Abstract

Masters of Engineering Degree (Mechanical)

Project Title:

Biomass Insertion System for Pyrolysis Experiments

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Biochar, a solid byproduct of heating organic materials in the absence of oxygen, has many benefits for agriculture and energy. Researchers at Cornell University use a pyrolysis flow reactor to study the production of biochar. These experiments depend on biomass samples undergoing a sudden rise in temperature, and the samples should not be near oxygen once this heating has begun. The way in which biomass samples are inserted in this reactor is difficult and fails to keep oxygen outside. This report deals with the design and analysis of an improved insertion system.

The improved system allows samples to be placed in a part of the reactor where they are not heated until the oxygen is removed. Two design concepts are modeled as networks of thermal resistors. Computational fluid dynamics software and correlations for conduction and free, forced, laminar, and turbulent convection are used to predict the relevant resistances. This model allows the dimensions of the new insertion system to be predicted. This model is shown to accurately predict the temperatures inside a flow reactor.

It is concluded that a duct hose should be added to the reactor in order to allow the samples to be held far away from the heat while the air is sealed outside. Also adding a solid cylinder to the current particle holder may improve the flow properties without affecting the thermal requirements.