UNIVERSITY OF FLORIDA

Combined Cooling, Heat, Power, and Biofuel from Biomass and Solid Waste

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Description: The goal of this project is to provide the underlying research and demonstration of a novel technology which would enable the economic utilization of dispersed biomass and solid waste resources to produce electric power, cooling, heat, and transportation fuels. This integrated gasification and power generation system combines University of Florida advances in high-temperature gasification, hydrogen generation and separation, and advanced gas turbine systems. Their integration is expected to result in significant improvements in the cost, emissions, feedstock flexibility, and water requirements, all in a relatively compact, modular plant system. This in turn will enable much greater utilization of renewable energy supplies, helping the development of a sustainable energy supply infrastructure.
Budget: $576,000
Universities: UF
External Collaborators: Siemens Power Generation, Florida Turbine Technologies, Energy Concepts Co., Alturdyne, Inc., LPP Combustion, Planet Green Solutions.

Progress Summary

Continuing progress has been made in three areas: development of a system architecture and thermodynamic model, development of models and system-level experiments for the PoWER gas turbine unit, and exploration of the underlying science and demonstration of the high temperature steam gasification subsystem. These activities are structured in such a way as to allow stepwise research and development of the overall plant in outlying years.

The system architecture includes the full integration of waste heat and water produced in the gas turbine module with the gasification subsystem. This in turn allows efficiency gains, reducing the proportion of hydrogen utilized internally, and allows zero net usage of external water resources. A thermodynamic system model is operable, though more sophisitcation is needed for full optimization of the system and accurate prediction of performance.

The PoWER system has been validated as an early demonstration unit in previous programs. Experimental results from the combustion process have been obtained, allowing the quantification of soot and other emissions in flameless combustion, including the effect of biofuels. Combustion modeling supports the experimental findings. System thermodynamic models have shown the potential of the PoWER system to improve efficiency and produce fresh water. These models are being integrated into the overall system model for improved fidelity.

On the gasification side, we have primarily been working on the development of the experimental systems. Two different sized units are under development, one a laboratory-scale system and the larger one installed on a trailer. Both systems have been designed and constructed under FESC support. The characterization and evaluation of both systems have been undergoing.

The laboratory-scale system that was designed for high-temperature pure steam gasification research has been completely built and is undergoing calibration evaluations. The system will be ready for gasification experiments at the beginning of June, 2010.

For the trailer-scale system, we have performed six test runs and found that the system can produce 12 kW of power with a biomass (wood chip) consumption rate of 20 kg/hr. This result is consistent with the theoretical model prediction. We also discovered that the gasifier produced excessive amount of tars that condensed on the inside of the syngas paths, as expected for the initial downdraft combustion design. The system has been under repair and modification to operate at higher temperature to avoid tars, and will be available for next phase of experiments in the middle of May, 2010.