

ABSTRACT

New Theory of Rotors Dynamics: Disk Rotor Dynamics with Static Unbalance

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Existing theory of the rotor dynamics is based on theory of vibrations. It is assumed that rotating unstable shaft performs bending vibrations. At that a simplest rotor mounted on to the flexible shaft has one degree of freedom.

This paper is introduction to new theory of rotor dynamics, which is based on new hypothesis. According to the hypothesis the simplest rotor mounted on to the flexible shaft has two degrees of freedom. It is supposed that the rotor shaft performs no bending vibrations, but deflects and in such position rotates about the axis passing through the bearings.

Base of new theory is variation of the rotor and shaft moments of inertia during shaft deflections due to laws of material nature. Changes of the moments of inertia are disturbing factor to overcome which it is need applied an additional torque.

Rotation of the vertical disc rotor possessing unbalance and mounted onto two bearings (classic scheme) is considered from the point of view of understanding the laws of physics and nature.

For the first time the complete scheme of the forces affecting the rotor under vacuum is presented, and new system of equations of the rotor dynamics is deduced.

The obtained equations are analyzed taking into account the gradual increase of speed. The analysis results are compared with known effects obtained experimentally, such as quiet rotation at under-critical speeds, bearing vibration appearance, resonance and Sommerfeld effects, quiet rotation at over-critical speeds.

Three general modes are showed up and speed ranges corresponding to these modes are set.

New approach presents the resonance effects are caused by otherwise than shaft deflection under the rotor unbalances.

It presents that resonance effect is requirement to the rotor transient to over-critical rotation mode.

It is proved that when rotor reaches the over-critical mode, the retrograde precession occurs and so, the rotor transient to over-critical mode can be considered as spasmodic.

The Sommerfeld physics takes substation.

New dependencies to calculate value and direction of the forces affecting the rotor and bearing responses.

First, the rotor self-alignment effect is considered from physics point of view.

Accumulation of a potential energy during self-alignment process is substantiated and role of the potential energy in the rotor dynamics is presented.

The emphasis is placed to explanation of the rotor stabilization at accidental deflections and torsion turns of the rotor at accidental changes of the torque.

The calculation dependencies to determine values and directions of the rotor displacements, as well as rotor turn angels depending on rotation speed are provided.

For the first time, it is presented that when torque removes the rotor stops under braking torque caused by changes of the rotor moments of inertia.