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Hydrothermal liquefaction and partial oxidation of microalgae

Tsilla Bensabath, Olivier Boutin, Jean-Henry Ferrasse

Aix-Marseille Université, CNRS, ECM, M2P2 UMR 7340, FR-13451 Marseille, France

Microalgae, which constitute third generation biomass, allow the production of bio-fuels through various conversion routes. Because of the high amount of water in this biomass, hydrothermal liquefaction is particularly appropriate for the conversion of microalgae into liquid fuels. Microalgae mainly consist of proteins, lipids and carbohydrates. Lipids are easily recoverable and are often extracted by different methods. Thus, the valorization described here can follow a first step of lipid extraction.

Complementary to classic hydrothermal liquefaction of microalgae, an additional process is proposed by using partial oxidative conditions. This process may change the reaction pathways and increase the formation of some recoverable products such as organic acids.

Experiments are carried out in a batch reactor in the range 10-30 MPa, 473-623 K. Aqueous microalgae are introduced in the reactor at a known concentration. Then, the reactor is heated at the operating temperature and air may be added to adjust the oxygen content in the gas phase. The amount is calculated to represent from 0% to 30% of the total organic carbon. After the reaction, remaining phases are recovered and analyzed. In the aim to study the influence of the algae composition, experiments are performed with whole microalgae, same microalgae after lipid extraction, pure algae proteins and pure algae carbohydrates.

Presented results compare the yields in recoverable products during hydrothermal liquefaction with and without oxygen of biomass according to operating conditions. A particular attention is paid to the influence of microalgae composition. Moreover, the analysis of the products is used to understand the reaction mechanisms in order to model and simulate the process in further studies.