Optimization of Algae Residues Gasification: Experimental and Theoretical Approaches

ABSTRACT

Gasification is one of the thermochemical pathways of biomass conversion that produces synthesis gas, tar, and char. This study aims to convert algal residues via gasification at different operating conditions; temperature, equivalence ratio, and biomass loading. The study was carried out in 3 steps; (1) testing the outcomes of temperature and loading effects on synthesis gas yield, (2) experimental optimization of gasification via Design Expert, and (3) theoretical optimization of gasification via Aspen Plus simulation. Temperature and equivalence ratio highly influenced synthesis gas composition, while loading demonstrated less effect on the synthesis gas composition. The experimental and simulated gasification outcomes were compared to obtain optimized conditions that produce high H2 and CO yields. The data were validated using root mean square error. The optimized temperature, loading, and equivalence ratio were found for both algal residues that produced 36.38 and 13.28mol% of H2 and CO, respectively for lipid extracted algae (LEA) and 47.99 and 26.05mol% of H2 and CO, respectively for fucoidan extracted seaweeds (FEA). There was a considerable variation between experimental and simulated data due to the simulation and experimental limitations. The average Carbon Conversion Efficiency values were 66.36 and 80.42% for LEA and FES, respectively, denoting that LEA produced less carbon-containing products, while FES produced more carbon containing products. In conclusion, LEA gasification yielded more H2 while FEA produced more CO.