PhD position at the University of Orléans

in Mechanical engineering (Fluid mechanics and Energetics)

Study of Turbulent Hydrogen-Air Combustion in a Spherical Chamber. Impact of Flame Instabilities.

Europe has outlined its trajectory to ensure its ecological transition, known as the "Green Deal," through the implementation of a set of political initiatives. In the field of ground transportation, several technologies help meet these commitments: electric propulsion powered by batteries or fuel cells, as well as propulsion using internal combustion engines running on hydrogen.

The industrial chair DELHYCE ("DEsign of Low emission and efficient Hydrogen Internal Combustion Engines"), led by the PRISME laboratory, Stellantis, and Renault Trucks, aims to develop a scientific methodology for designing internal combustion engines running on hydrogen, using small-displacement diesel engines for commercial vehicles and larger-displacement engines for trucks. The objective is to optimize the efficiency of internal combustion engines while reducing NOx emissions, with a focus on controlling abnormal combustion characteristics typical of these engines.

Several strategies help reduce NOx emissions and control abnormal combustion: air dilution, which allows for very low fuel-air ratios (between 0.2 and 0.45), water dilution through water injection in the intake, or exhaust gas recirculation (EGR). The combustion of hydrogen in lean mixtures creates flame instabilities, causing small-scale wrinkles in the flame front. These wrinkles, along with those induced by turbulent flow, alter the flame reaction rate and the dynamics of flame propagation.

The thesis aims to study the structure of the flame and its propagation dynamics. A constant-volume chamber with six fans and a high-pressure, high-temperature chamber will help simulate turbulence conditions similar to those found in spark-ignition engines burning hydrogen. The mixture's fuel-air ratio, turbulence intensity, pressure, temperature, dilution rate, and type of diluent will be among the parameters studied. The flame structure will be examined using Laser-Induced Fluorescence on the OH radical, and the dynamics of flame propagation will be measured using high-speed Schlieren imaging.

The doctoral candidate will need to acquire knowledge in hydrogen combustion, propose and set up experimental protocols, and carry out tests. They will also need to become familiar with optical diagnostics and develop skills in this area. The unique nature of the topic will allow the selected candidate to interact with other doctoral students from the DELHYCE industrial chair to acquire solid skills in physico-chemistry and turbulent combustion of air-hydrogen mixtures.

Keywords: Hydrogen; Green combustion; Spark Ignition engine

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Doctoral School	École Doctorale EMSTU ED552 (Université d'Orléans)
Renault Trucks supervisor	Jean-Marc Neveu, jean-marc.neveu@volvo.com
PhD location	PRISME Laboratory , Université d'Orléans, France
Duration and start date	3 years, starting in the fourth quarter of 2024
Employer	Université d'Orléans
Language requirements	Fluency in French or English
Profile	Engineering degree or Master's degree in energy, fluid mechanics.

To apply, please send your cover letter and CV to the supervisors indicated here above.