4.1.25. NON-DESTRUCTIVE VACUUM MECHANISMS FAILURE PREDICTION SYSTEM

Deulin E.A., Pichuzhkin V.V., Savransky V.V., Tomilin V.A., Bauman Moscow State Technical University, Moscow, Russia

The researches show that the gas flow being desorbed from the mechanisms in vacuum depends on many parameters: resistance force , torque moment, sliding velocity , which play a key role in mechanically stimulated desorption (MSD). The expected service period of the mechanism can be estimated with help of desorbed gas flow Q_Σ and MSD flow measurement. The theoretical model takes into account friction parameters: normal load, sliding speed, energy of sorption.

The vacuum mechanisms failure predicting system [1] uses the total pressure p measurement results, rotation speed of vacuum mechanism elements n, resistance torques $M_{\min}$ and $M_{\max}$, amplitude of vibration A. The measured and calculated values of M and p are compared and expected service period is being estimated. For example, the experimental diagnosing system based on rotation motion feedthrough with sealing bellow uses 3 vacuum ball bearings and the theoretical model shows that the values of parameters are: torque moments $M_{\min} = 0.21\ Nm$, $M_{\max} = 2.74 Nm$, out gassing flow $Q_\Sigma = 1.50 \cdot 10^{-6}\ m^3 Pa\, s^{-1}$, and they may be compared with the experimentally measured ones: $M_{\min} = 0.25\, Nm$, Q_Σ $1.1 \cdot 10^{-6} m^3 Pa s^{-1}$ to $1.5 \cdot 10^{-6} m^3 Pa s^{-1}$. The results show that the outgassing flow from the mechanism being diagnosed in vacuum is an important source of information about the mechanism wear processes. The researches of MSD were done to use this phenomenon for the system of vacuum mechanisms failure predicting [2]. The outgassing gas flow is considered as function of the mechanism being diagnosed parameters: 1 – load, 2 – sliding velocity, 3 – materials of friction pair . Let us consider some positions of the system on the examples:

For the non-coaxial nut-screw pair the normal stress in the contact is used as a base for outgassing flow determination:

$$Q_{Bearing} = (4 - 582.2\vartheta_{\text{ск}} - 0.007P + 0.06\vartheta_{\text{ск}}P) \cdot 10^{-1} A_a\,, \qquad (1)$$

where A_a – nominal contact area; P – normal stress in the contact; $\vartheta_{\text{ск}}$ – sliding velocity;

The same idea is used in case of ball-bearing being rotated in vacuum diagnosing system and the out gassing flow may be calculated:

$$Q_{B-S} = (10{,}6 - 0{,}2\,\vartheta_{\text{ск}} - 4{,}6\,P + 0{,}6\,P^2 + 3{,}9\,\vartheta_{\text{ск}}\,P) \cdot 10^{-3}\ A_a\,. \qquad (2)$$

The comparison of the experimental values of outgassing flows with the calculated ones shows a good coincidence (the difference is less 10%). This method lays the ground for a computer-based non-destructive system of vacuum mechanisms failure predicting and it is based on permanent pressure variation measurement as a result of vacuum mechanisms operation [3]. This method was used for different types of vacuum mechanisms wear estimation and failure predicting: ball bearings, non-coaxial nut-screw pairs, coupling gears. Now it is considered as a foundation for a computer-based system of vacuum mechanisms failure prediction. The model for estimation wear degree and wear rate of kinematic pairs operating in vacuum is proposed [4]. This model is based on measuring and analysis of the outgasing rate from mechanisms. The model was verified using ex-

perimental data. The comparison of the experimental values of nominal and additional outgasing rates with calculated ones showed good consistence with mismatch between the experimental and calculated values less than 10%. New method of estimation of reactions between the components of a ball bearing using the outgasing flow measuring is proposed. This method lays the ground for developing a computer-aided diagnosing system of vacuum mechanisms. This system is based on information acquisition and following analysis of the data on instant changes of the pressure in a vacuum chamber during operation of mechanism, as well as on vibration and rotation speed mechanisms. Then probabilistic assessment of expected left operation life of vacuum mechanisms is calculated by the diagnosing system.

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