Oxyfuel Cofiring of Miscanthus Char and Coal in a 300 kW Furnace with Integrated Carbon Fixation

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Oxyfuel co-firing of miscanthus biochar and coal is experimentally studied in a 300 kW furnace with integrated carbon fixation unit using furnace slag as carbon dioxide absorbent. The feasibility of a system incorporating oxyfuel cofiring of biomass and coal and carbon fixation based on industrial metal waste, which can potentially achieve near zero emission, is demonstrated. The miscanthus char was made of miscanthus floridulus, which is a native miscanthus species widely available in Taiwan. The miscanthus feedstock was first torrefied at 300 ^{o}C to increase grindability, hydrophobicity, heating value and ease of storage. The elemental analysis revealed that the biochar possessed lower H/C and O/C ratio and higher energy density comparing to raw material.

The biochar was mixed with Australian pulverized coal to study the cofiring characteristics in both air and O_2/CO_2 environments using thermogravimetric analysis. The results showed that the ignition temperature and burnout temperature of the blended fuels were effectively reduced, while their fuel conversion rates and combustion characteristic index were enhanced as the ratio of miscanthus biochar ratio in the fuel was increased under both air and oxyfuel conditions. It was also found that the combustion characteristics index in 30% O_2/ 70 % CO_2 oxidizer is higher than in air for the blended fuels.

An integrated test of oxyfuel co-firing of 5% miscanthus char with Australian coal was then carried out in the 300 kW research furnace equipped with external flue gas recirculation system. Influence of flue gas recirculation ratio was investigated in the tests. It was found that stable combustion can be maintained through a wide range of flue gas recirculation ratio, while CO_2 concentrations (dry) of the flue gas were above 93%. Part of the flue gas was diverted into a fluidized bed carbonation reactor using steel mill desulfurization slag as the absorbent. The slag utilization percentage of the high concentration CO_2 stream was 63%, comparing to 36% for air combustion flue gas.

Keywords: Miscanthus biochar, thermogravimetric analysis, oxyfuel co-firing, carbon fixation