1. Title of PhD thesis:

Studies on flexible journal bearings for improved tribological and stability behaviours

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Abstract

Vertical rotor-bearing systems exist in many machines and mechanical systems such as vertical centrifugal oil filters (COF), vertical condensate pumps (VCP), vertical sinking machines, helicopter rotors etc. It is worth noting here that oil-lubricated journal bearings are employed in COF and VCP to support and guide the vertical rotors energy efficiently. Since vertical rotors are get balanced before making them operational in the real applications, hence, the journal bearings supporting these rotors are subjected to extremely light radial loads may be due to minor installation and other field issues. It is worth mentioning here that a centrifugal oil filter processes different oils (having different viscosities) and uses the oil being filtered for lubrication in the supporting journal bearings of vertical rotor. But as per the concept of design of a rigid bore oil journal bearing, the clearance is kept constant for a set of operating parameters including a lubricating oil. Thus, need arises to perform the study on a vertically installed centrifugal oil filter (COF) for addressing the concerns of instability arising due to the light load by accommodating the different viscous oils for lubrication by varying the clearance in the journal bearing. To address the concerns mentioned above, mainly flexible (bump) bore journal bearings have been considered herein with the objectives of exploring numerically and experimentally the frictional and dynamic characteristics of the system. Explorations have also been made with multi-axial slotted floating bush bearings and employing textured journal surface.

Numerical investigations have been performed considering the textured, micro-grooved and micro-rectangular pocketed top foil surfaces for understanding and improving the lubrication and dynamic performance behaviors of the rotor bearing system employing air as a lubricant. Moreover, pocketed top foil has also been used for analysing the performance behaviors of oil lubricated bump foil journal bearing. With air lubrication cases, the micro-rectangular pocketed top foil yielded better dynamic performances as compared to the textured, grooved and conventional cases. It also yielded a significant reduction in friction coefficient varying in the range of 8 -11% as compared to conventional case. Inspired from these results, pockets have been employed on the top foil of oil lubricated bump foil bearing. The six-pocketed top foil yielded the best performances followed by four, eight, and ten pocketed cases. With micro-pocketed top foil, the coefficient of friction reduced in the range of 7-18% in comparison to the conventional foil case. Furthermore, pocketed foil provided improved stability of the rotor-bearing system in oil lubricated cases.

Experimental studies on lightly loaded vertical rotor (rotor of centrifugal oil filter) have been conducted employing three pairs of bearings and journals namely: (a) conventional foil bearing with plain shaft (b) conventional foil bearing with textured shaft, and (c) multi-axial slotted floating bush with plain shaft. For conducting the experiments on rotor of centrifugal oil filter, a specialized test rig was designed and got fabricated. Different viscosity grade oils namely: SAE 10W30, SAE 15W40, SAE 20W40 and SAE 20W50, were employed in performing the experiments. The frictional characteristics and stability of rotor-bearing system improved significantly with pair of conventional top foil and textured journal surface. However, the pair of multi-axial slotted floating bush and plain shaft surface also provided encouraging results. Moreover, at the elevated operating speed of vertical rotor, seizure between conventional top foil and plain journal surface has taken place. The pairs namely: textured shaft vs. conventional top foil and multi-axial slotted floating bush vs. conventional journal surface, exhibited improved performance behaviors irrespective of viscosity of oil i.e., grades of oils.