК-КУЛЕР" ГИДРАВЛИЧЕСКИХ ЭЛЕКТРОБЛОКОВ ГИДРАВЛИЧЕСКИХ ГОРНЫХ МАШИН

DOI: 10.31618/ESU.2413-9335.2020.4.71.598

Абдуазизов Н. А.
к.т.н, проректор
Навоийского государственного горного института,
Узбекистан.
Тошов Ж. Б.
д.т.н., декан
"Энергетического факультета"
Ташкентского государственного технического университета,
Узбекистан.
Жураев А. Ш.
Ассистент
кафедры горного дела и электромеханики
Навоийского государственного горного института,
Узбекистан.

THE RESEARCH OF "HYDROBANK-COOLER" SYSTEMS OF HYDRAULIC POWER UNITS OF HYDRAULIC MINING MACHINES

Abduazizov N. A.
PhD, Vice-rector,
Navoi state mining Institute's.
Uzbekistan.
Toshov Zh. B.
DSc, dean of
“Energy engineering" faculty,
Tashkent state technical University,
Uzbekistan.
Zhuraev A. Sh.
assistant teacher,
Department of Mining and Electromechanical Engineering,
Navoi State Mining Institute,
Uzbekistan.

АННОТАЦИЯ

Сегодня на горнодобывающих предприятиях используется мощное дорогостоящее оборудование. Простои, поломки и ремонт гидравлических горных машин приводят к большим финансовым потерям горных предприятий. Механические частицы, микрокапельки воды и пузырьки воздуха, попадающие в гидравлические жидкости во время работы, существенно влияют на свойства рабочей жидкости. В связи с этим поддержание качества рабочей жидкости, используемой в дорогих гидравлических горных машинах, является одной из важнейших задач современной гидравлики.

ABSTRACT

Today, powerful expensive equipment is used in mining enterprises. Downtime, breakdowns and repairs of hydraulic mining machines lead to large financial losses of mining enterprises. Mechanical particles, micro-droplets of water and air bubbles that fall into hydraulic fluids during operation, significantly affect the properties of the working fluid. In this regard, maintaining the quality of the working fluid used in expensive hydraulic mining machines is one of the most important tasks of modern hydraulics.

Ключевые слова: рабочая жидкость, вязкость, температура, очистка гидравлических масел, твердые частицы, гидравлическое оборудование, гидравлические системы.

Keywords: working fluid, viscosity, temperature, cleaning of hydraulic oils, solid particles, hydraulic equipment, hydraulic systems.

Introduction

The principal task of the air conditioning system is to maintain temperature, relative humidity, purity, composition, and speed of movement of the hydraulic fluid (HF). As a result, a stable productive work of the mining machine will be ensured. Inadequate purity and elevated temperature of HF reduce its performance to the most significant extent. Therefore, in this work, a range of issues is related to specific tasks of maintaining a certain level of purity and temperature of HF directly in the working lines of hydrostatic transmissions of mining combines operating in high ambient temperatures of the Central Asia, in particular in the quarries of NMMC.

Methodology

Temperature conditions in hydrovolume power plants of open-pit equipment in specified operating conditions: we actualize them to solve the following problems:

-limiting the highest temperature (the lowest viscosity of the HF) to exclude failures of the hydraulic equipment of the power plant;

-limitation of the lowest temperature (the highest viscosity of HF) to minimize pressure losses in hydraulic lines of the hydraulic system;

-limiting the maximum equivalent temperature of the loading cycle of the resource-determining hydraulic equipment and hydraulic fluid reservoir.

The solution of the indicated tasks can be performed only for boundary conditions.

The dependence of technical and economic indicators of the operation of mining machines on the temperature conditions of transmissions leads to the need for its preliminary assessment. The results and methods for determining the local temperature of various hydraulic elements of transmissions are given in the works [1, 2, 3, 19].

