the ENERGY lab

PROJECT FACTS

Fuels

Advanced Systems: Preprocessing and Characterizing Coal-Biomass Mixtures as Next-Generation Fuels and Feedstocks

Background

Significant progress has been made in recent years in controlling emissions from coal-fired power plants in the United States (U.S.) through research, development, and deployment of innovative cleaner technologies such as gasification. Gasification is a process that converts a solid feedstock such as coal and/or biomass to a synthetic gas (syngas). Syngas is a mixture of predominantly carbon monoxide (CO) and hydrogen (H_2), which can be converted to electricity, fuels, or chemicals. Through gasification, potential pollutants can be captured and either safely disposed or converted to useful by-products.

The Department of Energy (DOE) is committed to supporting research focused on making use of the nation's coal and biomass resources for affordable power generation, fuels, and chemicals using methods that are less damaging to the environment. For example, production of electricity from fuels derived from coal-biomass feedstocks can contribute to the reduction of overall greenhouse gas emissions from fossil power plants. One area of research is the development and characterization of multiple coal-biomass mixtures and types that are transportable and storable and accommodate direct co-feeding into gasification systems. The National Energy Technology Laboratory (NETL) is partnering with Virginia Polytechnic Institute and State University (Virginia Tech) to develop advanced systems for processing and characterizing coal/biomass mixtures, next-generation fuels, and feedstocks.

Project Description

The project team is developing engineered systems for manufacturing coal-biomass briquettes or pellets containing 10 to 30 percent biomass that are ideally suited for transportation, storage, and direct co-feeding into industrial gasifiers. An in-depth experimental study to determine the key reactive properties for coal-biomass mixed fuels is underway, testing sub-bituminous coal mixed with biomass feedstocks of hybrid poplar wood, switchgrass, or corn stover. Enabling technology for this project includes the application of novel binding additives and, when required, an advanced conditioning process for upstream sizing, upgrading, and drying. Upon completion, the project will provide information on the equipment, necessary conditions, and process requirements for the manufacture of optimal coal-biomass feedstock for co-gasification.

CONTACTS

Jenny Tennant
Gasification Systems Technology Manager
National Energy Technology Laboratory
3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880
304-285-4830
Jenny.Tennant@netl.doe.gov

Richard Dunst
Project Manager
National Energy Technology Laboratory
626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940
412-386-6694
richard.dunst@netl.doe.gov

Michael E. Karmis
Principal Investigator
Virginia Polytechnic Institute & State. University
460 Turner Street, Suite 304
Blacksburg, Virginia 24061
540-231-5273
mkarmis@vt.edu

PARTNERS

None

PROJECT DURATION

Start Date	End Date
10/01/2010	03/31/2014

COST

Total Project Value
$1,250,817

DOE/Non-DOE Share
$999,061 / $251,756

PROJECT NUMBER

FE0005451

U.S. DEPARTMENT OF ENERGY

Goals and Objectives

The overall objective is to perform an in-depth study of coal-biomass preprocessing. Specific project objectives are to (1) identify, collect, and fully characterize samples that best represent the range of high-rank eastern bituminous and low-rank western sub-bituminous coals present in the U.S.; (2) identify, collect, and fully characterize individual samples of corn stover, grasses, and wood that best reflect the wide spectrum of renewable biomass resources available in the United States; (3) briquette/pelletize coal-biomass mixtures (10 to 30 percent biomass) using novel binding aids and advanced conditioning processes for sizing, upgrading, and drying; (4) perform statistically-designed experiments to examine a range of feed compositions such as fuel type/source, mixture percentage, particle size, moisture, equipment settings, and additive formulations; (5) develop and evaluate methodologies for characterizing the physical, physicochemical, and thermal properties of manufactured coal-biomass mixtures under various operational conditions, including heat and pressure, so that standardized characterization methods can be identified; (6) fully characterize the handling, storage, and utilization behavior of coal-biomass products generated from the parametric study; (7) conduct bench-scale gasification tests using selected mixtures to ensure that the most desirable manufactured coal-biomass mixtures have been produced; and (8) assess the technical and economic feasibility of the proposed preprocessing and conditioning steps with respect to their impact on fuel cost, gasifier throughput, and environmental emissions.

Accomplishments

Researchers have completed gasification testing on a variety of coal-biomass briquettes made in their laboratories. Some of the variables examined included the type of coal (bituminous vs. sub-bituminous), the percentage of biomass in the mixture (10-30%), and the use of binder for making the briquettes (starch binder vs. no binder). It was observed that blends of corn stover and sub-bituminous coals can be gasified very easily, with a much higher tendency to produce syngas at a higher efficiency at the same steam-to-oxygen ratio than blends of corn stover and bituminous coal.

Researchers have developed new test methods for characterizing briquettes produced from compacting coal and biomass fines. Water content, particle density and water resistance are three important characteristics of the briquettes which need to be evaluated in order to assess the quality of briquettes being made. A standard method for determining the water content of briquettes was adopted and evaluated. A device was built to measure the particle density (apparent density) of coal-biomass briquettes and evaluations were performed to determine the optimum configuration of this test method. A device was also built to measure and quantify the water resistance of the coal biomass briquettes.

Researchers have completed a water content optimization study for bituminous coal-biomass briquettes. The results show that previously-developed compaction concepts can be successfully applied to bituminous coal-biomass briquette production using a hydraulic press. A strong correlation was observed between the dry density of all bituminous coal-sawdust briquettes and two quality indicators - crushing strength and mechanical durability. These findings suggest that an exhaustive experimental study on roll press briquetting coal-biomass mixtures could be streamlined by simply determining the water content that results in the greatest dry density for a fixed set of conditions (i.e. coal type, biomass type, biomass content, particle top size, etc.), because the maximum strength and durability likely exist at or near this water content value as well.

Benefits

This project is expected to provide critical data about the equipment, conditions, and processes necessary to manufacture optimal coal-biomass feedstock for co-gasification. Research completed under this project will provide methodologies and standards needed to classify coal/biomass mixtures based on thermal, physical, and economical values. Commercial-scale use of coal-biomass co-gasification will promote the use of domestic fuel resources. Consequently, U.S. energy security will be enhanced and greenhouse gas emissions from power generation will be reduced. Analysis of the results obtained from this research could be useful in minimizing the impact of issues associated with biomass transport, storage, and intermittent availability, which could provide a transition path to green energy utilization in existing facilities.