Kryshtopa L.I.,
Bogatchuk I.M.
Ivano-Frankivs'k National Technical University of Oil and Gas,
t. Ivano-Frankivs'k, Ukraine
E-mail: L.I.Kryshtopa@mail.ru

INFLUENCE OF GAS DYNAMIC IN INTERCONTACT SPACE ON MIGRATION OF GAS ENVIRONMENT FROM OUTSIDE

UDC 621.891

There were showed the necessity of the forced input of gas environment for intercontact space of hard loading friction units of band-block brakes of drilling hoists with surplus pressure which must exceed pressure of gaseous products of destruction of connective asbopolymer materials. System and method of serve of gas environment is developed, for example, exhaust gases of combustion engines on the friction contact with the purpose of increase of liveability of the brake.

Keywords: intercontact space, friction contact, surfaces of friction, band-block brakes of drilling hoists, gas dynamic.

Entry

Laboratory and natural researches [1] showed that on migration of external environment selection of gas on the friction contact influences in intercontact space.

Researches on the questions of selection of gas at friction of asbopolymer materials it is conducted extremely small. In work [2] the given question is first affected and influence of gas dynamic is explored on friction widely widespread class of the asbocontaining friction materials ФК-16Л, ФК-24А which are used in band brake winches. At temperatures higher 400 K selection of gas which depends on geometry of contact is marked.

Comparison of results of laboratory and natural researches confirms this conformity to the law. At laboratory researches on gas dynamic the data got in an interval 370-600 K differ from the results got at natural researches. Such distinction can be accounted for to those, that in laboratory terms, measuring of pressures was produced on the capillaries of small section that resulted in falling of pressure on his length, and also difference of the dynamic loadings, affecting the pairs of friction of brake and in the laboratory setting realizing the statistical mode.

Raising of problem

However, the got results confirm a conclusion that the chemistry physics processes of destruction, resulting in the selection of gaseous products, prevail in the process of the FAPM friction.

Thus, the selected gaseous products of destruction hinder to the receipt of gas environment from outside in intercontact space. And, consequently, delivery of gas environment from outside can take place only at an adsorption effect, when the areas of surface of friction go out from the contact, and a crack effect degenerates here. In a band brake, pumping over is structurally impossible an effect. Thus the superficial and subsuperficial layers FAPM substantially change the properties (density falls to $\rho = 1{,}6 \cdot 10^3$ kg/m^3) and they are composition from an earth-flax, barite and coconut type matter formed at thermo destruction phenolformaldegide resins.

Consequently, in the process of friction of asbofriction materials effective influence on the friction pairs of active gas environments is possible at the forced serve of them in intercontact space with pressure exceeding pressure of gaseous products of destruction, so higher ΔP = 1000 Pa. The forced serve of gas environments in intercontact space allows to render active influence on friction wear properties of friction pairs.

The hydraulic calculation of the pneumatic system of serve of exhaust gases was produced coming that from, that exhaust elements represent the mixture of gases, mainly: nitrogen – 77 %; oxygen – 8 %; carbon dioxide – 12 % and aquatic steam – 3 %.

The closeness of mixture of gases is determined by formula:

$$\rho = 0{,}01\left(\rho_1\alpha_1 + \rho_2\alpha_2 + \ldots + \rho_i\alpha_i\right), \tag{1}$$

where, ρ_1, ρ_2, ρ_3 – closeness of components;

α_1, α_2, α_3 – by volume stakes of constituents in percents.

Dynamic viscidity of mixture of gases it is determined [4]:

$$\eta_m = \frac{100}{\dfrac{\alpha_1}{\eta_1} + \dfrac{\alpha_2}{\eta_2} + \ldots + \dfrac{\alpha_i}{\eta_i}}, \tag{2}$$

where η_1, η_2, η_i – viscidity of components.

It is set on the basis of laboratory and model researches, that density of mixture of components ρ_m = 1,314 · 10^3 kg/m^3, viscidity η_m = 1710 · 10^8 kg/m·s and pressure in intercontact space in the period of braking must be no less P_e = 5 kPa.