Experimental results

The most common is the assessment of the thermal regime of the hydraulic drive by the average temperature of the HF- t^o, which is determined from the heat balance equation, for the entire hydrostatic transmission [4, 5, 6].

$$\theta d\tau = G_i c_i dt^o + k_i F_i (t^o - t_o^o) d\tau \qquad (1.1)$$

where, θ - amount of heat released per unit time, W;

G_i – mass i – of that element of hydrostatic transmissions with HF, kg;

c_i – average specific heat i – that material element hydrostatic transmissions with HF, J / kg.deg;

k_i – average heat transfer coefficient i – that transmission element, W / m^2.deg;

F_i – active heat transfer area,м^2;

t_o^0 – ambient temperature, deg;

τ - time coordinate, sec.

Dividing (1.1) by $k_i F_i d\tau$, we get the differential equation in the form:

$$\frac{G_i c_i}{k_i F_i}\frac{dt^o}{d\tau} + t^o = \frac{\theta}{k_i F_i} + t_o^o. \quad (1.2)$$

For constant coefficients on the right-hand side, a particular solution of differential equation (1.2) is an exponential

$$t^o = \frac{\theta}{k_i F_i}\left[1 - exp\left(-\frac{k_i F_i}{G_i c_i}\tau\right)\right] + t_o^o \quad . (1.3)$$

In expression (1.3), the amount of heat - θ is defined as average per cycle [7]:

$$\theta = \frac{\Delta\theta_1\Delta\tau_1 + \ldots.. + \Delta\theta_i\Delta\tau_i + \ldots\ldots. + \Delta\theta_j\Delta\tau_j}{\Delta\tau_ц}.$$

here, $\Delta\tau_ц$ – average duration of the cycle, sec;

$\Delta\theta_i$ – power losses on i-number loading interval per cycle, W.

The most difficult for the thermal calculation of the hydrostatic transmission is the determination of the heat transfer coefficient – k_{TO}.

Average heat transfer coefficient for the entire hydrostatic transmission – k_{TO} is usually determined by surface weighted i- number of hydrostatic transmission elements with total surface F

$$k_{\text{ТО}} = \frac{\Sigma k_i F_i}{F}$$

Heat transfer coefficient - k_i For elements whose curvature is neglected (the ratio of the outer diameter to the inner is less than two [8], is determined by the expression:

$$k_i = \frac{1}{\frac{1}{\alpha_{ж}} + \frac{\delta_{ст}}{\lambda_{ст}} + \frac{1}{\alpha_{в}}}$$

where, $\alpha_{ж}$ – heat transfer coefficient from liquid to wall, W/m^2.deg;

$\alpha_{в}$ – heat transfer coefficient from the element wall to the environment, W/m^2.deg;

$\delta_{ст}$ - wall thickness, m;

$\lambda_{ст}$ – wall thermal conductivity, W/m^2.deg;

When determining the heat transfer coefficient $\alpha_{в}$, heat transfer by radiation is taken into account:

$\alpha_{в} = \alpha_{вк} + \alpha_{ви}$

here, $\alpha_{вк}$ – heat transfer coefficient from the element wall to the environment due to convection, W/m^2.deg;

$\alpha_{ви}$ – heat transfer coefficient by radiation, W/m^2.deg;

In view of the complexity of the analytical determination of the heat transfer coefficient - k_{TO}, for practical calculations, in particular for the thermal calculation of hydraulic volumetric transmissions of a mining combine, we propose the following (table 1.3 and 1.4) values of heat transfer coefficients.

From a comparative analysis of the recommended values of the coefficients (tab. 1.3 and 1.4) it follows that the difference in their values in some cases exceeds 100%. In addition, they do not fully reflect the functional dependence of the heat transfer conditions and, thus, do not allow investigating the bonds affecting the heat transfer process. The use of the data in tables 1.3 and 1.4 is also difficult when designing new machines with hydraulic diagrams, layout, and working conditions that are different from the information sources.

In a number of works [1,4,9], the apparatus of the theory of convective heat transfer is used to determine the heat transfer coefficient of hydrostatic transmission elements. The criterion dependences of convective heat transfer in this case most fully reflect the influence of individual factors on the heat transfer process.

