2 PhD Position towards the development of a flameless, 100% hydrogen capable, highly fuel-flexible combustor for mGT applications

Context

Within the context of an ever-increasing share of renewables, the need to store energy to balance the electricity grid is growing in importance for the short, medium, and long term. One of the most promising routes for this mid to long-term storage is to produce hydrogen through electrolysis using excess renewable electricity and store it. Instead of using this H_2 to generate electricity in a conventional, large power plant, a more efficient route is to use it in a Decentralised Energy System (DES) using micro Gas Turbines (mGTs), possibly in cogeneration applications. Although the mGT presents itself as a promising option to convert pure H_2 into electricity, the main challenge remaining is that currently, the combustion chamber of the mGT does not support pure H_2 combustion. The major issues are related to flame stability and NOx emissions.

The project HYDROGENATE, funded by F.R.S.-FNRS, is a collaboration between the University of Mons (UMONS) and the Université Libre de Bruxelles.

Description of the PhD

Therefore, the main aim of this project is the characterisation of the use of H_2 in a classical mGT combustor and in flameless or MILD mode, finally leading to the development of a 100% H_2 capable, highly fuel-flexible, low NO_x, flameless combustion chamber for mGT applications. This project aims thus at characterising the behaviour of H_2 combustion when shifting from classical to flameless mode. Additionally, the impact of H_2 addition to a classical mGT combustion chamber will be assessed, both on the component itself as well as on the cycle. Moreover, the impact of several measures to reduce hydrogen reactivity for increased flame stabilization, e.g., exhaust gas recirculation and humidification, will be assessed on the combustor but also on cycle level. Finally, information obtained within these two steps (consisting both of numerical evaluation with experimental validation) will lead to the specific development and design of this 100% H_2 capable, fuel-flexible, flameless combustion chamber for mGTs, which will eventually be validated on a pressurized test rig.

Description of Team

This offer will be for a joint PhD between Université de Mons (UMONS) and the Université Libre de Bruxelles (ULB). The candidate will receive a PhD from both institutions.

The supervisor at UMONS is Prof. Ward De Paepe. The research interests of Prof. De Paepe are in the fields of advanced thermodynamic cycle development towards highly flexible and efficient, carbon-clear electricity, and possible heat when considering cogeneration, production in the future energy system.

The ULB supervisor is Prof. Alessandro Parent. Prof. Parente's research activity includes turbulent/chemistry interaction in turbulent combustion and reduced-order models; non-conventional fuels (hydrogen ammonia and other solar fuels) and pollutant formation; novel combustion technologies, e.g., MILD combustion; numerical simulation of atmospheric boundary layer flows; and verification, validation, and uncertainty quantification in computational fluid dynamics.

Starting date: July 2022
End date: June 2026
Location: UMONS and ULB (Belgium)
Application Deadline: April 15th, 2022
Salary: 2000€ (approximate net income)
Profile: Candidates should be proficient in English, have a master's degree in chemical or mechanical Engineering, with a specific interest in combustion. Experience in programming (ideally Python), CFD combustion analysis using commercial software (e.g., Fluent, OpenFoam, Yales2), or performing combustion experiments would improve the ranking.

Application: applications should contain a letter of motivation, a letter of recommendation, a short analysis of the project idea (max one page), and a short video (2 minutes max) explaining why we should hire the candidate. The application package should be sent to ward.depaepe@umons.ac.be and Alessandro.Parente@ulb.be.