

Integration of poultry litter gasification with conventional pulverized coal fired power plant

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The purpose of this federally co-funded project is to demonstrate the technical and economical feasibility of biomass gasification and co-firing in an existing pulverized coal fired utility boiler operated by Western Kentucky Energy Corporation. The primary focus is the use of poultry litter as fuel for the gasification process. However, any other biomass-based fuel that meets the sizing requirements and can be easily transported to the stand-alone gasifier is suitable for this application. Specific objectives of this project are:

- ?? To commercialize a biomass co-firing technology that utilizes biomass, agricultural waste and/or farm animal wastes in an environmentally benign, technically practical, and economical application
- ?? To evaluate the technical and economic impact of gasification based co-firing on the existing class of fossil fuel fired boilers currently within proximity of animal waste and agricultural biomass resources of reliable consistency and delivery rates needed for economic operation
- ?? To determine possible modifications, if any, required in either the proposed gasification or boiler technology, for effective utilization of the biomass sources available
- ?? To evaluate these factors specifically for the Reid Plant operated by Western Kentucky Energy Corp. and to develop cost and schedule estimates for implementation
- ?? To implement such a facility at the Reid Plant in Phase II, provided that the estimates and evaluations indicate that a useful demonstration of the proposed biomass gasification and co-firing technology can be carried out at that plant

Fuel Supply

The Reid plant is located adjacent to a large poultry processing plant with over 500 poultry farmers within a 50-mile radius of the plant and estimated litter supply of over 120,000 tons per year. Primenergy has analyzed poultry litter samples from various sources, and a summary of the analytical results is provided in Table 1.

Table 1. Poultry litter sample analysis [1]

	Moisture (Percent)	Proximate Analysis (% dry)			Sulfur (% Dry)	Higher Heating Value (Btu/lb.)	
		Ash	Volatiles	Fixed C		Dry	As Received
Avg.	27.01	25.15	61.49	13.36	0.79	6,315	4,608
Min.	17.00	16.49	53.22	9.94	0.59	5,307	3,788
Max.	39.34	36.84	67.38	16.54	0.95	7,242	5,353

Reid Plant Boiler

The existing Reid Plant boiler is a Riley Stoker forced draft, pulverized coal (PC) fired boiler built in 1964. The boiler is rated at 690,000 lbs. of steam/hr at 1300 psi and 955° F at the super heater outlet. Primary fuel for the boiler is compliance coal from the local Kentucky coalmines. The boiler was recently converted to a dual fuel system that gives boiler the capability of switching to natural gas during the NOx mitigation season.

Proposed Gasifier

The proposed gasifier is a Primenergy KC-18 system consisting of fuel feed system, one gasifier, hot gas filtration system and a two staged after burner combustion system. The KC-18 will handle 8.4 tons/hr. of poultry litter. The KC Reactor/Gasifier is a fixed bed, air blown, updraft, near atmospheric pressure gasifier.

Fuel is introduced into the gasifier by a water-cooled screw conveyor that discharges into the drying and heating zone of the gasifier. The gasification process is controlled by the proportioned injection of gasification and combustion air in a manner that supports efficient gasification. Residence time in the gasifier is varied by a residence control system that is adjusted to achieve the desired carbon content of the ash discharged from the gasifier. The use of mechanical bed agitation, precise gasification air control and zoning produces a clean, combustible gas with heating value of about 110 Btu/cu. ft. [2]. In order to minimize impact of the external gasifier on the existing boiler operation, the gases are filtered through hot ceramic filters to remove particulates and other contaminants.

Ash from the gasifier retains phosphorous and potassium present in the poultry litter while the fuel bound nitrogen is lost with the gasification products. The ash has potential value as P&K fertilizer. Project will be investigating potential application and market for the ash.

Boiler Gasifier Integration

The low Btu gas from the gasifier (producer gas) is at 1550°F and has a calorific value of about 110 Btu/std. cu. ft. The gas is burned in a two-stage combustor, which raises the temperature of the gas to about 2330°F. The gas can be fed into any existing boiler at a suitable location as additional heat input to the boiler. For the Reid plant, the cleaned hot gases will be fed above the existing burners, allowing the reduction of the primary fossil fuel to the boiler. It is estimated that about 8~10% of heat input will be coming from the synthesis gases, which will allow Reid operators to reduce proportionate amount of coal.

Conclusions

Due to low sulfur content in the poultry litter, and two staged combustion process, the gasifier is expected to reduce the SO₂ and NO_x by over 5% from the boiler. With the hot gas filtration system, clean gas is fed into the existing boiler. This will reduce particulate loading on the electrostatic precipitator (ESP). Poultry litter is a renewable energy resource. The Reid plant will be able to reduce their fossil fuel consumption by 8~10% and can claim a reduction in greenhouse emissions (CO₂) from their boiler.

References

- [1] Scott WN. Analytical Test Results of Poultry Litter Samples. Private correspondence, March 1999.
- [2] McQuigg K, Scott WN. Starved Air Gasification on Five Biomass Feedstocks. Paper presented at the BioEnergy '98 conference, Madison, WI. October 4-8, 1998.