
From microalgae to biofuels: promises and challenges of the hydrothermal pathway

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Résumé

Microalgae are promising for biofuel production since they have higher areal yields than terrestrial plants, and do not compete with food. However, their production cost, environmental performances and energy balance need to be improved.

Hydrothermal liquefaction (HTL) converts wet biomass into a biocrude at a temperature between 250 and 350°C and a pressure of 50-100 bars. HTL accepts wet feedstock and has better energetic and mass yield than traditional lipid extraction pathway.

Two different microalgae strains were tested, a carbohydrate-rich (*C. sorokiniana* NIES2173) and a lipid-rich (*C. vulgaris* NIES227). 13 biomass batches of these two strains were obtained in pilot-scale photobioreactors (180 and 300L) with lipid yield as high as 53%.

HTL operating conditions were optimized to maximize biocrude production. Links were unveiled between composition of the biomass and characteristics of the HTL products, leading to recommendations for feedstock specifications. The aqueous phase produced during HTL was recycled to the microalgae culture. Firstly, *Chlorella vulgaris* NIES227 was not able to grow on a diluted aqueous phase. Using Adaptive Laboratory Evolution, this strain was accommodated to grow on 100% recycled HTL aqueous phase

Biocrudes from NIES227 were hydrotreated using commercial presulfided NiWS/ γ -Al₂O₃ catalyst, and resulted in upgraded fuel with low heteroatom content (0.6 wt.% of nitrogen; 0.7 wt.% of oxygen).

Life cycle analysis of the whole process revealed algal feedstock production to be the most impacting step. Prospective scenarios have shown that the threshold required for transportation fuels by the RED II legislation (32.9 CO₂ eq/MJ) could be reached.

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