Manure Biomass Briquette Research Project

Interim Report

for

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Project Background

The use of manure and other farming by-products as an alternative energy source that can be delivered by means of briquetting offers numerous potential benefits for the environment and producers. A typical 450 kg feedlot steer produces about 10 metric tons of fresh manure per year, and feedlots will keep up to hundreds of thousands of these animals. Colorado producers must deal with potential contamination of air and water, and the expense to store or remove manure to a waste facility. Current manure removal costs can be as high as $100/ton. Compressing the manure into a briquette that can be combusted to generate heat, electricity, or both would lead to cleaner facilities. It would also reduce the need for storage, and provide an alternative for producers who do not have good access to a local fertilizer market or sufficient land for manure application, while potentially reducing farm dependency on fossil fuels and Colorado producers' energy costs.

The purpose of this research project is to discover the optimal composition and properties for briquettes that will yield maximum energy output and handling ability. The process must be simple enough so producers can implement it without significant disruption of their existing processes or excessive new capital improvements. If the research project is successful, it will point the way towards creating new jobs, reducing waste, alleviating several major costs to Colorado producers including disposal of manure and energy overhead, all of which could help revive rural communities.

Work Completed/Accomplishments

FACILITATING COLLABORATION

The Plan of Work envisions an extensive collaboration of producers, universities, and the public/private sector to achieve the goals of this project. One of the key proposal co-sponsors was Dr. Doug Sutton, Director of the Senior Engineering Design program at Colorado School of Mines (CSM). Existing CSM engineering laboratories, and engineering design teams, have been premised for meeting many of the project's work tasks. For example, these fully-equipped laboratories in Golden, CO provide standard and specialized diagnostic equipment, analysis tools, different types of furnaces including a cogeneration unit, that will be used to test for optimum briquette composition and properties. Student engineering design teams are expected to improve upon briquetting equipment designs used previously by iCAST to test fly ash/sawdust fuel briquettes in a coal-fired power plant. Dr. Doug Sutton retired during the summer of 2009. We have met and worked with his replacement, Dr. Cameron Turner to ensure that a senior design team would be involved in this project. At present, we have two senior design teams from CSM that will be building two different briquetting equipment prototypes. We have also secured a commitment from the USDA's Burlington field office to provide a variety of farming by-products for experiments to determine the biomass material that will bind and burn optimally with cow manure.

IN-HOUSE RESEARCH

While waiting to engage the senior design teams with appropriate tasks from the Plan of Work, iCAST

has reviewed current literature and developed necessary background information to enable the efficient involvement of other collaborators in meeting the objectives of this research project. This research has focused on the following areas:

- Identifying applications of briquetting agricultural waste products
- Recent developments in commercial briquetting and pelletizing equipment
- Building on iCAST's previous briquetting work
- Identifying pitfalls associated with briquetting agricultural waste products
- Appropriate style furnaces for combusting briquettes, and
- Identifying key parameters to factor into student design projects.

Applications of Agricultural waste Briquetting

An updated review of manure briquetting or pelletizing for renewable energy generation still indicates this Advancing Colorado's Renewable Energy (ACRE) research project is at the forefront of developing a viable solution for manure treatment. Examples of similar early-stage projects include:

- Central Vermont Public Service is funding a study the potential use of pelletized digested or pre-digested manure solids for fuel in a cogeneration system to produce electricity and heat.[1]
- The idea of building a pellet or briquette plant is already in the pipeline in Maine. This pellet plant is expected to bring over 30 direct good paying jobs and 100 indirect jobs to the community.
- Manure mixed in with wood pellets, i.e. used animal bedding, for small-scale pellet fuels is noted by Freedom Equipment LLC of Rockford, IL.[2]
- RENEW Energy Systems was awarded a $300,000 Iowa Power Fund grant to develop a mobile biomass briquetter[3] utilizing a Danish (CF Nielsen) briquetting press.

Commercial Briquetting and Pelletizing Equipment

We recently attended the 31st Biennial Institute for Briquetting and Agglomeration Conference in San Antonio, TX and have been following up with presenting scholars and equipment exhibitors. This information complements the previously developed by iCAST and enables us to help better advise engineering design teams which will work on improved equipment designs that may result in more economical pelletizing. This also confirms key design parameters including the need to remove contaminants, optimizing biomass feed properties versus the horsepower the pellet mill must produce, moisture content, binders needed to strengthen the briquettes or pellets, and maximizing die life in order to minimize costs. Die thickness, milling speed, temperature, and pressure are also keys to optimizing efficiency and pellet quality.

