CFD and Experimental Investigation of Spring Supported Thrust Bearings

CATEGORY OR KEYWORDS
Thrust bearing, TEHD simulation, Measurements, Spring supports

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INTRODUCTION
Thrust bearings are a critical component for hydraulic machines. Their reliability is a major concern as, in case of failure, the electricity production is affected and rehabilitation generates extra costs. Spring supported thrust bearings are equipping a wide portion of the hydraulic turbines of Hydro-Québec. Despite operating adequately most of the time, unexpected behaviors and failures occur time to time. Some elements of designs are often questioned and bring us to the fact that more knowledge is required when maintenance and repair are needed. To achieve that, a thermo-elasto-hydrodynamic (TEHD) numerical model has been developed to predict the performance of such spring supported thrust bearings. Besides, some measurement campaigns have been performed on two different types of thrust bearings equipping hydraulic machines of Hydro-Québec.

STUDY CASE AND SOME RESULTS
The TEHD model developed links a fluid model to a solid model. A one-pad sector is simulated with periodic boundary conditions. The CFD model extends to the oil tank in order to provide more realistic thermal boundary conditions. The solid model of the pad contains the Babbitt coating on its surface and the springs underneath whose rigidity has been determined experimentally. A mesh deformation algorithm manages the movement of the runner due to a balance of forces as well as the deformation of the pad due to pressure and thermal effects. The effect of cavitation is taken into account in the force balance. In this 2-way fluid-structure coupling, the solid model sends temperatures and displacements to the CFD model which returns the heat fluxes and total forces at each coupling step. Care is taken to keep a proper mesh quality during this process.

Measurement campaigns have been performed in order to validate the numerical results. Some proximity sensors were installed on two thrust bearings of different conception. Film thickness, runner elevation and temperature were measured in different operating conditions. The results from the numerical model are well in agreement with the experimental measurements. In Figure 1, it can be noticed that the maximum temperature is located near the trailing edge of the pad as expected. Also, the bearing operates a few degrees higher in summer conditions. The measurements together with the simulations have contributed to a better understanding of the behavior of this type of thrust bearing. The knowledge acquired could now be used to improve some elements of these old designs.

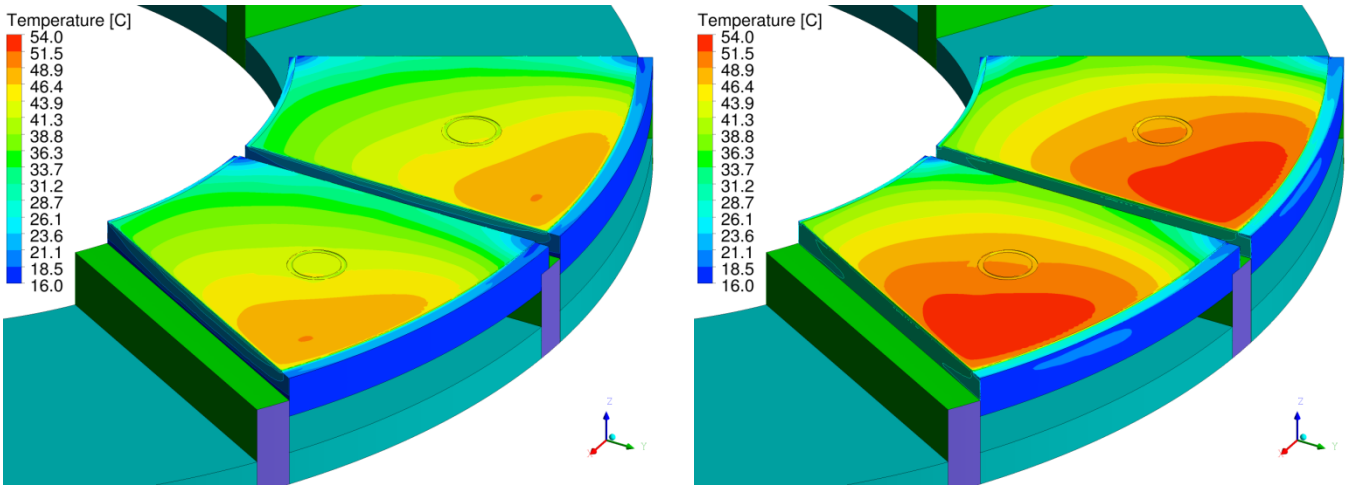

Fig. 1. Temperature on the pad of a spring supported thrust bearing in winter (left) and summer (right) conditions.