The heat transfer theorem is summarized in the works of academician M.A. Mikheev [10]. Separate recommendations used in practical calculations are contained in [8,11,12].

Heat transfer coefficients $\alpha_ж$ and $\alpha_{вк}$ are in this case according to the Nusselt heat transfer criterion N_u, characterizing the intensity of convective heat transfer:

$$N_u = \frac{\alpha_{TO} d_Г}{\lambda_{TH}}$$

where, α_{TO} – heat transfer coefficient, W/m².deg;

$d_Г$ – featured geometric size, m²;

λ_{TH} – heat transfer coefficient of heat carrier, W/m².deg;

Table 1.

Heat transfer conditions	The calculated value of the average heat transfer coefficient of the hydraulic drive W/m².deg;	The source of information
difficult circulation air	10,1 7÷14 9,3÷11,6 10,5	[13;39] [11] [8] [16]
free streamlined by air surface	15,1 10÷17,5 18,6÷22,1 17,4 20,8	[13; 16; 21; 39] [11] [40] [10] [41]
air flow Air Velocity 1.25 m / s Air speed 1.8 m / s Air speed 2.0 m / s	23,3 14÷20 19÷28	[13;16] [11] [11]

Table 2.

Heat transfer conditions	The estimated value of the heat transfer coefficients, W/m².deg;		The source of information
	From fluid to wall	From wall to environment	
when fluid flows in a pipe when fluid flows in the tank with natural. chilled	116÷593 59,3÷233	59,3÷23,3	[10]
air speed 5 m / s air speed 10 m / s	1163	29 58	[25] [39]
circulation is difficult open space with intensive blowing		9,3÷11,63 13,9÷20,8 23,2÷40,5	[25]
difficult. circulator. air speed 2 m / s	1500÷4000	10 20	[42]

In the general case, during the thermal interaction of transmission hydraulic elements with the environment, the following modes of movement of heat carriers are possible:

- forced HF movement (HF movement in hydraulic lines, hydraulic cylinders, distributors);
- movement due only to natural convection of the HF (the movement of the HF in hydraulic lines at zero feed-flow);
- joint free-forced motion of the HF (the movement of the HF in the "tank-cooler" system).

In an analytical study of the thermal regime of hydrostatic transmissions, a physical or so-called thermal model of its elements is used [2]. When developing such a model, the design of the hydrostatic transmission elements is idealized and only the most important heat transfer processes occurring in them are taken into account. Complex geometric shapes are replaced by simple surfaces. The main carrier is HF.

In [13], equation (1.1) is written for hydraulic tanks, taking into account the difference in the initial temperature of the hydrostatic transmission from the ambient temperature.

In [14], solution (1.1) is given for constant coefficients and the right-hand side, similar to (1.3), in which the initial coefficients are reduced.

In [15], when calculating the hydraulics of a forklift, the heat balance equation (1.1) was written taking into account the temperature dependence of power losses in hydraulic lines. The general solution of the obtained equation in the transition mode gives temperatures higher than the solution of equation (1.1), performed with a constant right-hand side. The values of the steady-state calculated temperatures in both cases coincide.

In [2], when constructing a mathematical model of the thermal regime of hydrostatic transmissions, it is proposed to use the theory of power flow [14]. The mathematical model in this case is based on a strictly sequential consideration of heat sources and determination of heat losses in the relevant areas so that the heat balance of the entire hydrostatic transmissions is most accurately established at a given mode of operation. When using the power flow scheme for calculating the thermal regime of hydrostatic transmission in [2], by analogy with [14], the concept of nodal points is introduced.

For a more accurate determination of the steady-state temperature, it is proposed to solve the differential heat balance equation by numerical methods, setting the time interval equal to 10-20 seconds, and substituting the values of the coefficients corresponding to this temperature equation.

The main disadvantage of the calculation constructions discussed above is the impossibility of determining the temperature for characteristic sections and fluxes of the HF. Particularly, in the suction, discharge and drainage collectors, i.e. at the inlet and at the exit of the HF from the hydraulic tank-cooler system.

