

## Abstract

Rising concern over the impacts of climate change due to anthropogenic greenhouse gas emissions have prompted research and proposals on negative emissions technologies that reduce atmospheric greenhouse gas concentrations. Bio-energy with carbon capture and storage (BECCS) is an example of a negative emissions technology, where biomass is grown for combustion in biomass-fired power plants and energy is produced while CO<sub>2</sub> is separated from the exhaust and sequestered [1]. An alternative BECCS model has been previously proposed to lessen the energy inputs to the process. Instead of growing crops for energy production, waste biomass is used and pyrolyzed to produce biochar. The biochar is gasified using CO<sub>2</sub> to produce a CO heavy syngas, which is used as fuel for electricity generation in a solid-oxide fuel cell (SOFC).

This thesis focuses on the kinetics of the biochar gasification step, which is accomplished via the reverse Boudouard reaction. Four waste feedstocks were studied: pistachio shell, walnut shell, corncob, and pumpkin seed shell. The kinetics were studied using thermogravimetric analysis, and the resulting data was fitted to existing gas-solid kinetic models, where it was found that a modified version of the random pore model best described the data. The effect of ash content on gasification reactivity was observed by removing the ash from each feedstock through acid washes, where it was found that most leached biochars exhibited significantly lower reactivities, demonstrating the importance of feedstock inorganics to gasification reactivity.