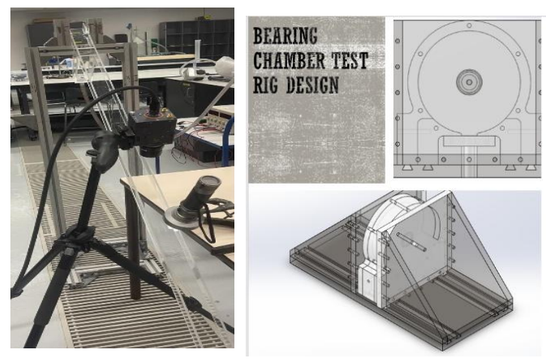
Computational and Experimental Representation of Simplified Gas Turbine Bearing Chamber Geometries

Ahmad Attia
Supervisors: C.A. Toomer, Budi Chandra
Contact: Ahmad.Attia@uwe.ac.uk
Chris.Toomer@uwe.ac.uk
Budi.Chandra@uwe.ac.uk

Research Overview

Gas-turbine bearing chambers must deliver reliable lubrication while limiting oil loss and heat buildup. Predicting and measuring oil-film behaviour in these complex multiphase flows remains challenging, leading to inefficiencies and uncertainty in design. At UWE Bristol, we developed and validated a combined experimental + CFD approach to quantify residence time distribution (RTD) and film thickness in simplified geometries. The method achieved strong agreement between simulation and experiment and now underpins further studies in rotating bearing-chamber rigs.



Industry Relevance

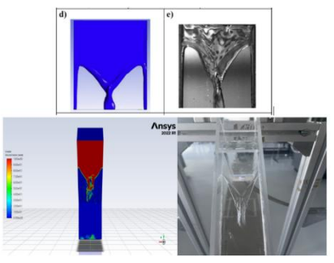
- Improves design accuracy for gas-turbine bearing chambers, reducing oil usage and maintenance cost.
- Provides validated CFD data for OEMs to optimise sealing and lubrication systems.
- Contributes to sustainability goals through lower oil consumption and improved thermal efficiency.
- Aligns with Aerospace Technology Institute and Clean Aero priorities on reliability and environmental performance.
- Method adaptable to aerospace, automotive, and energy rotating-equipment sectors.

Methods & Technologies

- Experimental setup: inclined acrylic channel (1.4 m × 0.05 m × 0.03 m at 39°) with air–water flow and UV dye visualisation.
- Sensor calibration: Keyence CL-P030 confocal displacement sensor; shim-based error analysis (0.1–1.0 mm shims), deviation ± 3 µm, uncertainty < 0.5 %.
- CFD modelling: Volume of Fluid (VOF) with air as the primary phase and water as the secondary; SST k–ω turbulence model for near-wall accuracy.
- Cylindrical rig: bearing chamber geometry with shaft Ø 50 mm and chamber Ø 200 mm operating between 9000 and 14000 rpm.
- Facilities: UWE Thermo-Fluids Laboratory providing high-speed imaging, precision sensors, and a dedicated CFD cluster for multiphase simulations.

Innovations

- Established a quantitative link between experimental RTD data and CFD predictions.
- Reduced measurement error to below 1 % through precise sensor calibration and noise filtering.
- Demonstrated accurate VOF-based simulation of film evolution under variable flow rates.
- Published in the International Journal of Thermofluids (2025, Vol. 26, Article 101097).



Results from Haroun et al (2014, Top image), Test rig flow (bottom right), CFD flow at 1.69 l/min with water volume fraction contour (bottom left).

Opportunities

- Seeking collaboration with an industrial partner to test and validate the developed methods on an actual bearing chamber under operating conditions.
- Opportunity for joint research and data-sharing to enhance CFD model accuracy and support component-level validation.
- Potential to co-develop new diagnostic methods for oil-film behaviour and residence-time prediction.
- Industry partners gain insight into performance, reliability, and oil-management efficiency, supporting next-generation engine designs.

RISE WITH US

UWE Bristol