ANALYSIS OF VIBRATORY ACTIVITY OF SUBMERSIBLE PUMPS FOR OIL OUTPUT ON THE BASIS OF FEM

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In the Russian Federation more than 65% of oil is outputted with the help of the well electric centrifugal pumps (ECP). ECPs are very complex dynamic systems (multi-section and multi-stage), in which it is necessary to differ the internal vibrations – the relative oscillations of the rotor and stator and external vibrations - the relative oscillations of the pump stator and the casing pipe.The main factor affecting the reliability and service life of the pumps is their vibratory activity, the level of which overlap with very tight restrictions.

Analysis of the ECP section structure as a dynamical system shows that it is possible the exciting the next types of vibrations:

● forced vibrations under the influence of imbalance (linear and angular) of the working wheels; ● parametric vibrations, caused by the anisotropy of the shaft stiffness due to the presence of key slot; ● self-oscillations caused by non-conservative forces, caused by oil layer of the bearings and the oil layer between the shaft and the adjoining parts of the guide vanes.

The features of the pump section in the "field" is the uncertainty in the section stator of the ESP contact with the casing pipe.This entails uncertainty in formulation of the corresponding boundary conditions, as well as in magnitude and distribution of working wheels imbalance along the shaft axis. Therefore an actual task consists in identifying the reasons, witch in the greatest extent affect the ECPs vibration activity, and in the developing the algorithms for quantitative estimates of corresponding vibration levels.

In the report based on the analysis of ECP section dynamics it was proposed the principle of formation of the machine structural scheme, and also there are represented the mathematical model and the methodology of the quantitative analysis of the arising vibrations levels on the basis of FEM. When creating the FE model of the «rotor - casing pipe» system, the main attention was paid to the peculiarities of the following matrices and vectors formation:

● the stiffness matrices of bearings and bushings; ● the global matrix of inertia and stiffness; ● the global matrix of rotor and stator compliance; ● the matrices of compliance referred to bearing; ● the matrix of the system compliance from excitation forces; ● the full vector of exciting forces; ● the vector of reactions in the bearings; ● the vector of rotor and stator vibration amplitudes .

It is proposed the example of calculation of the vibration characteristics for the DVS5-50 pump section, the results of which are sufficiently well coincide with the experiment data in the test bench conditions. The offered technique can serve as the calculation basis for the elaboration of recommendations on implementation of activities to increase the vibration reliability of submersible centrifugal pumps for oil output.