Combustion of pelletized freshwater macroalgae and pine blends using a fixed bed reactor

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Abstract

Freshwater macroalgae are an underutilized group of ubiquitous algae with greater yield potentials than most terrestrial energy crops, but whose combustion characteristics are not thoroughly understood. This effort compared the combustion of pelletized 100% pine and macroalgae-containing solid fuel mixtures (90%/10% and 75%/25% pine/macroalgae) using a fixed bed co-current reactor. Macroalgae increased pellet density as its protein and calcium content promoted hydrogen bonding and cross-linked the carboxylic acid functionality of polysaccharides. In addition, higher concentrations of freshwater macroalgal biomass required a greater air flow rate to achieve the mixing required for combustion. Since the macroalgae had a higher level of fuel nitrogen and fuel sulfur, emissions of nitrogen and sulfur oxides largely grew with an increasing proportion of this fuel. Overall, pelletized macroalgae can be co-combusted with woody biomass and its pre-treatment (water-rinsing and modulating cultivation conditions) can reduce or eliminate drawbacks found in the harvested naturally occurring algal material.