Link to detailed PhD description :

PhD position at IFP Energies nouvelles (IFPEN)

in Mechanical engineering (Fluid mechanics and Energetics)

3D modeling of the ejection and combustion of vented gases during the thermal runaway of Lithium-ion battery cells

The rapid growth in the use of electric vehicles has led to a strong demand for batteries. Lithium-Ion batteries are currently the dominant technology, as they offer good performance, in particular high energy density. Nevertheless, these batteries can be subject to thermal runaway, potentially leading to the destruction of the vehicle. It is therefore important to develop adequate numerical tools to predict and prevent this type of accident. Many existing numerical models allow to simulate internal chemical reactions in a battery cell undergoing thermal runaway and the thermal conduction within the surrounding cells. However, gases are ejected during the runaway process and can even ignite. The impact of these hot gases and their combustion on the cell temperature and therefore on the propagation of the thermal runaway within a battery pack is currently poorly understood and modeled. The use of multi-dimensional calculations (2D and more particularly 3D) is necessary to correctly predict these effects. The challenge is then to: (i) predict the gas composition and velocity at the cell exit; (ii) predict the gas combustion in the external environment of the battery. The objective of this thesis is to develop a coupled 3D model, which considers the thermal runaway inside the cell, the thermal conduction, the dynamics and the combustion of the gases generated by the reactions inside the cell, and the convective heat transfer induced by these gases on the cell. The results will be compared with experimental measurements currently carried out at IFPEN. The thesis will proceed according to the following milestones: (i) Implementation in the CFD solver of the thermal runaway model of the battery using IFPEN know-how; (ii) Implementation of a model predicting the venting of gases from the cell; (iii) Coupled simulation with combustion of an isolated cell and confrontation with the experiment; (iv) Simulation of thermal runaway propagation in an industrial battery pack.

Keywords: Li-ion batteries, combustion, thermal runaway, 3D simulations, heat transfer, gas venting

Academic supervisor	Pr Ronan VICQUELIN, laboratoire EM2C, CentraleSupelec, ORCID : 0000-0002-2055-5244
Doctoral School	École Doctorale « SMEMAG » ED579 (Université Paris Saclay)
IFPEN supervisor	Dr MEHL Cédric, cedric.mehl@ifpen.fr, ORCID : 0000-0003-2293-9281
	Dr POUBEAU Adèle, ORCID: 0000-0002-0842-9667
	Dr CHEVILLARD Stéphane
PhD location	IFP Energies nouvelles, Rueil-Malmaison, France
Duration and start date	3 years, starting in the fourth quarter 2024 (Novembre 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.

Link to detailed PhD description :

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 our WEB site.

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.