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Influence of fuel properties on NO_X emission in fluidized bed combustion of biomass

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ABSTRACT

NO_X emission from fluidized bed combustion is primarily determined by a series of competing formation and reduction reactions from fuel bound nitrogen. To provide an improved understanding of NO_X emission from fluidized bed combustion of biomass, a systematic evaluation of the impact of fuel properties, including nitrogen content, mineral content, and co-combustion, on NO_X emission was investigated.

Continuous biomass combustion experiments were conducted in a lab-scale fluidized bed reactor. At otherwise similar conditions, a variety of biomass fuels, including pine wood, beech wood, straw, sunflower husk, sunflower seed, and sewage sludge, were combusted with the emission of NO_X monitored. The impact of co-combustion of selected fuels was examined at air staged and one-stage conditions. In addition, the interaction between ash forming elements and NO_X emission was investigated by combustion of washed and K-doped (KCl, K_2CO_3, and KOH) biomass.

Selected results from the experiments are shown in Figure 1 and 2. The results in Figure 1 indicate that the NO emissions from straw-sunflower seed and straw-sunflower husk co-combustion were additive, while a synergy effect was observed in the case of sewage sludge-straw co-combustion. This may be attributed to the catalytic effect of sewage sludge ash on the nitrogen chemistry. The results in Figure 2 show that the conversion of fuel nitrogen to NO decreased with the fuel nitrogen content, increased when washing the straw, and decreased slightly upon K-doping of the washed straw and raw pine wood. The largest influence of K-species was observed in the case of KCl-doped washed straw, showing a significantly lower conversion of fuel N to NO, while for the pine wood, K-doping did not change the conversion of fuel N to NO significantly.

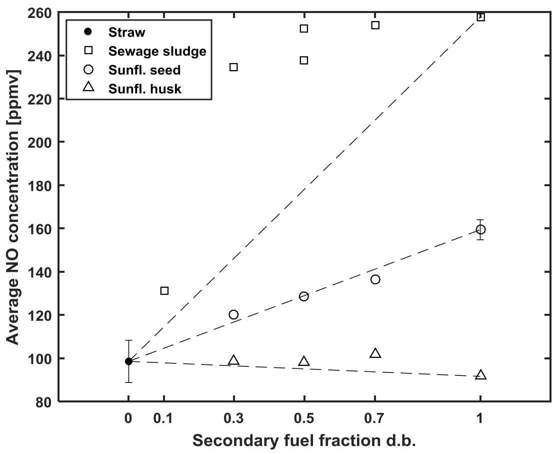

Figure 1*: Average NO emission from co-combustion of primary fuel (straw) and secondary fuels (sunflower seed and husk, and sewage sludge) at 850℃ with an excess air ratio 1.4-1.5 in one-stage combustion.*

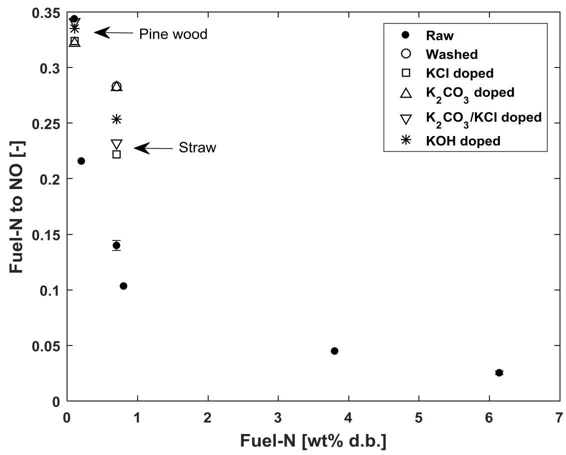

Figure 2: *Conversion of fuel nitrogen to NO from combustion of washed straw and K-doped washed straw, and K-doped pine wood at 850℃ with an excess air ratio 1.4-1.5 in one-stage combustion.*