BURNERS, COMBUSTION AND HEAT TRANSFER

(627) - (*) - EXPERIMENTAL INVESTIGATION OF SINGLE WOOD PARTICLE COMBUSTION IN AIR AND DIFFERENT O2/CO2/H2O ATMOSPHERES

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To achieve the objective of limiting global warming to below 2 °C compared to pre industrial times it is not sufficient to only decrease anthropogenic CO_2 emissions but the gas has to be actively removed from the atmosphere. In generating net negative CO_2 emissions it is also possible to balance residual emissions that are difficult to avoid for e.g. from the transportation sector. One possibility to achieve net negative CO_2 emission is bioenergy with carbon capture and storage (BECCS). On the other hand separated CO_2 from biomass conversion processes can be used to e.g. produce CO_2 neutral chemicals like methane or methanol. Oxyfuel combustion of biogenic fuels to generate a flue gas with high CO_2 concentration is a technology to efficiently separate CO_2 for storage or utilization. The Oxyfuel process describes the combustion of a given fuel with pure oxygen instead of air. To control the temperatures the oxygen is mixed with recycled flue gas containing mostly CO_2 and H_2O. Due to the different physical and chemical properties of the three atomic gases CO_2 and H_2O compared to N_2 the combustion behavior of the fuel is different under oxyfuel conditions compared to air combustion. Since grate incineration facilities are predestined for the combustion of solid biogenic fuels due to the relatively low requirements for fuel preparation and handling the oxyfuel process is investigated for solid biomass combustion in grate incineration furnaces. To better understand the combustion behavior of woody biomass under oxyfuel conditions relevant for grate incineration facilities single particle combustion experiments have been performed with varying O_2 concentrations (10 – 40 Vol.-%) in O_2/CO_2, $O_2/CO_2/H_2O$ and O_2/H_2O atmospheres at 900 °C. The duration of the characteristic stages of the thermal conversion process ignition delay, volatile and char combustion has been investigated by means of taking videos with distinct frame rate. Additionally the temperature of the flame as well as the particle has been measured throughout the combustion process. The ignition delay has been evaluated according to the measured temperature profiles. It has been found that with increasing oxygen content the ignitions delay decreases. H_2O in the atmosphere further enhances this trend. The duration of the volatile combustion is influenced relatively little by the oxygen and H_2O content in the atmosphere. The temperature of the flame on the other hand is increasing with higher oxygen concentration. Char combustion duration is decreasing with increasing oxygen content and at a given O_2 concentration additional H_2O in the atmosphere decreases the char combustion duration. The particle temperature during char combustion is lower in the oxyfuel cases compared to air combustion however H_2O increases the temperature. One can conclude that considering the carbon consumption endothermic gasification reactions of C with CO_2 and H_2O gain in relevance during oxyfuel combustion so that the particle temperature is lower compared to air operation. Also substitution of CO_2 by H_2O in the atmosphere at the same O_2 concentration leads to decreased char combustion durations.

Palavras-chave : Oxyfuel, Oxy steam, Biomass combustion, single particle