We will define the expense of gas mixture at expiration of it from one opening in a skid [6]:

$$q_0 = \mu F_0 \sqrt{2gH}\ , \qquad (3)$$

where F_0 – area of transversal section of the output opening by a diameter d_0 = 0,005 m.

$$F_0 = \frac{\pi d_0^2}{4} = \frac{\pi (0{,}005)^2}{4} = 1{,}96 \cdot 10^{-5}\ \text{m}^2;$$

μ – coefficient of expense, attributed to the output opening. At the sharp entrance edges of opening μ = 0,82;

H – pressure under the centre of gravity of the output opening: $H = \dfrac{\Delta P}{g\rho}$

$H = \dfrac{5 \cdot 10^3}{9{,}81 \cdot 1{,}34} = 403{,}2$ m. So, it means that $g_0 = 0{,}82 \cdot 1{,}96 \cdot 10^{5}\sqrt{2g403{,}2} = 1{,}44 \cdot 10^{-3}$ m^3/s.

General expense of gas on area O – B (fig. 1) must be evened:

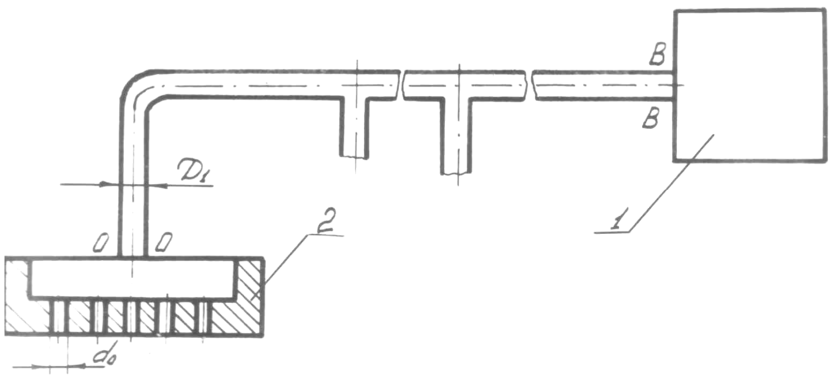

Fig. 1 – Chart of area of the system of admission of exhaust gases:
1 – regulative valve;
2 – skid

$$Q_{O-B} = 5q_0;\ Q_{O-B} = 5 \cdot 1{,}44 \cdot 10^{-3} = 7{,}2 \cdot 10^{-3}\,\frac{m^3}{s}.$$

For providing of pressure on $P_e = 5\,kPa$ an exit from a regulation valve must be equal:

$$P_V = P_e + \Delta P_{O-B}\ , \qquad (4)$$

where ΔP_{O-B} – losses of pressure at definite area.

After valve regulation the gas goes out through twenty two openings in skids. As openings are evenly distributed on the area of gas pipeline so this area we can examine as an area on length l at which is evenly taken away gas by q, where q – specific expense of gas on unit of length of gas pipeline. Analytical expense of gas in any point of gas pipeline can be expressed by linear dependence:

$$Q_{nx} = q(l - x). \qquad (6)$$

Overfall of pressure is determined by formula [6]:

$$P_{B.} - P_X = \frac{\rho}{2F_1^2 D_1}\int_0^l \lambda_1 [q(l-x)]^2 dx\ , \qquad (7)$$

where F_1 – area of transversal section of pipeline;

D_1 – diameter of pipeline;

λ_1 – coefficient of hydraulic resistance, which depends on the mode of flow.

Research results

By a criterion determining the mode of flow of gas there is the Reynolds number determined by formula [3]:

$$\mathrm{Re} = \frac{\omega_1 D_1 \rho}{\eta}, \quad (8)$$

where ω_1 – speed of stream.

Speed of stream is determined by formula:

$$\omega_1 = \frac{Q_n}{F_1} = \frac{4Q_n}{\pi D_1^2}, \quad \omega_1 = \frac{4 \cdot 7{,}2 \cdot 10^{-3}}{\pi \cdot (0{,}012)^2} = 63{,}4 \text{ m/s}. \quad (9)$$

Then $\mathrm{Re} = \frac{63{,}4 \cdot 0{,}012 \cdot 1{,}314}{1710 \cdot 10^{-8}} = 5{,}85 \cdot 10^4$.

