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Design and Analysis of a Radial Active Magnetic Bearing for Vibration Control

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Abstract

Vibration caused by rotor unbalance is one of the most pertinent problems facing the rotating machines, including electrical motors and turbo machinery among others. Thus vibration attenuation has become very essential in improving the overall performance of such machines. In this paper, a 12-pole radial Active Magnetic Bearing (AMB), using AC excitation has been proposed to counteract the unbalance. Here a switching variation of AMB teeth excitation currents is implemented to generate a rotating force, synchronous with the rotor unbalance but in opposite direction.

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*Keywords:*vibration control; rotor; unbalance; AMB

1. Introduction

Active Magnetic Bearing (AMB) is being extensively used in many rotating machine applications, mainly because of their non-contact motion control characteristics and related advantages as compared with various passive control schemes.Many researchers have exploited the capability of producing a controllable electromagnetic force by AMB, among them Nickolajsen et al. [4] in 1979 introduced their use for vibration damping. Later many authors have worked for vibration suppression using AMB [3,5,7]. They have demonstrated the use of AMB as between-bearings to introduce damping and stiffness into the system and compensate for rotor unbalance such that the magnitude of vibration can be minimized, their focus have been on suppressing the vibration by changing the pole currents based on position feedback.

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The present paper proposes a force production technique to generate a rotating control force in-order to counteract any unbalance with the help of a 12-pole radial AMB. Here the controlling force to negate the rotor unbalance has been generated by implementing a switching variation of the bearing pole control currents, which has been achieved by utilizing an AC supply. The switching is executed in such a way that a rotating force is generated by the AMB which is synchronous with the unbalanced force and whose direction can be controlled by changing the phase of the AC supply. The electromagnetic design of the proposed model has been developed and verified using FEA (Finite element analysis) software OPERA 2D.

2. Electromagnetic Design of AMB

The design of the radial AMB has been developed by calculating the dimensions of the actuator parameters based on the initial design criteria like the maximum load capacity, air gap, and number of poles. Various analytical equations made available in [1,2,6] are utilized for calculating these parameters. Fig. 1 shows the design methodology adopted in developing the model.

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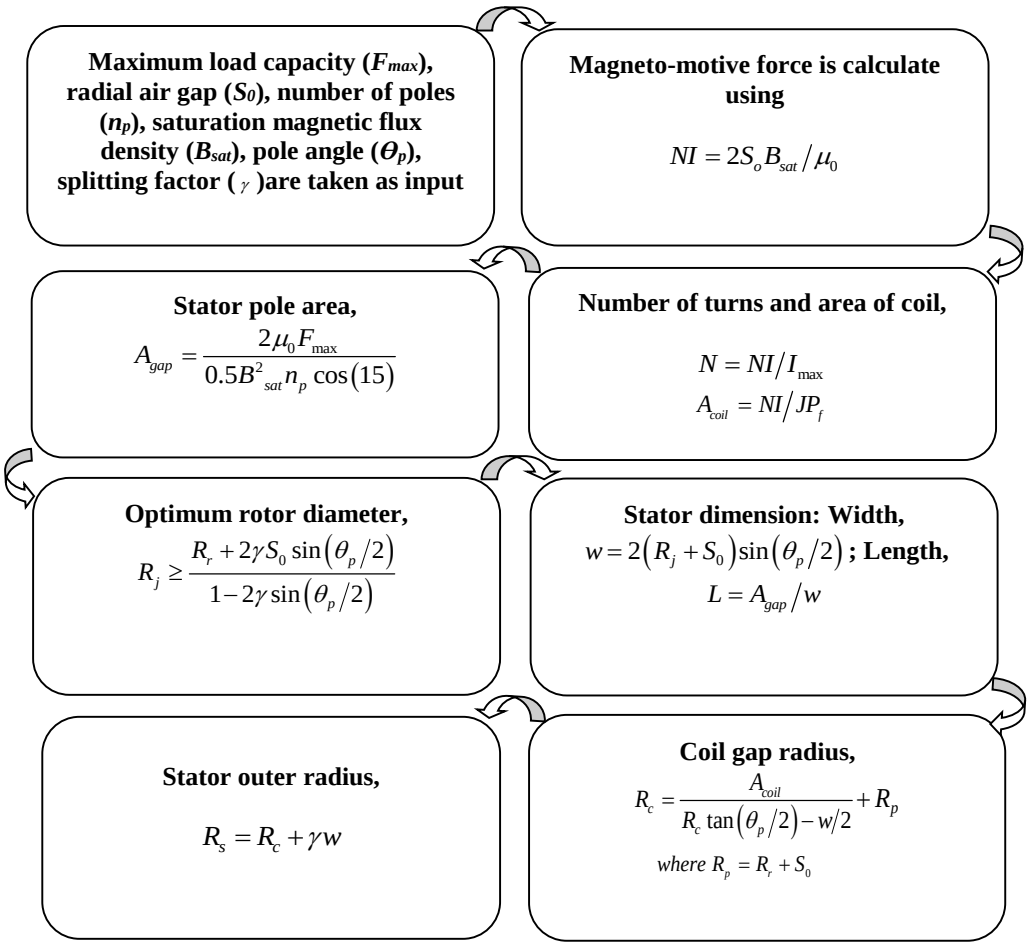

Fig. 1. Flow chart depicting the design methodology.