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Coal-firing and biomass-firing in a 150kW swirl-stabilized burner flow reactor

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Introduction
The worldwide concern with global warming and low availability of fossil fuels has spurred interest in using biomass for energy production. Co-firing biomass with coal in existing large-scale power plants offers an attractive option. Co-firing biomass in a wall-fired boiler could be far more challenging, because burner aerodynamics and fuel properties have a much greater impact on combustion and emission characteristics in a suspension-fired boiler than other boilers. The body of useful work available in literature for the fundamental characteristics of biomass/coal co-firing flames is still severely limited, in particular, the comparison of firing pure biomass and firing pure coal under similar conditions.

This paper studies the combustion characteristics of firing pure coal and firing pure wheat straw in a 150kW swirl-stabilized burner flow reactor under nearly same conditions. The results indicate very different combustion characteristics between the coal flame and straw flame and provide some clues in design of biomass (co-firing).

Method
- Model development & numerical simulations: 62600 quadrilateral cells for steady 2D axisymmetric swirl simulation; custom vs. default DPM laws; Realizable k-ε, DO radiation, Jones and Lindstedt (JL) 4-step mechanism vs. Westbrook and Dryer (WD) 2-step mechanism. Simulations validated with the measured species map (done by project partner, BYU at Utah, USA).
- Use the validated simulation as a tool to look into more details.

Experimental

Result
- For pulverized biomass particles of a few hundred microns in diameters, the intra-particle heat and mass transfer is a secondary issue at most in their conversion.
- Very different combustion aerodynamics and characteristics between the coal flame and the straw flame.

Conclusions
For pulverized biomass particles of a few hundred microns in diameters, the intra-particle heat and mass transfer is a secondary issue at most in their conversion. JL 4-step mechanism can better predict the gas phase combustion. There exist different combustion aerodynamics and characteristics between the coal flame and the straw flame. In order to better implement biomass/coal co-firing in a swirl burner, comprehensive consideration on fuel feeding, air supply and combustion aerodynamics must be made.

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