

abstract

This study is partly motivated by the demand for lowering the emissions of carbon dioxide to the atmosphere by replacing fossil fuels, used for combustion, with biomass. Biofuels behave differently during combustion compared to fossil fuels and the reconstruction or design of power plants for biomass use requires mathematical models. Models are needed both for the prediction of the processes in a combustion facility and for the processes regarding single particle pyrolysis.

Pyrolysis of single wood particles and main wood components has been performed in a single particle reactor and the devolatilisation was studied. Experimental parameters that were determined were decomposition kinetics, surface temperatures and emitted gases sampled both inside and outside of the particle surface. Results show that the decomposition of wood can be modeled by taking the sum of the decomposition of the separate wood components. A molecular beam mass spectrometer was used for gas analysis during pyrolysis and results clearly show that the gas emission change character during the course of pyrolysis and is strongly influenced by reactor temperature.

Mixing of gases and particles influences the performance in a combustion facility and insufficient mixing may lead to lean combustion with lower efficiency and an increase in hydrocarbon emissions. Knowledge of the mixing characteristics is needed for modeling the processes in the furnace. A molecular beam mass spectrometer system has been used to measure the fluctuations in gas composition in a 12 MW circulating fluidized bed reactor. Results show that the system can capture the rapid changes in gas composition in the furnace as well as to follow the consumption of oxygen and the production of carbon dioxide during the combustion.

A part of this thesis concerns pyrolysis processes of construction materials or polymers, relevant for flame spread studies. Pyrolysis models represent one part in larger flame spread models and studies performed within this thesis have focused on pyrolysis processes in reference to thermal devolatilisation. In order to provide a pyrolysis model that can give a realistic picture of the decomposition behavior, studies of mass loss and simultaneous surface temperatures during rapid pyrolysis of different construction materials have been performed.

KEYWORDS: Pyrolysis, biomass, molecular beam mass spectrometer, birch, PMMA, fiber boards,