PhD position at IFP Energies nouvelles (IFPEN)
in Chemical Engineering

Characterization of Gas-Solid Injection into Fluidized Bed Reactors for Biomass Residues Valorization

The use of biomass/biomass residues as feedstocks for bioenergy and biofuel processes is of rising interest for climate change mitigation. Thermochemical conversion of biomass in fluidized bed reactors, through pyrolysis, gasification, and combustion, requires efficient feedstock penetration and mixing through reliable feed injection systems. Pneumatic biomass injection produces a gas-solid jet in the reactor that requires proper momentum to disperse the feedstock. Nevertheless, assessing multiphase jet penetration in fluidized beds is challenging because complex and opaque systems with rapid interactions of the jet and the bed bubbles, and because of the many experimental challenges to characterize gas/particles flows.

In this thesis, biomass residues will be used as feedstocks to investigate the jet penetration and mixing in fluidized beds at ambient and reaction conditions. The experiments at ambient conditions will be performed at IFPEN with different pneumatic injectors coupled to a fluidized bed of 20 cm. The gas-solid flow will be evaluated with a high-speed camera and the jet penetration in fluidized beds of Geldart A and B powders will be measured with different techniques, such as optical, pitot, capacitance, and fluorescent probes. From this, the injector design and testing conditions will be defined for biomass penetration experiments in reaction environments, such as gasification and combustion. A hot fluidization unit is available at the Hamburg University of Technology (Germany), which can achieve 950°C and has a similar diameter than IFPEN's cold-flow unit.

From this experimental campaign, empirical models and operation maps will be developed for pneumatic biomass injection and jet penetration for a wide range of operating conditions. Furthermore, the experimental data will be used for CFD model validation at IFPEN and, subsequently, for developing scale up rules for proper biomass injection and mixing at industrial scale.

Keywords: Fluidization, Biofuel, Bioenergy, Pneumatic Conveying, Combustion, Gasification, CFD

Academic supervisor	Prof Frederic AUGIER (IFPEN, ORCID: 0000-0003-1640-4360) and Prof Stefan HEINRICH (TUHH, ORCID: 0000-0002-7901-1698)
Doctoral School	ED162 MEGA, University Lyon 1, Claude Bernard
IFPEN supervisor	Dr Lucas MASSARO SOUSA, lucas.massaro-sousa@ifpen.fr, ORCID: 0000-0002-4182-9347, and Dr Benjamin AMBLARD, benjamin.amblard@ifpen.fr
PhD location	IFPEN (Solaize, France) with 6 months in TUHH (Hamburg, Germany)
Duration and start date	3 years, starting in fourth quarter 2024 (4 November)
Employer	IFPEN
Academic requirements	University Master degree in chemical engineering or fluid mechanics
Language requirements	English level B2 (CEFR)
Other requirements	Interest for experimentation and modelling would be appreciated (background on fluidization, CFD tools and/or biomass valorization).

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

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.