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Modelling of Sealing Elements Wearing

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Abstract. Ensuring of permanent and continuous working process of oil-gas and field equipment alongside with the other factors, depends also on reliability of sealing units. A problem of deterioration modeling of a sealing element of a packer including into an oil field equipment complex is considered in this paper.
Key words: corrosion, flush valves, compressor, linguistic variables, diagnosis.

I. INTRODUCTION

Physical pressure (related to the temperature), chemical processes (rust, oxidation, corrosion), mechanical load (static and dynamic forces), public services (attitude related to equipment and its work) affecting parts of the equipment during the operational process are characterized exploitation conditions of the equipment.From the above, we can say that various factors are caused shattering of different devices durability and their work process. The main factor affecting of fountain well-devices which is stipulating their strength is the pressure of the extracted product. Fountain armatures are worked under from 5 atm pressure till 80 atm pressure. In the process of exploitation by means of compressor gas lift method gas is injected under high pressure into the annulus. As the pressure of gas is changed in wide limits the details of compressor, above-ground pipelines, connector fixtures and downhole pipelines are working under a variable (repetitive) tension. In compressor gas-lifting for exploiting a group of wells the equipment complex and influenced forces are more compound. Equipment complex consists of a compressor station, a network of gas distribution, a gas preparation system and a gas-lift equipment of the well. It is evidently that, every detail of the complex has to meet the definite demands on strength. Forces affecting details of the complex are periodically related to extracted oil and crossbar weight. Rocker loom gets the maximum and minimum values. Therefore, crossbars are worked fatigue.

II. STATEMENT OF THE PROBLEM

As the sealing elements of oil field equipment packers work in a complicated condition the wearing takes place more intensively as a result of friction. It is known that sealing unit is tribotechnical pair of friction relation [1]. Friction created in these pairs has double nature: it is directed to liquidate adhesion relation in rubber (elastomer) – metal contact and strains thin surface layer due to the contact of the elastomer to the metal surface. That's why destruction of various friction relations (units) exists depending on the durability of adhesion relations created there and contact – pressing of the elastomer-rubber strain value [2] and more of them take place by mechanical bilateral influence which belongs to sealing units. Thus durability of the sealing materials to wearing is determined as it depends on the type of destruction of friction relations. That's why modeling of wearing in non-stationar external friction is of great significance for determining destruction nature of any type of friction relations in the contact of metal surface of the sealing element. Wearing occurs in the packers in various deformations of the rubber. Various destruction types of friction relations having physicomechanical character determine friction and wear durability. Physical modelling for friction wearing gives good results while carrying out model experiments in the laboratory. This method is based on "analogy and physical modeling" and according to measuring analysis method information needed for the investigated object is got by criterial functions.

III. SOLUTION OF THE PROBLEM

Scale pass coefficients are estimated for the natural and model. When calculating scale coefficients additional boundary conditions are added to the equation system. Let's use measureless functional dependence of wearing [2].

$$\Pi_i = \frac{J'}{J} = \varphi\left(M_{\pi_1}, M_{\pi_2}, \dots, M_{\pi_n}\right) \quad (1)$$

Here J' and – J are wearing intensity of sealing element in the model and natural one;
$M_{\pi_n} = \pi'/\pi$ is ratio of model criteria to natural criteria;

1, 2, 3,…n – are parameters of physical modelling of wearing. π' and π are related for model and natural one as the following:

$\pi' = M_\pi \cdot \pi$, where M_π is a scale coefficient of transition from model to natural one. It is possible to solve the problem by various approaches. But for sealing units energetic approach can be considered as the simplest one [1]. When we say energetic wearing intensity [1], expression $J_W=V/W_F$ for linear wearing can be accepted and written as the following.

$$J_W = \frac{J_h \cdot A_a}{F} \tag{2}$$

Here A_a is a nominal area of friction. For model and natural constructions of the sealing element according to analogy condition (5) we can write

$$\frac{J'_w}{J_w} = M_{J_w} = 1 \text{ or}$$
$$M_{J_w} = \frac{M_h M_a}{M_F M_S} = 1;$$

Then considering numerical values h, s and A_a for scale coefficients we obtain

$$\left.\begin{aligned} M_{J_w} &= \frac{M_r^{\frac{1}{6}} M_r^{\frac{1}{3}}}{M_F M_r^{\frac{1}{6}}} = 1 \\ M_F &= M_a = M_r^{1/3} \end{aligned}\right\} \text{ or} \tag{3}$$

Here $M_F = F'/F$ simplifies friction force for the model and natural sealing element. To assess a friction property of wearing in the friction pair of the sealing element the equality of model and natural coefficients of the pair must be provided: f=f' or M_f=1. Then we can write:

$$M_f=1.\ M_f=f'/f=M_f/M_p=1 \text{ or } M_p=C_r^{1/2}$$

(here M_p=P'/P is a simplex of the force in the sealing pair) Let's provide equality of the friction force of the model and natural construction:

$$M_{N_a} = \frac{M_N}{M_a} = 1$$

Simplex M_N (friction force) can be written as [5]:

$$M_N = M_v \cdot M_p; \qquad \text{then} \quad M_{N_a} = \frac{M_v \cdot M_p}{M_a} = 1$$

Here $M_v = v'/v$ is the simplex of linear rate in the relative displacement of the sealing element in the friction unit of the packer. Thus, equality of energetic indices for the constructions of the model and nature sealing elements is provided in the case when we get $v' = v$ equality of linear rates in the relative displacement of the sealing element of the friction pair. It becomes obvious that $M_p = M_a = M_r^{1/3}$, but in the friction pair $P_a = P/A_a$ self scale coefficients of the force are

$M_{P_a} = \frac{M_P}{M_a} = 1$, then $P_a = \frac{N_a}{f \cdot v} = \text{const}$ or $M'_a \cdot v' = P_a \cdot v$=1. Thus according to the above mentioned the following results can be obtained:

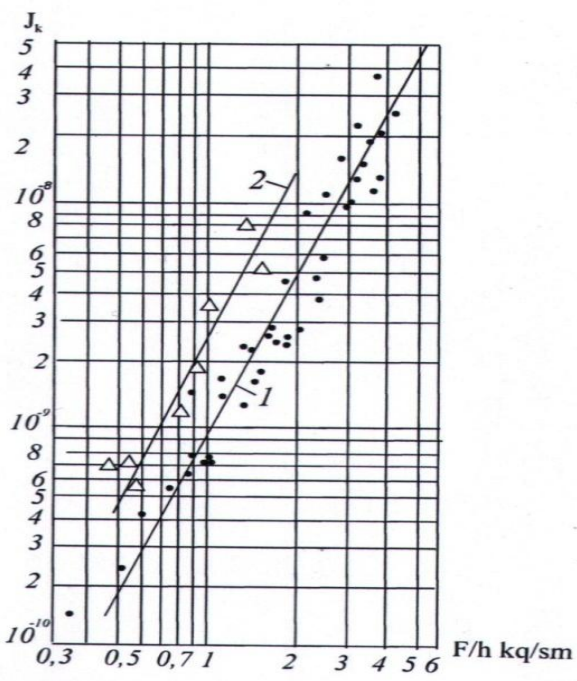

Fig.2. Dependence of wearing intensity of rubber packers J_k on the force of F/h kq·q/sm: in contact friction (in movement); 2- when strain – compression is stopped.

IV. CONCLSION

1) Using wearing – friction property model for non-stationar work regime in the sealing friction unit, durable and reliable work for field packers can be prognized.

2) The obtained physical model is confirmed experimentally (fig.1) and is extended to packers of field equipment packers.

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