the ENERGY lab

PROJECT FACTS

Fuels

R&D to Prepare and Characterize Robust Coal/Biomass Mixtures for Direct Co-Feeding into Gasification

Background

Domestically abundant coal is a significant primary energy source and, when mixed with optimum levels of biomass, has lower carbon footprint compared to conventional petroleum fuels. Coal and biomass mixtures are converted via gasification into synthesis gas (syngas), a mixture of predominantly carbon monoxide and hydrogen, which can be subsequently converted to produce liquid fuels and chemicals by Fischer-Tropsch chemistry. Custom coal/biomass blends can ensure the availability of abundant and affordable domestic feedstocks for production or co-production of clean, low-cost, and environmentally-sustainable power, fuels, and chemicals in support of Nation's energy economy.

The Department of Energy (DOE) is committed to supporting research focused on making use of the nation's coal and biomass resources to produce affordable power, fuels, and chemicals using methods that are less damaging to the environment than those presently available. For example, the production of fuels and chemicals from coal and biomass feedstocks can reduce overall greenhouse gas emissions. One area of research is the development and characterization of multiple coal/biomass mixtures and types that are transportable, storable, and accommodate direct co-feeding into gasification systems. The National Energy Technology Laboratory (NETL) is partnering with Gas Technology Institute (GTI) and partners to prepare and characterize robust weather-resistant coal/biomass mixtures suitable for direct co-feeding into commercial coal/biomass gasifiers.

Project Description

The research team will subject lignocellulosic biomass (plant biomass that is composed of cellulose, hemicellulose, and lignin), in the form of loblolly pine (a lignocellulosic, short rotation woody crop), to hydrothermal carbonization (HTC), creating a densified coal-like product by exposing biomass feedstocks to heat and pressure in the presence of water. The process will deconstruct the lignocellulosic feedstock to produce aqueous and solid streams. The first stage of this work will occur at a small bench-scale facility at the Desert Research Institute to determine optimal HTC processing parameters and develop accurate mass and energy balances. The second stage will utilize larger sample sizes at a larger, dedicated Process Development Unit (PDU). Initially, the HTC product will be mixed with ground coal, pelletized, and assessed for strength and grindability by team member Clean Coal

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PARTNERS

Parker Towing Incorporated
Desert Research Institute
University of Nevada–Reno
Clean Coal Briquette Incorporated

PROJECT DURATION

Start Date
10/01/2010

End Date
09/30/2013

COST

Total Project Value
$1,250,639

DOE/Non-DOE Share
$1,000,465 / $250,174

Briquette Incorporated (CCBI). The University of Nevada–Reno will assess the durability of lignin and similar binders in wood when subjected to HTC. In a later phase, loblolly pine samples will be processed using HTC and internally mixed with ground coal within the PDU so that it can be directly formed to a final densified product, which will also be assessed for strength and grindability by CCBI. Finally, GTI will use Aspen software (Aspen Technology, Inc.) to carry out process simulations based on engineering results attained during the project. These simulations will provide the technical basis for developing a techno-economic analysis to evaluate the economic viability of HTC for producing a new coal/HTC biomass fuel.

Goals and Objectives

The overall goals of this project are to demonstrate and assess the economic viability of fast HTC for transforming lignocellulosic biomass into a densified, friable fuel that has been shown to gasify like coal, easily blend with ground coal and coal fines, and form into robust, weather-resistant pellets and briquettes.

Specific project objectives include:

- Utilize biomass HTC technology and facilities developed under previous DOE cooperative agreements to produce a densified, uniform feedstock from loblolly pine. This HTC processed feedstock has been shown to chemically resemble coal and gasify like lignite.
- Combine HTC processed loblolly pine with finely divided bituminous coal to form a uniform coal/HTC biomass mixture containing 10 percent by weight dry biomass and another mixture containing 30 percent by weight dry HTC biomass.
- Form robust, weather resistant pellets and/or briquettes (stable forms suitable for transportation and storage) from the two coal/HTC biomass mixtures.
- Characterize the coal/HTC biomass pellets and briquettes to quantify their physical properties (i.e., flow properties, homogeneity, moisture content, particle size, shape, and bulk physical properties including compressibility, heat transfer, and friability) and assess their suitability as fuels for commercially-available coal-fired gasifiers.
- Perform techno-economic analyses using Aspen-based process simulations to determine the costs for deploying and operating HTC biomass processing facilities for the ultimate production of robust coal/HTC biomass fuels suitable for fueling commercially-available coal-based gasifiers.

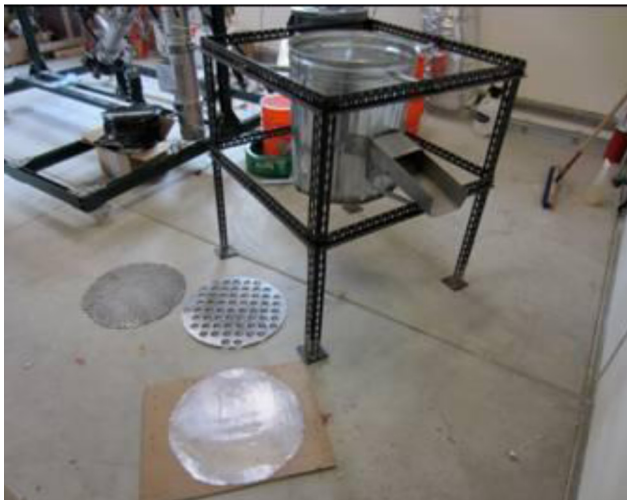
Accomplishments

A semi-continuous PDU to treat loblolly pine chips in hot, pressurized water will be utilized. The product of interest in this project is the solid (hydrochar). Hydrochar can be readily pelletized to produce robust and water resistant pellets. Design, fabrication, and installation of the PDU in Desert Research Institute's (DRI) Renewable Energy Experimental Facility (REEF) to process 2–4 kg of feedstock and produce 60–70% hydrochar is continuing. A simple, manually operated system for sorting raw loblolly chips to the desired chip size range of 0.5–1.0 inch has been built to optimize operation of the PDU's feed auger. Construction of a water/solid separator that will retain the hydrochar on a screen, but allow the liquid to pass through has also begun. In order to take advantage of the abundant source of solar heat available within the DRI-REEF, a solar oven will be used to dry the hydrochar. The oven is currently being designed.

Benefits

This project will broaden the applicability of commercially available gasifiers to include utilization of mixtures of carbon-neutral biomass and coal, which will extend our energy resources, increase energy security, and directly address pressing environmental concerns by reducing fossil-based energy production carbon emissions.

DRI's Small Bench-scale Semi-continuous PDU.



Photograph of the wood chip sorter.

(Source: Quarterly Research Performance Progress Report Submitted by GTI on April 30, 2012)