The Influence of Damping on the Efficiency of Autobalancing Devices for Rigid Rotors

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ABSTRACT

Automatic balancing devices comprising several balls in circular tracks can efficiently compensate rigid rotor unbalance within certain ranges of rotational speed. But for an inappropriate choice of parameters the vibration level near critical speeds may be comparatively high due to non-synchronous motions, when balls continue to move with a speed close to the rotor eigenfrequency, whereas the rotor gains in speed and passes the critical speed area. To diminish vibrations connected with non-synchronous motions and to provide quick compensation of unbalance in the postcritical area it is necessary to optimize the parameters of device.

Among the most "critical" parameters essentially influencing both the non-synchronous ball motions in the critical speed areas and the synchronization of the balls with unbalance compensation are damping coefficients, characterizing the resistance to the ball motions relatively to the track. Low damping causes a high level of vibrations near critical speeds and hamper synchronization of the balls, provoking ball oscillations around the compensation positions. High damping allows to diminish the areas of non-synchronous motions, but may also be the cause of increased vibrations due to superposition of centrifugal forces from the primary unbalance and autobalancing balls. The optimal choice of damping is an important problem discussed in presented paper.

The optimization of damping is a rather complicated process. As a rule, the optimal damping values for passing critical speeds and for yielding compensation of unbalance do not coincide. Therefore a "compromise" value needs to be determined, providing an acceptable level of vibrations on resonances and comparatively fast compensation of unbalances in the post-critical area. In addition, it must be taken into account that the optimal value of damping may be different for low and high values of primary unbalance, and hence a compromise must be found here as well. However, our experience shows that it is possible to find optimal damping for each rotor system to sufficiently improve the vibration performance of the system compared to a "non-optimized" case.

Investigations are based on the results of analytical study on the balls "behavior" near the nominal speed and critical speeds, and on computer simulations of transient processes during the rotor system run-up. General recommendations for the optimal choice of damping, as well as other parameters of device, are presented as the main practical outcome.