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Review

A theoretical model for analyzing the dynamic behavior of a misaligned rotor with active magnetic bearings

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ABSTRACT

The dynamic response of a misaligned rotor, mounted in two identical active magnetic bearings (AMBs) was numerically investigated in this work. Three simplified models of current biased radial active magnetic bearings were presented, where four, six and eight electromagnets were powered by the bias current i_0 and respective control current. The magnetic forces acting on the rotor, the coil currents and the displacement of the rotor were obtained through an electromagnetic theory. The AMBs' dynamics support parameters were modelled by linearised direct cross axes stiffness and damping coefficients. These are strongly dependent on the air gap between the stator and the shaft. A spatial model of a misaligned rotor with two degrees of freedom was presented. The motion equations were established for the rotor bearing system and simulated with Newmark method. Simulations results were carried out to survey the dynamic behavior of spatial misaligned rotor mounted in AMBs. The angular misalignment was such that the $2\times$ and $4\times$ running speed components are predominant. Their magnitudes varied with the number of magnets in the bearing and with the air gap between the stator and the shaft.

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1. Introduction

Active magnetic bearings (AMBs) are currently used in a number of industrial and research applications. They have several advantages over the conventional rolling-element [1–3] and fluid film bearings [4–6] of which the most significant is their higher mechanical efficiency. This is mainly due to their contactless operation which greatly reduces the friction losses. The absence of lubricating fluid in their operation also allows them to be used in some specialized applications, such as the bio-medical field, which requires an entirely oil free environment. However, AMBs, in their interaction with the rotor that they support, lead to various phenomena in the rotor's response. The AMBs consist of pairs of electromagnets. Each electromagnet produces a pulling force, whose intensity depends on the coil current. They are used by pairs in order to produce forces with both signs. In the work on the response of rotor with AMBs reported in [7–9], the rotor was assumed to be centered in the bearing. This was achieved in practical application by

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