In [16], the proposed calculation system of equations is written taking into account the internal heat transfer between different sections of the hydraulic system. The site, in this case, is the elements of the regulatory circuit having different temperatures relative to others. The average temperature of the entire site is taken as the calculated one. When using the obtained equation, it is necessary to separate the serial and parallel circuits of internal heat transfer. The solution of the system of equations (1.1 1.3) is assumed to tend in all modes with constant loading to a steady value.

The recommendations obtained on the basis of the developed model of the thermal regime suggest the possibility of lowering the temperature of the working fluid in the pressure and suction hydraulic lines of the hydrostatic transmission with a make-up flow that is directly proportional only to the amount of leakage.

The disadvantages of this model are the neglect of taking into account changes in both the temperature inside the section, for example, along the length of the hydraulic lines, and the effect on the unevenness of heating with constant heat generation, and the circulation of the HF flow inside the section under consideration.

In [17], when studying the thermal conditions of single-bucket excavators, the heat balance equation in the transition mode is replaced by a linear approximation of the experimental values of the temperature dependence of the temperature of the rocket from time to time.

In [3], formulas and graphs characterizing the change in temperature are given - Δt_c^o when passing through the hydraulic fluid separately through hydraulic resistance (pipelines, valves, throttles, etc.):

$$\Delta t_c^o = \frac{\Delta P_c}{10\rho c_1}$$

where, ΔP_c – pressure loss on resistance, Pa;

c_1 – specific heat capacity of hydraulic resistance HF, J / kg.deg;

ρ - HF density, kg / m^3.

In [18], formulas are given for determining the temperature change - $t^0(x)$ along the length of the hydraulic lines - x:

$$t^o(x) = t_O^o + \text{в}_\theta + (t_{\text{вхл}}^o + t_O^o - \text{в}_\theta)\, exp\left(-\frac{k_{TO}\pi d_л}{G_1 c_1}\text{x}\right)$$

here, $t_{вхл}^0$ – temperature at the inlet to the hydraulic line, deg;

$в_\theta$ - coefficient taking into account power losses, deg;

k_{TO} – heat transfer coefficient, W/m^2. deg;

$d_л$ – external diameter of hydraulic lines, m;

G_1 – mass flow of HF, kg/s;

t_0^0– ambient temperature, deg.

Conclusion

Thus, based on the analysis of the above works, we can draw the following conclusions: it is still relevant to study hydraulic mining machines and solve problems of hydraulic systems. The development of these solutions should investigate and analyze hydraulic machines in the condition of exploitable terrain. This can be used as a source of information for hydraulic system problems.

References

1. Osipov A. F. Volumetric hydraulic machines. Moscow: "Mechanical engineering", 1966, 160 p.

2. Bazhan P. I. Study of the thermal regime and evaluation of the efficiency of the ship's hydro-volume transmission using calorimetric characteristics. Abstract of dissertation., Gorky, GIIVT, 1973, 24 p.

3. Bashta T. M. Machine-building hydraulics. Reference manual, M., GNTI "Machine-building literature", 1963, 523 p.

4. Kovalevsky V. F. heat Exchange devices and thermal calculations of hydraulic drive of mining machines, M.: "Nedra", 1972, 224 p.

5. Poderni R. Yu., Saidaminov I. A., Khromoy M. R., Najmidinov sh. z. Comparative analysis of the working fluid flow in the control circuits of single drives of SBS machines. // MINING - THE MOSCOW STATE MINING UNIVERSITY, No. 12, 1999. 153-154.

6. Khayrov V. U. Features of machine operation in a hot climate, - "Construction and architecture of Uzbekistan", 1971, no. 2, p. 39.

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

Mubarakan Madaminova Atajanova
Senior Teacher,
Tashkent State Technical University
of the Republic of Uzbekistan.
Gulchehra Shodievna Zhuraeva
Associate Professor
of Tashkent State Technical University of Islam Karimov
Uzbekistan Tashkent
Bakhtiyor Abdurakhmanovich Aliboev
Doctor of Philosophy in Technical Sciences (PhD),
Military Technical Institute of the National Guard
of the Republic of Uzbekistan

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