2021 DSTA dys-ta.com
16th INTERNATIONAL CONFERENCE
Dynamical Systems – Theory and Applications
December 6-9, 2021, On-line

Numerical and experimental characterization of the temperature profile in a gas foil bearing

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Abstract: In the paper, the authors present the outcomes from the investigation on the thermal properties of a gas foil bearing. At the current stage of the conducted research a test stand has been constructed and experimentally tested. The temperature field on the bearing's top foil has been considered as the object of the study. This physical quantity becomes important for maintaining the nominal working configuration in the bearing. In reference, numerical simulations have been also performed employing finite element method. The conducted virtual tests are crucial as enabling for cost-effective, convenient and reliable inference on the bearing's operational properties. In the paper the measurement instrumentation employed for temperature identification as well as a specialized sensing top foil are described. The work is concluded with the pointed directions for the planned future developments regarding more comprehensive characterization of the gas foil bearings' properties.

Keywords: gas foil bearing, temperature profile, thermocouple, numerical simulation, experimental identification

1. Introduction

Rotating machineries require bearing systems since they assure desired load capacities and rotational degree of freedom. Durability of the machineries depends on the condition of the bearings [1]. Hence, various algorithms developed for the assessment of their properties have been proposed. However, the specificity of a technical solution being considered requires dedicated methods to be used for the bearing characterization. In the current paper, the results of the investigation on the properties of a gas foil bearing (GFB) are reported. GFBs are fluid film bearings consisting of a set of thin foils mounted between the rotating shaft and solid bushing. They are especially dedicated to support lightly-loaded but high-speed rotors [2]. GFBs exhibit a unique capability since a gaseous medium directly taken from the surroundings is used for lubricating. It is however worth noting that stable operation of a GFB strictly depends on the thermally induced mechanical behaviour of the thin foils. In the worst case scenario, the required clearance between the shaft's journal and the top foil may be suddenly lost due to unexpected thermal behaviour [3]. Excessive thermal elongations of the bearing's components may lead to its break and machinery failure. Being motivated by the above presented challenges for the GFBs development, the authors of the current work constructed a prototype installation equipped with the specialised sensing top foil dedicated for temperature identification, as shown in Fig. 1.

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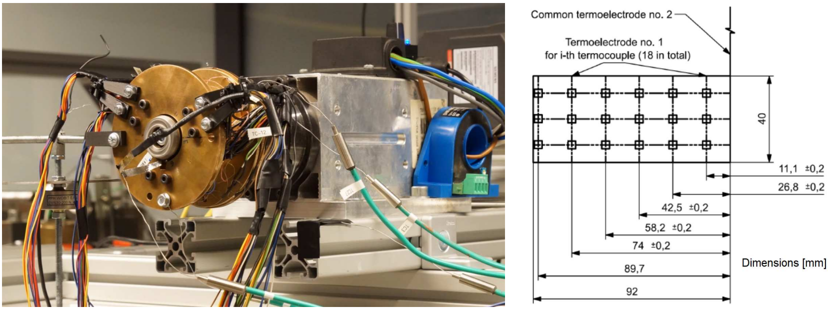

Fig. 1. GFB with integrated thermocouples: prototype (left), thermocouples locations (right).

2. Results and Discussion

Fig. 2 presents the temperature profiles identified in both experimental and numerical tests. The integrated sensors show uneven temperature profile for the top foil which corresponds to the investigations reported in the literature [4].

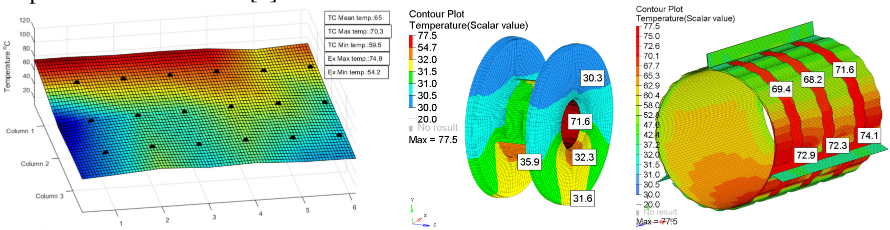

Fig. 2. Temperature identified for: top foil during experiment (left), simulations (centre and right).

3. Concluding Remarks

The paper presents the proof of concept for the method of temperature characterization for a GFB. The proposed approach makes use of a dedicated specialised sensing foil with integrated thermocouples. As of the future work, the authors plan to improve the developed numerical model via validation procedure. The authors' ongoing work is focused on the enhancement of the set up with integrated strain gauges. The final goal is to characterize the thermomechanical coupling in a GFB.

Acknowledgment: This research was funded by the National Science Center, Poland, within the project grant number 2017/27/B/ST8/01822.

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