A Novel Sliding Pad Contour for Conical Sliding Bearings

Timm Jakobs[1)*], Georg Jacobs[1)], Amadeus Rolink[1)], Tim Schröder[1)], Dennis Bosse[1)] and Anurag Patil[1)]

[1)] Chair for Wind Power Drives (CWD), RWTH Aachen
*Corresponding author: timm.jakobs@cwd.rwth-aachen.de

At CWD a novel conical sliding bearing for the rotor bearing of wind turbines has been developed and validated on a system test bench. Due to the conical shape this sliding bearing can utilize the principles for hydrodynamic pressure built up of radial sliding bearings (bearing clearance) and these of axial sliding bearings (pad inlet contour). For each of these classical sliding bearings designs standards, how to build-up the hydrodynamic lubrication film, exists. In this paper a simulation approach containing CFD, MBS and EHD-simulations will be used to determine feasible pad contours for the novel conical sliding pad bearing.

Keywords (from 3 to 5 max): wind turbine, drivetrain, segmented sliding bearing, inlet contour

1. Introduction

Wind turbines play a relevant role in reaching the climate targets set in the “The European Green Deal”, whereby improving the technical availability by reducing drivetrain failures is one of the key challenges in the wind industry. Especially main bearing failures can lead to a total economic loss of the wind turbine, due to expensive and time-consuming repairs [1]. A currently in wind industry discussed solution to tackle this problem is to switch from roller bearings to segmented sliding pad bearings which allow for fast and cost-efficient on-tower exchange of faulty components, such as the sliding pads. At CWD a novel conical sliding bearing for wind turbines was developed and validated [2]. This sliding bearing has a double flexible sliding pad mount to compensate main shaft tilting and thus the risk of edge wear (Fig. 1 bottom pictures).

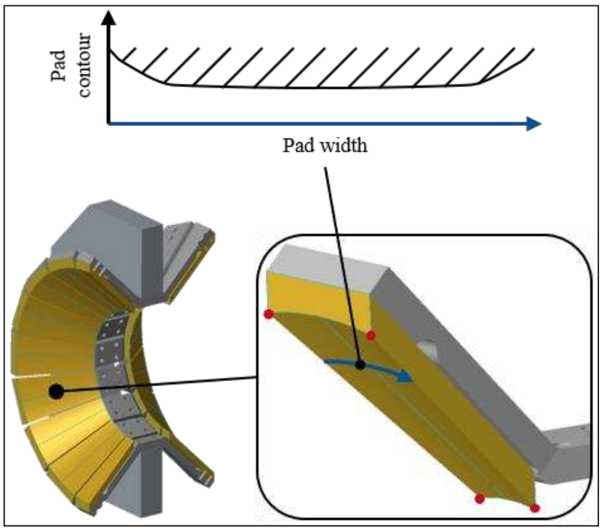

Figure 1: CAD model of FlexPad demonstrator (bottom left). Detail of double flexible pad mount with attached sliding pad (bottom right). Possible pad contour (top).

To build-up a stable hydrodynamic lubrication film this bearing can utilize the principles of radial sliding bearings by using the bearing clearance resulting in a convergent gap, but also inlet contours known form axial sliding bearings. For the pad design of conical bearings no standard exists, such as the DIN standard for segmented radial and axial sliding bearings. Therefore, the scope of this paper is to investigate the influence of different pad contours on the hydrodynamic lubrication film, pressure distribution over the pad and edge wear.

2. Methods

To investigate the pad contour, computer simulations with different modelling depth are conducted. First, a single sliding pad is simulated with the open source Computational Fluid Dynamics (CFD) software OpenFOAM. This model allows for quick geometric adjustments and has a short simulation time. Second, the whole sliding bearing is simulated with the software FIRST by IST. Thereby the bearings structure, such as housing and pad mount, are modeled as flexible structures within a multibody simulation (MBS). The lubrication gap between shaft and sliding pad is calculated with a double elasto-hydrodynamic (EHD) simulation.

3. Discussion

The CFD simulation of the single pad is used to determine the key parameters of the contour which influence the hydrodynamic lubrication film by varying the contour shape (e.g. straight line or polynomial function), length and elevation gradient. The short simulation time allows for testing of various geometries. Using the contours found, the subsequent EHD-simulations allow to evaluate the global pressure distribution of the conical siding bearing. Additionally these simulations are used to determine the contours shape effects on edge wear, which can occur at the pads corners due to a misalignment of the bearings pads to the shaft induced by shaft tilting or system deformations (Fig. 1 bottom right, red marks).

4. References

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