Onset of levitation in thrust bearing: FSI study using Abaqus-FlowVision coupling

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Abstract: Lift force formation in a thrust bearing of 800-tons rotor of electric power station is discussed in the given paper. The problem is solved numerically. Direct coupling between finite-element system Abaqus calculating stress and strain state of an bearing parts and finite-volume system FlowVision-HPC calculating oil flow in gap between a collar and a shoe of bearing is used. The shape of the gap between the shoe and the collar, the clearance value, the moment of the friction force, and the temperature distribution of oil over the clearance are determined..

Keywords: Thrust bearing, CFD Coupling, Fluid-Structure Interaction

1. Introduction

Sliding bearing is widely used in machine building, power generation, automobile industry, mining industry. Characteristics of the bearing are defined by using several methods as theoretical calculations, engineering semi-empirical calculations or using numerical simulations (Petrushina, 2006). A calculation of sliding bearing parameters using direct coupling (Aksenov et al., 2004, Aksenov et al., 2006) between Abaqus finite-element code and FlowVision finite-volume code is described in this paper. Novelty of this method for calculating bearing parameters consists in allowing taking into account mutual influence of oil motion with friction heating in the bearing and heat deformation of bearing shoes.

Thrust bearing is one kind of the sliding bearings. Schematically it consists in two main details: rotating collar and several unmoved shoes. Collar transfers loading from heavy rotor on shoes. For normal bearing operation, a small clearance between the collar and the shoes must exist. Clearance is filled by oil. As in lubrication theory well known, a lift force between two surfaces exists if a clearance between the surfaces is wedge-shaped. Before bearing operation the clearance between collar and shoes is constant. Thus, what is the source of lift force in thrust bearing? It turns out that thrust bearing is a good example of design which uses strong fluid-structure interaction phenomena. Oil is heated in clearance by huge friction stresses generated in very thin layer. Direction of average oil motion forms non-symmetrical oil temperature distribution over the clearance, which results in shoe deformation by correct way to form wedge-shaped clearance between collar and shoes. Results of modeling this process is described in this paper. Lift force as function of collar rotating speed and initial clearance between collar and shoes is calculated.

It is shown, that method of defining parameters of thrust bearing offered in this paper allows defining value and shape of clearance between collar and shoes, temperature distribution and heat generation inside bearing, friction torque in bearing and power loss.