Dynamic Response of a Rotor Supported on a Floating Ring Bearing

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ABSTRACT

Turbochargers (*TC*) increase the power output and efficiency of internal combustion automotive engines. Conventional *TC* rotors are usually supported on floating ring journal bearings (*FRBs*) comprising two thin lubricated films in series. *FRBs* offer lower power losses, damping characteristics, and also cooler operating conditions than simple hydrodynamic journal bearings. Although *TC* on *FRBs* exhibit sub synchronous rotor whirl in most of their operating range, they often reach stable limit cycles, thus becoming cost-effective solutions in a competitive market. Measurements of the dynamic response to imbalance on a small test rotor supported on a floating ring bearing are presented. Threshold speeds of instability, sub critical bifurcations, amplitudes of limit cycles, ranges of whirl frequencies as a function of bearing load, rotor imbalances, feed pressures and rotor speeds were characterized from the experiments. The rotor-*FRB* nonlinear response shows two self-excited sub synchronous vibration components related to the hydrodynamic instability of the inner and outer films of the *FRB*. A linear rotordynamics model predicts poorly the onset speed of the instability and offers no insight in estimating the limit cycle amplitudes of rotor motion. Localized absence of sub synchronous vibration components was observed within specific rotor speed ranges for high feed pressures emulating large loads. The dynamic response of the rotor supported on a semi-*FRB* was also tested and found to be less favorable due to high levels of vibration induced by air entrainment into the outer film.

Keywords: Fluid film bearings, rotordynamic instability, modeling and experiments