High Temperature Combustion of Biomass in an Entrained Flow Reactor

RAPHAEL MARRO

Technische Universität München, Institute for Energy Systems, Munich, Germany

ABSTRACT

At the *Institute for Energy Systems* a research group for the project "*Thermal use of Biomass in High Temperature Process*" was established. The overall aim of the works is to examine and overcome problems and limitations within the thermal use of biomasses, which are existent with conventional arrangements. Essential questions are the reduction of emissions like unburnt components, sulphur, chlorine, particles, tar formation, the influence of the biomass treatment on sulphur, chlorine and alkalis as well as the question of the sustainability of the process.

The project comprises the high – temperature processes (combustion and gasification), the pre-treatment of the biomass (torrefaction and hydrothermal carbonisation) with respect to the generation of electricity. As fuels, all agricultural residual materials, straw, energy plants and processed biomasses from torrefaction and hydrothermal carbonization (HTC) like grass cut or landscape conservation material are of interest.

For the high - temperature combustion investigations of in – furnace DeNOx technology is carried out using air staging in an electrically heated entrained flow reactor to reduce the NOx emission by varying different parameters. For the first investigations torrefied ash, poplar, spruce and alder are used. The investigated parameters are the temperature (1000 – 1400 °C), the residence time (1-3 seconds) and in particular the stoichiometry in the fuel rich primary zone (0.6 1.1). The consideration of the burnout is also from significance. With decreasing stoichiometry in the fuel rich zone and high residence times the burnout increases.

Depending on the fuel and the combustion technology the combustion temperature should be below the ash melting point or in the range of forming a completely liquid phase (above the critical viscosity temperature). The high – temperature combustion has the advantage to achieve a high burnout and form a molten slag in which the alkali components can be bounded. Furthermore the liquid slag (low viscosity) has the effect of an oxide layer, which protects the reactor surfaces against corrosion. Therefore a critical viscosity temperature for a Newtonian fluid behavior in dependence of the coal ash composition must be delimited.

To distinguish the melting behavior of the several ashes different Ex-situ measurement methods are used. The characteristic temperatures, given by the ash melting microscope (ASM), will be compared with the data of Differential Thermal Analysis (DTA). With the DTA the heat flows, which are the result of physical or chemical changes of the samples, can be detected. With FactSage the volume fraction of the liquid phase within a specific temperature range was calculated and will be compared with the data of the ASM and DTA. In addition measurements with a high – temperature X-ray spectrometer to analyse the qualitative and quantitative compounds in the ash and viscometer are planned.