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La soutenance a lieu par visioconférence

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Fonction	Doctorant
Laboratoire INSA	LaMCoS
Ecole Doctorale	ED162 : Mécanique, Energétique, Génie civil, Acoustique (MEGA)
Titre de la thèse	« Dynamics of Rotors on Refrigerant-Lubricated Gas Foil Bearings »
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Lieu de soutenance	Visioconférence

Composition du Jury

Civilité	Nom	Prénom	Grade / Qualité	Rôle
M.	FILLON	Michel	Directeur de recherche	Rapporteur
M.	HETZLER	Hartmut	Professeur des Universités	Rapporteur
MME	MEZIANE	Anissa	Professeur des Universités	Examinatrice
MME	FROHNAPFEL	Bettina	Professeur des Universités	Examinatrice
M.	BOU-SAÏD	Benyebka	Professeur des Universités	Directeur de thèse
M.	SEEMANN	Wolfgang	Professeur des Universités	Co-directeur de thèse

Résumé

The gas foil bearing (GFB) technology is considered one of the key factors for the intended transition to oil-free rotating machinery in future transportation systems. Besides numerous advantages in terms of size, weight, efficiency, and cleanliness, GFBs offer the unique ability to be lubricated with working fluids such as refrigerants. However, the computational analysis of refrigerant-lubricated GFB–rotor systems represents an interdisciplinary problem of enormous complexity and with conflicting interests between all-encompassing but efficient modeling and solution approaches. This thesis succeeds in exploring and pushing forward existing limits of feasibility and thereby establishes a new strategy that enables stability and bifurcation analyses. Owing to the precisely identifiable fluid–structure–rotor interaction mechanisms, three submodels that are of reasonable complexity but nevertheless take into account all relevant nonlinearities can finally be transformed into a single dynamical system. As an essential model feature, the non-ideal characteristics of a typical refrigerant that may undergo vapor–liquid phase transitions are described by thermodynamic equations of state to be included in modified Reynolds and temperature equations. Also, it becomes feasible with the proposed lumped-element foil structure model to include dry friction in various ways reaching from highly efficient regularized Coulomb friction models to bristle models that can reproduce stick–slip transitions. Altogether, this makes the entire problem accessible to rigorous mathematical theory and allows for developing a monolithic research code with interchangeable modules. Introduced by a brief overview of the mathematical theory of dynamical systems, the description and discussion of relevant findings is divided into three sections and guides through a selection of the most important nonlinear effects and phenomena. Firstly, the particular features of refrigerant lubrication with phase transitions are focused on with regard to both steady-state operation and vibrational self-excitation. Secondly, the influence of some foil structure design parameters and the importance of dry friction are thoroughly investigated using stability and bifurcation analyses. Finally, the addition of rotor unbalance gives an outlook to quasi-periodic behavior with even more complex scenarios resulting from combined excitation mechanisms.