ABSTRACT

New Theory of Rotor Dynamics:
Rotor Dynamics with Moment Disbalance

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The subject paper analyzes the existing theory of rotor dynamics, which is based on the theory of vibrations. Contradictions of the existing theory, which made conditional upon necessity to search for principally new approach to understanding of rotation process, are cited. A new hypothesis is expounded for nature of rotor rotation promoting understanding of rotor realignment physics at rotation.

The new hypothesis is based on fundamental generally accepted laws of engineering mechanics.

From the position of the new understanding of disk rotor rotation physics, a complete pattern of the forces affecting a vertical rotor is adduced. A set of equations defining a rotation process with specified constant speed is formed. A relation between the new equations of rotor dynamics and well-known facts and rotation peculiarities is established. Aptitude of the new theory is proved, and it is juxtaposed to basic theses of the rotor dynamics theory of vibrations. The three main rotation modes are detected, and reasonable speed ranges corresponding hereto are specified. Dependences for magnitude and direction estimation for all the forces affecting the rotor, responses from the supports included, are cited. Directions of the affecting forces are reckoned from an arbitrarily selected direction of the rotor imbalances principal moment.

In order to explain rotor rotation physics within the entire speed range, special emphasis is placed upon the analysis of the derived rotor dynamic equations. An expression is derived describing the rotor turn angle depending on rotation speed. The rotor turn angle is demonstrated not to depend on static imbalance value. Our conception of rotor self-alignment and the role of this condition in maintaining the specified number of revolutions are set out. The reasons why a rotor maintains a certain position relatively to a rotation axis at random offsets and torsional deviations from a nominal position are explained. Peculiarities of rotor vibrations about the nominal position are specified. The Sommerfeld effect is explained from the position of physics and the derived rotation equations.

Design dependences are cited to determine magnitude and direction of the rotor axis deviation from the nominal position for any number of revolutions. A positive role of resonance condition in the rotor self-alignment is explained.

New power capabilities of the revolving rotor are demonstrated. The problem of rotor free deceleration and shutdown is considered.

Keywords: Dynamics, Rotor, Imbalance, Shaft, Supports.