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U.S. Department of Transportation

SunGrant INITIATIVE South Central Region

Project Title: *Cofiring Cattle Biomass (CB) and Agricultural Biomass (AB) Fuels in Low NO_x Burners*

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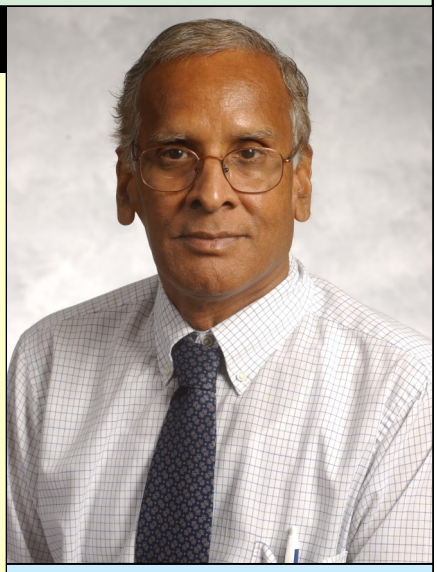

Rationale

Due to restrictions regarding maximum total daily loads of phosphorus, animal waste can no longer be disposed of by land application and an alternate, cost effective disposal method must be developed. Simultaneously, NO_x emission restrictions for fossil fueled power plants are becoming increasingly stricter. Cofiring coal with the high N animal waste, termed as dairy biomass (DB), was done as the thermo-chemical method to address the concerns. DB wass evaluated as a cofiring fuel with Wyoming Powder River Basin (PRB) subbituminous coal in a small scale 29 kWt low NO_x burner (LNB) boiler facility equipped with air staged combustion for NO_x control.

Project Outcomes

- Proximate and ultimate analyses performed on coal and DB revealed the following: nitrogen and sulfur loading on heat basis: 0.15 to 0.48 kg/GJ for the coal and 0.33 to 2.67 kg/GJ for the dairy biomass; ash loading : 3.10 to 8.02 kg/GJ for the coals and 1.57 to 139 kg/GJ for the dairy biomass.
- The cofiring experiments were performed with 85:15, 90:10, 95:5 (by mass percent) coal:dairy biomass blended fuels as well as pure coal. Standard emissions from solid fuel combustion (O2, CO2, CO, NO_x, and SO_2) were measured in addition to the temperature profile along the axial length of the furnace.
- A new method called Respiratory Quotient, used widely in biology is introduced to engineering literature to rank global warming potential (GWP) of various fossil and biomass fuels; the higher the RQ higher CO_2 emission and higher the GWP. They were estimated as 0.92 and 0.94 for PRB and DB while for CH_4 it was 0.5
- Standard emissions from solid fuel combustion (O_2, CO_2, CO, NO_x, and SO_2) were measured and NO_x on a heat basis (g/GJ), fuel burnt fraction, and fuel nitrogen conversion percentage were estimated .The gas analyses yielded burnt fraction ranging from 100% to 89% and gas analyses confirmed RQ of 0.9 to 0.94 which is almost same as RQ based on fuel composition.
- By staging 20% of the total combustion air as tertiary air (1.12 initial equivalence ratio), NO_x was reduced to 545 ppm (304 g/GJ) for the 90-10 blended fuel which is a 16.5% reduction from the unstaged pure coal. In addition to these emissions measurements, zero dimensional modeling of the combustion within the low NO_x burner and economic analysis were performed.

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