Post-doc position at IFP Energies nouvelles (IFPEN)

Turbulent Jet ignition modeling using Thickened Flame Model

Pre-chamber ignition is a key technology for improving the efficiency of gasoline engines. The prechamber concept is to add in the cylinder head, where the spark plug is located, a volume that is segregated from the main combustion chamber by a perforated cap. In the case of passive pre-chamber ignition, the mixture enters the pre-chamber through these apertures during the compression stroke and is ignited by the spark plug located therein. Following ignition in the pre-chamber, the pressure inside it quickly rises, with spark energy multiplying by several order of magnitudes and several turbulent jets shooting into the main combustion chamber. This leads to multiple places of ignition outside the center of the combustion chamber and, in general, brings about rapid combustion and a lower knock tendency. Pre-chamber ignition is of particular interest for engines with ultra-high dilution rates which are a key option to improve engine efficiency. Turbulent Jet Ignition enables very fast burn rates due to the ignition system producing multiple, distributed ignition sites, which consume the main charge rapidly and with minimal combustion variability. The fast burn rates allow for increased levels of dilution (lean burn and/or EGR) when compared to conventional spark ignition combustion. A major difficulty on the CFD calculation of pre-chamber combustion resides in the range of combustion regimes encountered. In the pre-chamber, standard spark ignition is used but it is followed by a drastic acceleration of gases through the holes due to the overpressure generated by the prechamber. This in turn can lead to partial flame extinction which is difficult to represent with the standard flamelet ECFM-LES model. After reignition, the flame possibly propagates in a very lean mixture which is also difficult to describe.

Due to these modelling challenges, this Post-doctoral position will focus on the Large Eddy Simulation of this ignition system using the Thickened flame model (TFM) instead of the standard ECFM-LES model used at IFPEN. Indeed, this approach has the potential to correctly represent spark ignition, flame extinction and reignition without additional modelling effort. Besides, TFM was recently coupled to AMR by IFPEN, allowing a drastic decrease of the flame thickening, and consequently, a potential improvement on combustion prediction.

The Post doctoral student will employ and possibly improve this TFM-AMR approach for TJI in a Spark ignition engine experimented by Aramco research group. This Postdoctoral position will take place in an IFPEN / Aramco Paris collaborative framework that will require a coordinated effort and progress meeting.

Keywords: Turbulent Jet Ignition, Large Eddy Simulation, Thickened Flame Model

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PhD location	IFP Energies nouvelles, Rueil-Malmaison, France
Duration and start date	12 months, starting preferably on October/November/December 1, 2020
Employer	IFPEN
Academic requirements	PhD thesis in the field of Computational Fluid Dynamics, experience in combustion/reacting flows recommended

For more information or to submit an application, see theses.ifpen.fr or contact the IFPEN supervisor.

About IFP Energies nouvelles

IFP Energies nouvelles is a French public-sector research, innovation and training center. Its mission is to develop efficient, economical, clean and sustainable technologies in the fields of energy, transport and the environment. For more information, see www.ifpen.fr. 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.