Conversion of wet biomass by hydrothermal partial oxidation
Post Doc position, 2021-2022, M2P2, Aix-en-Provence, France

Laboratory M2P2, Mechanics, Modelling and Green Processes, UMR 7340, Europôle de l'Arbois, Bat Laennec, 13545 Aix-en-Provence, France
Contacts: Jean-Henry Ferrasse: jean-henry.ferrasse@univ-amu.fr
Olivier Boutin: olivier.boutin@univ-amu.fr

Deadline to apply: 10 June 2021 (send CV and cover letter by email)
Duration: 12 months Starting date: from September 2021
Salary: between 2466€ (1982€ net) for a postdoc with less than one year of experience and 2891€ (2323€ net) for a postdoc with at least 3 years of experience

Context of the subject

Algal biomass is valorised in a targeted way by recovering lipids and high added value molecules, such as pigments (very small quantities). The important issue of developing other high value-added compounds is identified in an ADEME report that highlights the strategic need to develop a production and high value-added compounds for algae in France by 2030, to obtain platform molecules for bio sourced green chemistry. Among the possible routes, the hydrothermal liquefaction, in partial oxidation conditions (150-300°C, 5-30 MPa) of algal biomasses into platform molecules is proposed. Hydrothermal liquefaction is a relevant process for algal biomasses because it avoids a drying step (energetic cos) and brings a real difference in product composition, compared to pyrolysis.
This method presents a scientific barrier to its development: the reaction products are multiple due to a lack of selectivity and require a costly downstream separation. The main objective of the project will be to determine the reaction pathways by acting on the O_2 stoichiometry (partial oxidation) which will be varied between 0 (direct liquefaction conditions) and 1 or more (wet air oxidation conditions).

Program of the study

Thermodynamic study. The aim is to determine the possible reactions that lead to the formation of platform molecules as a function of the exogenous oxygen content on the chosen model molecules. The conclusions (P and T conditions) will help to orient the experimental programme.
Experimental studies. The experimental tests will be carried out in a perfectly stirred reactor in order to overcome the limitation of gas/liquid oxygen transfer and to obtain the chemical kinetics. The tests will contribute to the establishment of the reaction pathways according to the operating conditions. They will be done based on an experimental design.
For the entire experimental plan, the different phases (solid, aqueous, organic) will be characterised by elemental analysis, NMR, HPLC, GC-FID/TCD, GD-2D, coupling with mass spectrometer. The pilots already existing within the TED team of M2P2 are the following: three stirred direct liquefaction/wet air oxidation batch reactors of 250 to 500 mL, one for direct visualisation, one 1L continuous stirred direct liquefaction/wet air oxidation reactor; a high-pressure, single (3) and double (1) body pump, TOC analyser (solid and liquid), COD, GC (FID/cata), on-line FT-IR, high-pressure and high-temperature calorimeter, and microscopy.
Reaction model. From the experimental results, the reaction schemes will be established. By coupling the advancement results to calorimetric measurements, the reaction rates will be calculated. In particular, the sensitivity of these rates to the oxygen content and the effect of the reactive medium (subcritical water) will be examined.