Link to detailed PhD description :

PhD position at IFP Energies nouvelles (IFPEN)

in Mechanical engineering (Fluid mechanics and Energetics)

Subgrid-scale modeling of thermo-diffusive instabilities in Large Eddy Simulation of turbulent hydrogen combustion: application to industrial safety

The increasing use of hydrogen (H_2) in industry and transport poses problems in terms of the safety of industrial installations. Indeed, H_2 is a volatile and flammable molecule which can cause destructive explosions. Computational fluid dynamics (CFD) constitutes an important tool for designing systems and is a complement to experiments, which are expensive and difficult to implement. CFD simulations must nevertheless achieve a high level of fidelity. In the case of the combustion of H_2, the numerical models must in particular take into account the effects of thermo-diffusive instabilities, which are a consequence of the very high diffusivity of hydrogen, and which generate a significant acceleration of the flames. These effects are, however, rarely taken into account in CFD models, and are often based on laminar flames, while the interactions between instabilities and turbulence are neglected. The objective of this PhD is to develop a large eddy simulation model taking into account the effects of thermo-diffusive instabilities, as well as their interactions with turbulence. The model will be developed in the formalism of the thickened flame model (TFM), currently used at IFPEN. The thesis will take place according to the following steps: (i) Implementation of direct numerical simulations (DNS), making it possible to understand and acquire detailed data on the interactions between instabilities and turbulence; (ii) development of a model in a TFM context and validation on canonical cases; (iii) test of the model on a practical case of industrial explosion.

Keywords: Hydrogen; Safety; Combustion; Thermo-diffusive instabilities; CFD

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PhD location	IFP Energies nouvelles, Rueil-Malmaison, France
Duration and start date	3 years, starting in the fourth quarter 2024 (November 4)
Employer	IFPEN
Academic requirements	University Master degree involving CFD, physics and/or numerical modelling
Language requirements	Fluency in French or English, willingness to learn French
Other requirements	Programming skills (Python, C++)

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

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IFPEN offers a stimulating research environment, with access to first in class laboratory infrastructures and computing facilities. IFPEN offers competitive salary and benefits packages. All PhD students have access to dedicated seminars and training sessions.