If, $4000 \le \mathrm{Re} \le 10^5$ we have the turbulent mode of motion. In this case

$$\lambda_1 = \frac{0{,}3164}{\sqrt[4]{\mathrm{Re}}}, \quad \lambda_1 = \frac{0{,}3164}{\sqrt[4]{58500}} = 0{,}0203. \quad (10)$$

Losses of friction in a pipeline at even gas extraction at turbulent motion of gas is determined by formula:

$$\Delta P_{O-B} = \frac{0{,}0577 \cdot \sqrt[4]{Q^7} \cdot \sqrt[4]{\nu} \cdot \rho \cdot l}{\sqrt[4]{F_1^7} \cdot \sqrt[4]{D^5}}, \quad (11)$$

where l – length of pipeline, m. So,

$$\Delta P_{O-B} = \frac{0{,}0577 \cdot \sqrt[4]{(7{,}2 \cdot 10^{-3})^7} \cdot \sqrt[4]{(1710 \cdot 10^{-8})} \cdot 1{,}314 \cdot 3}{\sqrt[4]{\left(\frac{\pi \cdot 0{,}012^2}{4}\right)^7} \cdot \sqrt[4]{0{,}012^5}} = 5{,}26 \cdot 10^3, \text{ Pa}.$$

Thus, pressure on an exit from a valve must be: $P_V = 5 + 5{,}26 = 10{,}26$ kPa. We ignore the losses of pressure in a valve and consider that pressure on the entrance in the valve 10,26 kPa.

We will consider the area of the system of admission of exhaust gases "exhaust pipe – regulative valve". Diameter of pipeline is D_2 = 25 mm. We consider that the stream of gas is incompressible. Speed of stream will be: $\omega_1 = \frac{4 \cdot 7{,}2 \cdot 10^{-3}}{\pi \cdot (0{,}025)^2} = 14{,}66$ m/s. The Reynolds Number is $\mathrm{Re} = \frac{14{,}66 \cdot 0{,}025 \cdot 1{,}314}{1710 \cdot 10^{-8}} = 2{,}82 \cdot 10^4$.

According to the Reynolds Number Re we have a conclusion that the mode of motion of gas is turbulent and in case that in the project system of admission of exhaust gases on the average (on operating standards) 6 turns, 2 sudden expansions and narrowing, the losses of pressure on the given area of pipeline are equal:

$$\Delta P = 0{,}0244 \cdot \frac{21 \cdot 1{,}314 \cdot 14{,}66^2}{2 \cdot 0{,}025} + \frac{1{,}314 \cdot 14{,}66^2}{2}(2 \cdot 0{,}6116 + 2 \cdot 0{,}8711 + 6 \cdot 0{,}23068) = 3{,}48, \text{ kPa}.$$

Conclusions

Consequently taking into account the losses of pressure on the entrance in the system of admission of gases pressure must be equal to $P_E = P_V + \Delta P = 10{,}26 + 3{,}48 = 13{,}74$ kPa.

On the basis of the conducted laboratory and natural researches gas dynamic effects taking place in intercontact space of friction pairs of band brakes of boring winches are studied. So, at the modes of hard loading friction units of band-block brakes of drilling hoists work at surplus pressure is created in intercontact space.

The analysis of results of researches showed the necessity of the forced input of gas environment for intercontact space with surplus pressure which must exceed pressure of gaseous products of destruction of connective asbopolymer materials. The system and method of serve of gas environment is developed, for example, exhaust gases of combustion engines on the friction contact with the purpose of increase of liveability of the brake.

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Надійшла в редакцію 16.09.2015

Криштопа Л.І., Богатчук І.М. **Вплив газодинаміки у міжконтактному просторі на міграцію газового середовища ззовні.**

Газодинаміка у міжконтактному просторі відіграє важливу роль та, у залежності від видів тертя, механічних та фізико-хімічних властивостей поверхонь тертя, може набувати як додатних, так і від’ємних значень. Надлишковий тиск перешкоджає міграції газу від міжконтактного простору до навколишнього середовища та створює умови для створення областей зі зменшеним коефіцієнтом тертя.

На підставі проведених лабораторних і стендових досліджень вивчені газодинамічні ефекти, які мають місце в міжконтактному просторі фрикційних пар стрічково-колодкових гальм бурових лебідок. Встановлено, що за важконавантажених режимів тертя, за яких працюють гальма бурових установок, в міжконтактному просторі створюється надлишковий тиск.

Аналіз результатів досліджень показав необхідність примусового введення газового середовища в міжконтактний простір з надлишковим тиском, який повинен перевищувати тиск газоподібних продуктів деструкції зв'язуючої речовини азбополімерних матеріалів. Розроблена система і методика підведення газового середовища, наприклад, вихлопних газів двигунів внутрішнього згорання, на фрикційний контакт з метою підвищення довговічності гальма.

Ключові слова: міжконтактний простір, фрикційний контакт, поверхні тертя, стрічково-колодкове гальмо бурової лебідки, газодинаміка.