The Fluid Force Model in Rotating Machine Clearances Identified by Modal Testing and Model Applications: An Adequate Interpretation of the Fluid-Induced Instabilities

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ABSTRACT

This paper presents a summary of experimental and analytical results on rotor dynamic behavior due to interaction with the surrounding fluid in rotor/stationary part clearances, like in bearings, seals, in blade tip-clearances or in shrouded impellers in rotating machines. These results have been obtained in the years 1981-1999 at Bently Rotor Dynamics Research Corporation. The fluid dynamic force model was identified by classical modal testing, adapted to the specifics of rotating shafts. It is shown that this model of fluid dynamic forces, acting on concentric or slightly eccentric, elastically supported solid body, rotating within a stationary containment, adequately predicts the system fluid-induced instability thresholds, identifies new fluid-related natural frequencies of the first and higher modes, and adequately describes the post-stability self-excited vibrations of the fluid whirl or fluid whip form. Physical factors affecting and controlling fluid-induced instabilities of rotors, as well as model application extensions are discussed.

Keywords: Rotating machines, Modal testing and identification, Fluid force model, Solid/fluid interaction, Fluid whirl and fluid whip instability of rotors.