# Master thesis and internship[BR]- Master's thesis : Modelling of Gas Foil Bearing with a high order Discontinuous Galerkin Method[BR]- Integration Internship

**Auteur :** Alshikh Saleh, Ammar
**Promoteur(s) :** Hillewaert, Koen
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# Modelling of Gas Foil Bearing with a high order Discontinuous Galerkin Method

**Ammar Alshikh Saleh**

Academic supervisors: Koen Hilleweart
Industrial supervisor: Martin Heylen
Master in Aerospace Engineering
Faculty of Applied Sciences, University of Liège
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## Abstract

In recent years, foil bearings, a special class of gas bearings, began to receive widespread converge in many scientific publications because of their advantages of environmental durability, higher reliability in operation (oil-free), and higher load capacity at high speed. Air Foil Bearing (AFB) supporting direct drive compressors or/and turbines have been gaining popularity in recent years. Mitis SA is developing a new generation of clean energy converters for decentralized Combined Heat and Power (CHP) based on flameless combustion chamber microturbines. Mitis SA is using AFB in their systems to guarantee an oil-free system and increase reliability.

The overall objective of this work is to contribute to a better understanding of the AFB technology. The work focuses particularly on the behaviour of the lubrication gas film. Numerical simulations of the isothermal, steady state Reynolds equation using the Discontinuous Galerkin Finite Element Method (DG-FEM) are performed. Compared to classical FD and FV methods, such a method provides high accuracy in terms of interpolation and spectral properties on unstructured meshes without opting for large stencils. The work comprises the development and implementation of a numerical prediction code with the use of DG-FEM. The numerical aspect of the hyperbolic-elliptic problem has been addressed with the implementation of specific approaches. First, upwind flux has been proposed for the convective formulation, and then an incomplete internal penalty method (IIPM) has been considered to evaluate the diffusive interface flux. Newton-Raphson method has been used to solve the nonlinear equation. The residual and the inverse of the Jacobian have been computed using direct solver, which is based upon the LU factorization technique. All these strategies were implemented in ForDGe, an immersed boundary, and in turn, Adaptive Mech Refinement (AMR) on multiple order Cartesian grids, still under development at the University of Liège.

The modelling of the foil structure is built based upon existing models. The coupling between structural and fluid parts has been done at the level of the film thickness using the Simple Elastic Foundation Model (SEFM). The validity of the analysis and numerical code has been assessed by comparing predictions to experimental and/or numerical published data.

This work would be recognized as the reference, providing numerical results for GFBs used by Mitis SA and/or any kind of GFBs with variable geometries and different working gases and operating conditions.

**Keywords:** Discontinuous Galerkin, Gas foil bearing, Reynolds equation, Bearing number, Load capacity