[1] http://www.cvps.com/AboutUs/news/viewStory.aspx?story_id=189 Central Vermont Public Service
[2] http://www.biomassmagazine.com/article.jsp?article_id=2465&q=&page=3 "The Art of Biomass Pelletizing", Biomass Magazine, March, 2009
[3] http://www.renewenergysystems.com/index.php?option=com_content&task=blogcategory&id=1&Itemid=87

FURNACE ISSUES

Several combustion trials of biomass pellets have been performed, primarily in power plants. It is likely that "The big demand, as we see it right now, is going to be the electrical utility plants, the coal-burning plants,… Before power companies can use biomass pellets, however, they must address emissions issues."[4] Based on this history, Plan of Work tasks related to optimizing the composition of agricultural by-product briquettes or pellets to minimize harmful emissions will be of particular interest. Agricultural residues typically have higher nitrogen, sulfur, chlorine and potassium content due to increased use of fertilizers, pesticides and herbicides than would be the case with wood residues. Consequently, this research project is likely to significantly contribute to knowledge of manure-based biomass emissions. This research also seeks to identify furnaces that are extremely efficient at producing heat and/or electricity out of the briquetted product. Understanding the current capabilities of producers and their facilities will play a key role in determining what kind of briquetting and power plant or furnace can most cost effectively be introduced to Colorado producers on a local scale.

The vast majority of manure to fuel applications to date have utilized anaerobic digestors to create a biogas that is burned to generate power. That said, a few solid manure to energy plants have been brought on line that burn poultry litter as fuel. A large domestic example is the 55 MW Fibrominn plant in Benson, MN.[5] In addition, a limited amount of experimentation has been done that shows co-firing coal with 10% beef feedlot manure can reduce nitric oxide and possibly mercury emissions.[6] Never the less, optimum manure combustion equipment is not off-the-shelf technology. This ACRE project represents a cutting edge effort in this regard.

Problems Encountered/Mitigating Circumstances

PLAN OF WORK

No significant problems have been encountered to date in implementing the Plan of Work.

Next Steps

KICK OFF ENGINEERING DESIGN TEAMS

As our two CSM senior design teams begin to tackle various project work plans, iCAST will guide them to in their design process to create a fully functioning briquetting prototype. As soon as the scope of these

[4] ibid
[5] http://www.biomassmagazine.com/article.jsp?article_id=1196&q=manure "Generating Poultry Power", Biomass Magazine, July, 2007.
[6] http://www.biomassmagazine.com/article.jsp?article_id=1401&q=manure&page=all "Cow Pies to Clean Power", Biomass Magazine, January, 2008.

student efforts becomes clear, iCAST will evaluate the need for additional internal or in-kind efforts to fulfill the Plan of Work.

CONTROLLED VARIABLES

Emphasis will be placed—both when advising the senior design teams and when considering the need for additional internal or in-kind efforts—on narrowing the range of variables that can be controlled during this research project. Examples include:

- *Composition* – Narrowing the biomass materials in the blend through bench testing and additional literature review will allow better focus in equipment design and furnace selection. It is expected animal bedding waste, cane grass, switch grass, or corn stover, will be needed to bind with manure in the briquetting process and to enable it to burn optimally with minimal emissions.
- *Impurities*-- Manure is often contaminated with other materials, such as urine, dirt, and sand. Different concentrations of impurities need to be introduced as a variable in our experimentation.
- *Pressure, Density and Shape* - Experiments to find the optimal briquette-forming pressure, the ideal density of the briquetted material, and which shape of briquette will have the best combustion as well as be easy to store and transport will help drive this research project.
- Moisture Content and Drying - Moisture allows the mixture properties necessary for cohesion during briquetting. However, the exact level must be determined. If it will be necessary to subject the briquettes to a mechanical drying process, costs will be affected.

Updated Project Timeline

TIMELINE

iCAST is confident the project's 4/1/11 end date can still be met. However, revisions to the CSM senior design program makes it likely initial experimentation will need to be performed using bench-scale presses and hardware, rather than waiting on improved briquetting equipment likely to result from the work of the teams. This will allow work to proceed on deriving optimum composition of the biomass mixtures in parallel with equipment development and testing.

Findings To Date/Conclusion

Although using manure in a form of briquette has been around for centuries, finding a blend of manure and other biomass materials readily available on farms to produce a briquette that can be easily transported, safely stored, and combusted in cogeneration units will be both environmentally and economically beneficial. This project, by conducting initial research into optimal briquetting strategies to generate energy from manure, is expected to yield cutting edge results. It can be hoped that these results will suggest viable opportunities for commercialization and for reducing environmental and economic impacts associated with current methods of manure disposal.