ISCORMA-3, Cleveland, Ohio, 19-23 September 2005

ON INCREASING THE STABILITY THRESHOLD OF A ROTOR BY OPEN-LOOP CONTROL OF THE BEARING MOUNT STIFFNESS

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ABSTRACT

It is a common problem in rotor dynamics that a rotor supported by fluid-film bearings or gas bearings may get unstable above a critical speed and then perform violent self-excited vibrations. Such vibrations can be a serious threat to the safe operation of rotating machinery and in general they have to be avoided by all means.

Self-excited vibrations may be caused by internal damping of an elastic rotor, hydrodynamic or aerodynamic forces in journal bearings, by forces generated in gaps and seals, etc. In this investigation we will focus on a rigid rotor supported by two journal bearings of some kind that are capable of generating destabilizing forces above a critical speed that cause the rotor to become unstable.

A novel method is proposed and investigated to counteract the destabilizing mechanism of the bearings. The basic idea of this method is to introduce a parametric excitation to the system, which cancels the self-excited vibrations. In previous publications by the authors this idea was applied to simple two-and three-mass systems. In this contribution we show that the method can also be applied to complex systems as a rotor-bearing system with 8 degrees of freedom.

The parametric excitation is realized by a harmonic variation of the stiffness of the bearing mounts. By choosing the appropriate frequency, which turns out to be a combination resonance frequency of the parametrically excited system, it is possible to fully suppress the self-excited vibrations and increase the operational speed range of the rotor. The effectiveness is demonstrated on a mathematical model of a rotor system by numerical simulation. Parameter studies show the range of some of the design parameters of the system investigated, where this concept is applicable.

Keywords: Rotor, instability, parametric excitation