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ABSTRACT

The present study investigates the thermal degradation behavior of Chlorella vulgaris using a thermogravimetric analyzer (TGA) to explore application as feedstock for syngas production. The biomass was heated continuously from room temperature to 1000 °C at different heating rates (5, 10 and 20 °C min− 1) under N2/air conditions at a constant flow rate of 25 mL min− 1. Experimental results showed that the combustion process of C. vulgaris can be divided into three major phases; (1) moisture removal, (2) devolatilization of carbohydrates, protein and lipids and (3) degradation of carbonaceous material. A degradation rate of 80% was obtained at the second phase of the combustion process in the presence of air whilst a degradation rate of 60% was obtained under N2 atmosphere at the same phase. The biomass was further gasified for syngas production using a Temperature Programmed Gasifier (TPG). The effect of three different process variables, temperature, microalgal loading, and heating rate was investigated. The maximum H2 production was found at 800 °C temperature with a biomass loading of 0.5 g. No significant effect of heating rate was observed on H2 production. The activation energy values, based on the Kissinger method, were evaluated to be 45.38 ± 0.5 kJ mol− 1 (1st stage), 61.20 ± 0.5 kJ mol− 1 (2nd stage) and 97.22 ± 0.5 kJ mol− 1 (3rd stage). The results demonstrate a significant potential for the utilization of the microalgae biomass as feedstock for large-scale production of syngas via gasification.

Keyword: Chlorella vulgaris; Microalgae; Biomass; Thermogravimetric analysis; Gasification; Syngas