Laboratoire de Mécanique des Fluides de Lille
Kampé de Fériet

Internship proposal

Thermo-Rheology in Annular Serpentine Flows for Exchanger-Reactors

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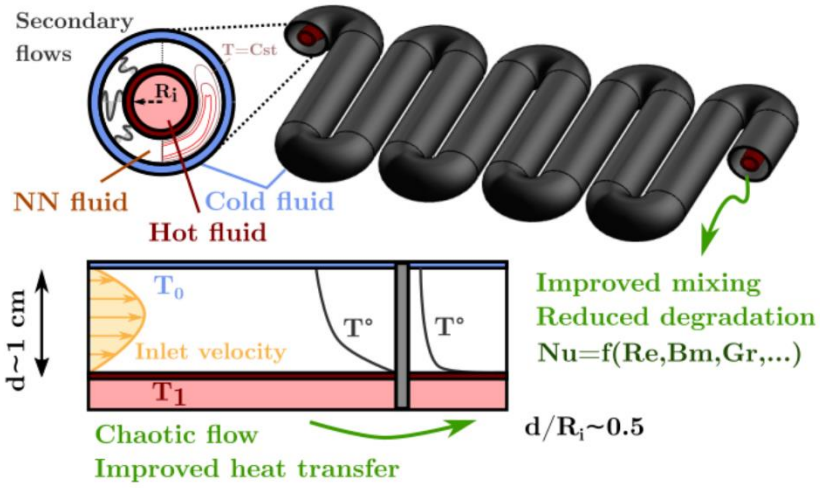
Location: ENSAM Lille, 8 Boulevard Louis XIV, 59046 Lille
Duration*:* 6 months
Level: M2
Expected skills and knowledge: fluid mechanics, numerical simulations (OpenFOAM preferred), experiments

Subject: Channel and pipe flows of complex fluids are paradigmatic configurations to study transport phenomena in nature and they are widespread in industrial applications. The intensification of heat transfer and mixing performance in such configurations is the target of intensive research work aimed at optimizing the industrial designs for ecological and energy transitions. For bio-process intensification, such as cosmetics, food processes and anaerobic digestion, special attention is paid to multi-functional heat exchanger-reactors operating in continuous processing mode, as an alternative to conventional batch processing. In 2000, the seminal paper by Groisman and Steinberg reported for the first time a purely-elastic turbulence-like behaviour of polymer solution flows at negligible inertia and high relaxation-time-to-strain-rate ratios. Since then, the so-called elastic turbulence has attracted the attention of several research groups, who focused on unravelling the intricate mechanisms at the core of such a mixing-enhancing phenomenon at micro- and millimetric scale. However, in order to take advantage of polymer-driven instabilities for exchanger-reactors, the scale-up to centimetric flows is needed, including thermal and buoyancy effects. The goal of this project is to understand the physics at the core of such complex fluids, focusing on the competition between thermal, inertial and rheological instabilities.



Principle of the serpentine exchanger-reactor.

Team: This internship is developed within the framework of the collaboration between ENSAM, Lille and IMT Lille/Douai about non-Newtonian fluids and energy transition. Potential continuations of this project in form of a PhD thesis may be funded by the ANR project TRANSFER, to submit in October 2021.

Preliminary organization of the work:

- Bibliographical study about non-Newtonian instabilities.
- Contribution to simulation and experiment plan.
- Realization of simulations, experiments and analysis of the results.
- Participation to scientific papers in collaboration with other colleagues performing the experiments.