CALL FOR APPLICATION
PHD STUDENT POSITION
DOCTORAL SCHOOL MEGEP – UNIVERSITY OF TOULOUSE
FÉDÉRATION DE RECHERCHE FERMAT
INSTITUT DE MECANIQUE DES FLUIDES DE TOULOUSE
TOULOUSE BIOTECHNOLOGY INSTITUTE

DEVELOPMENT OF A DIGITAL TWIN OF A FLOTATION DEVICE FOR MICROALGAE HARVESTING

CONTEXT AND OBJECTIVES

The project aims to create a digital twin of a microalgae harvesting process by flotation in order to allow the eco-design of microalgal production chains. The culture of microalgae is booming for the production of bio-sourced molecules for health and well-being, for animal and human food, as renewable carbon and 3rd generation biofuel. These photosynthetic microorganisms are produced in very low concentrations, in the order of a few grams/liter, because higher concentrations hinder the light that brings the energy necessary for their growth. Their extraction from the culture medium, a step called harvesting by analogy with agriculture, represents 30% of the production cost, which is prohibitive for many applications. Harvesting by flotation consists in capturing the microalgae by microbubbles in natural ascent in the culture medium, and thus to concentrate them gently while keeping them intact. Research work conducted at TBI has demonstrated that this process is effective in harvesting microalgae. Tests under real conditions on an industrial scale have also been successfully conducted. Original research by AFM (Atomic Force Microscopy) has allowed to identify the molecular mechanisms of the adhesion of microalgae to each other and to the surface of the bubbles. Very recent advances on the functionalization of bubble interfaces by bio-inspired surfactants (FERMAT-TBI-LAAS collaboration), should allow to intensify the flotation harvesting process, both from the point of view of its yield and its selectivity towards particular species.
The aim of the thesis proposed here is to quantify these adhesion mechanisms between bubbles and microalgae, in particular the interfacial forces involved, and then to use them to build a numerical model of the capture, to be inserted in a flotation simulator. This multi-scale numerical assembly, numerical twin of the harvesting process, will then constitute one of the (essential) links in the simulation of the microalgae production chain.

PHD WORK CONTENT

The thesis project consists of three successive parts:
The first part consists in numerically simulating the measurement by an AFM-FluidFM system of the interaction between a microalgae and a bubble, with the objective of proposing a quantitative modeling of the interaction forces involved, DLVO and non-DLVO (specific). It is based on experimental results acquired during a current thesis, but will require some measurements on mastered model systems to refine the quantification of the different forces.
The second part aims at determining by numerical experimentation the attachment efficiency of microalgae to the surface of ascending bubbles. The aim is to study the drainage dynamics of the interfacial film separating the microalgae and the bubble under the effect of the forces modelled in part 1. The results of these numerical experiments describing the influence of the attachment parameters will be modeled in the form of efficiencies and validated experimentally by measuring the bubble ascent velocities in the microalgal suspension.
The third part will consist in coupling the attachment efficiencies with the collisional efficiencies resulting from previous works, and with the simulation of the multiphase flow in a flotation device to build the "digital flotation device", a software brick that can be integrated in the simulation of microalgae production chains, in order to simulate their productive and environmental performances for their eco-design.

CANDIDATE PROFILE

The candidate, holder of a Master, will have a first experience in research (internship in a laboratory or in a company R&D department, Cf. http://www.ed-megep.fr/
With a strong taste for multidisciplinarity, modelling and simulations, he/she may come from an engineering background in Fluid Mechanics, Process Engineering, but also in physical chemistry of interfaces and colloids.
By virtue of his experience and training, he must be able to justify his skills in one or more of the following fields
- two-phase fluid mechanics
- physical chemistry of colloidal media
- simulations and numerical resolutions
- numerical fluid mechanics

He/she must speak and write English.

CONTRACT TERMS

Duration: 36 months
Starting date of the thesis: October 2021
Employer: INPT of Toulouse
Remuneration: Contractual research engineer level ; Gross salary ~2000€/month
Funding : University of Toulouse & Occitanie Region

RESEARCH GROUP AND SUPERVISORS

Reserach federation FERMAT Toulouse (https://www.federation-fermat.fr/)

IMFT – Toulouse (https://www.imft.fr/)
Group Interfaces
PhD supervisor: Pr. Dominique LEGENDRE

TBI – Toulouse (http://www.toulouse-biotechnology-institute.fr/fr/index.html)
Group Transferts, Interfaces, Mélange
PhD supervisor: Pr. Pascal GUIRAUD
pascal.guiraud@insa-toulouse.fr

APPLICATION STEPS

Applicants should send a single PDF file containing a CV and a cover letter in English by e-mail to the attention of Pr. Pascal GUIRAUD and Pr. Dominique LEGENDRE.
pascal.guiraud@insa-toulouse.fr & dominique.legendre@imft.fr

Depending on their suitability, an interview may be arranged and additional information requested.

Applications will be processed as they arrive until one candidate is selected by a recruitment committee in June 2021.

You can apply now.