Quantitative Multiphase Model for Hydrothermal Liquefaction (HTL) of Algal Biomass

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Hydrothermal liquefaction (HTL) of microalgae is promising, but improvements are needed

Critical Barrier: Lack of understanding of connections between feedstocks properties and product yields/characteristics.

Solution: Establish quantitative relationships between HTL outputs and feedstock inputs with experimental data of various feedstocks.

A multiphase component additivity (MCA) model was developed for product yields and characteristics prediction

Predicting product yields from feedstock biochemical composition

Yield of one product \( Y_i \) equals to linear summation of yields from all biochemical components (Fig. 1, eq 1)

\[
Y_i = k_{IL} \times Lip + k_{IP} \times Pro + k_{IC} \times Carb + k_{IA} \times Ash \text{ (eq 1)}
\]

Predicting product characteristics from feedstock biochemical/elemental composition

Elemental contents of one product \( M_i \) linearly correlates to feedstock components that contain this element, and are also major contributors to this product \( J, \text{ i.e., protein for N content in biocrude, Fig. 2, eq 2} \)

\[
M_i = a \times j + b \text{ (eq 2)}
\]

Fig. 1 Feedsstock biochemical composition and HTL product yields. Contour plots generated by interpolation of experimental data.

REFERENCES

Fig. 2 Biocrude mainly comes from feedstock lipid, protein, and carbohydrate components, and only protein contains N, therefore biocrude N content \( N_{Bio} \) linearly correlates to feedstock protein contents.

The model can be used to assess the feasibility and improve the performance of various valorization pathways

Fig. 3 Top: comparison of yield and price of fuel from HTL, combined algal processing (CAP1) and their integration pathways. Bottom: illustration of an urban wastewater (UWW) treatment system coupled with algal cultivation.2,3