PhD THESIS OFFER

An innovative millifluidic process for the recovery of a biobased organic acid

CONTEXT:

3-hydroxypropionic acid (3-HP) is a molecule used in the synthesis of numerous chemicals (acids and polymers). It is a key intermediate in the production of acrylic acid and its polymer derivatives. Currently produced from petroleum, the search for a bio-based alternative is now a major challenge: according to the Department of Energy (DoE), 3-HP is one of the 10 platform molecules that urgently need to be produced from biomass.

Research efforts, particularly at the SayFood joint research unit, are therefore being conducted to produce this molecule in a bioreactor and recover it using a separation process[1]. The current separation process used to recover 3-HP is a membrane contactor. The objective of this PhD study is to lay the scientific foundations for an alternative to this technology: an intensified continuous process at milli/microfluidic scale. A proof of concept has already been carried out on lactic acid (a positional isomer of 3-HP acid) by a Colombian research team[2,3,4] (Figure 1).

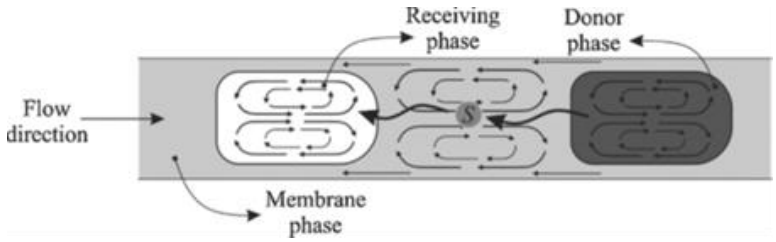

Figure 1: Lactic acid millifluidic extraction

The donor phase contains the acid to be extracted. This phase is dispersed in a continuous organic phase (membrane phase), which includes an extraction agent (amine). The extracted molecule is then recovered by a receiving phase. Taylor vortices (specific hydrodynamic structures typically found in confined fluid/fluid flow) ensure the transfer of the complexed acid from the donor phase to the receiving phase, as well as the renewal of matter inside the droplets.

THESIS GOALS:

This PhD thesis is the cornerstone of an ANR (French National Research Agency) project for Young Researchers (ANR JCJC IMPRINTS). The objectives of the study are as follows:

- Conduct a mechanistic **microfluidic** study of the kinetics of 3-HP acid extraction in a multi-component environment typical of fermentation;
- Develop a **millifluidic** three-phase separation process and conduct an exhaustive study;
- **Model** transfer performance in micro/millifluidics using dimensional analysis, and model two-phase flow using CFD with a view to designing and optimising the process.

In order to carry out these tasks, the successful candidate will be able to count on the support of a multidisciplinary scientific team, spread across the ModiC and ProBioSSep teams at the SayFood joint research unit, as well as the technical expertise of SayFood technology centre. Prototyping can also be carried out at the Ecole Polytechnique fab lab. Written and oral communications in English will be required throughout this thesis. The PhD student will be enrolled in the ABIES doctoral school, and will receive scientific and soft skills training as part of the formation.

REQUIRED PROFILE:

We are looking for a Chemical Engineering/Process Engineering or Fluid Mechanics student, at Master's level or equivalent (five years of higher education). The successful candidate must be independent and scientifically curious, and able to read and write fluently in English. A previous expereince in a research laboratory environment is required. Basic scientific programming skills in Python or MATLAB, as well as experimental planning skills, would be highly appreciated.

GENERAL INFORMATION:

- Entity: SayFood joint research unit, Agro Paris-Saclay campus, Palaiseau;
- Duration: 3 years starting October 2026 (subject to adjustment depending on the candidate);
- Remuneration: €2,300 gross per month. Transport costs are reimbursed by the employer at 75%;
- Accomodation: Possibility of renting student accomodation on site ;
- Secularism: The person recruited will be subject to the charter of secularism in public services (law 2021-1109 of August 24, 2021). In particular, no religious symbols may be worn in the workplace.

APPLICATIONS:

Applications and requests for further information should be sent to the persons listed below. The application file should include the following documents: CV, cover letter, reports for the 3 last academic year, TOEIC certificate or equivalent (if available) assessing a B2/C1 level in English. Applications will be processed in order of arrival, with a **deadline of April 22, 2026**.

- Violaine ATHES-DUTOUR (violaine.athes-dutour@agroparistech.fr) ;
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- Murielle HAYERT (murielle.hayert@agroparistech.fr) ;

BIBLIOGRAPHY:

[1]Arana Agueldo et al., *Reactive liquid–liquid extraction of bio-based 3-hydroxypropionic acid using a biocompatible organic phase containing a tertiary amine: A model-based approach to elucidate dominant mechanisms*, Separation and Purification Technology, 294 (2022), 1-13

[2] Pérez et al., *Integration of a liquid membrane in Taylor flow regime with a fermentation by Lactobacillus casei ATCC 393 for in-situ lactic acid removal*, Chem. Eng. Process.: Process Intensification, 140 (2019), 85-90

[3] Pérez et al., *Modeling of a liquid membrane in Taylor flow integrated with lactic acid fermentation*, Chem. Eng. Process. : Process Intensification, *144 (2019), 1-9*

[4] Pérez et al., *A new concept of liquid membranes in Taylor flow: Performance for lactic acid removal*, Chem. Eng. Process. : Process Intensification, 139 (2019), 95-102