New Developments in Fluid Film Bearing Technology

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Keywords: fluid film bearings, instability, stability threshold, oil whirl, oil whip, stable bearing design, journal bearings, active magnetic bearings.

This paper presents some new developments in Fluid Film Bearing (FFB) technology. The phenomena of oil whirl and oil whip leading to instability in FFB supported rotors; limit the performance of rotating machinery. This paper presents some new developments that affect the instability threshold, namely the positive effect of angular misalignment on the instability threshold and related design improvements in FFB design. In addition, the concept of an integrated FFB with active magnetic bearing (AMB) is discussed with implications on improving the stability threshold, and actively controlling FFBs.

Fluid film bearings are the main supporting elements for many heavy rotating machinery, including high-speed high-performance rotating machinery. However, the performance of rotating machinery supported by fluid film bearings are limited by the instability threshold known as oil whirl and oil whip. Even though this problem has been known for nearly a century now, yet it has attracted a lot of attention. Recently Prof. Gordon Kirk posed the following two questions:

1- Are there any possibilities that the rotor system transgress the threshold speed?
2- Can the rotor operate above this threshold speed?

These two questions clearly presented by Kirk are always pondered by both fluid film bearing designers and rotating machinery designers. These two questions are the motivation for this paper and the author believes that some progress towards the answer to these two questions is made here.

The paper clearly presents experimental results that show that the introduction of angular misalignment at the coupling significantly increases the speed of onset of instability, it also presents some numerical results illustrating the forces in misaligned bearings, in addition to This paper consists basically of three parts: Part I consists of some experimental and numerical results that illustrate the effect of angular misalignment on the performance of fluid film bearings; Part II presents some possible design changes to fluid film bearings; and Part III introduces the concept of an integrated fluid film bearing (FFB) and active magnetic bearing (AMB) to actively control the instability.

The experimental results for misaligned bearings. Possible bearing designs considering axial disturbance of the flow and pressure fields were also discussed.

Moreover the paper introduces the concept of an integrated JB/AMB and illustrates the possibility of transgressing the instability threshold effectively using a damping controller.

The above developments clearly illustrate that new FFB designs are possible that would provide better performance for high-speed high-load rotating machinery.