Crude Glycerol Combustion System

Introduction and Commercialization Plan

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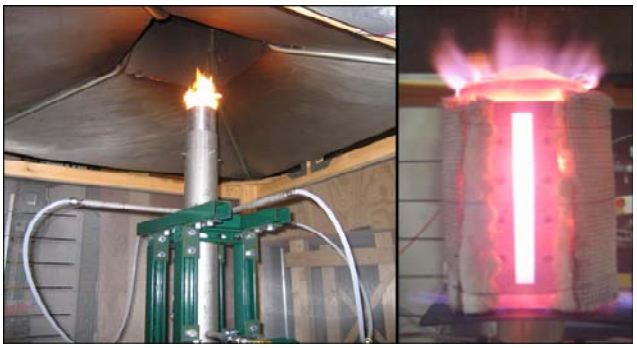
Background



Crude Glycerol Combustion - Prototype System

Diversified Energy Corporation (DEC) and North Carolina State University (NCSU) have developed an innovative technology to economically and safely combust crude glycerol for combined heat and power. The manufacture of biodiesel through the transesterification of triglyceride feedstocks results in approximately one pound of crude glycerol byproduct for every ten pounds of biodiesel produced. As the biodiesel industry has grown, so too has the supply of crude glycerol – reaching 32 million gallons in the U.S. in 2007, with that reflecting industry production at only 1/6th of nameplate capacity. In Europe crude glycerol generation is almost double that of the U.S. Crude glycerol contains artifacts from the biodiesel process like catalysts, alcohol, water, and soap and is therefore costly to refine into higher-grade glycerol. As a consequence, crude glycerol market prices are low and falling and the biodiesel industry is challenged with viable options for this glut of glycerol. The commercialization of a combustion technology would enhance the value for crude glycerol, thereby resulting in more attractive financials for the biodiesel industry and broader market penetration.

The combustion of crude glycerol offers an elegant solution, where roughly 16 MJ of energy per kilogram of glycerol burned could be provided back to the biodiesel process or to another co-located system, in an optimal combination of heat and power. However, the combustion of glycerol has heretofore been challenging because of technical, safety, and cost obstacles. By nature, glycerol has a high viscosity, high auto-ignition temperature and low heating value. This means that it is difficult to flow the product into a burner, hard to ignite, and even more challenging to maintain a flame. In addition, if the glycerol is not completely combusted it is possible to generate dangerous aldehydes like acrolein. For this reason the market has struggled to commercialize cost-effective, widely deployable combustion systems for crude glycerol.

Glycerol Burner Technology

The patent-pending burner system developed by DEC-NCSU uses a novel spray atomization swirl burner architecture that overcomes technical and safety issues. This includes a unique approach to pre-heat the combustion chamber, maximize heat and radical retention, and carefully mix the air and fuel flows. The system is also extendable to any liquid fuel having an ambient viscosity up to a few hundred centistokes. A 100,000 BTU/hr prototype has been built and tested at NCSU. Several forms of crude glycerol (from the transesterification of chicken fat, and virgin and waste soybean oil) have been successfully combusted in the burner. The crude glycerol does not require pre-treatment or blending with another fuel source. Preliminary emissions characterization has been completed to showcase the system's safety, *i.e.*, acrolein emissions have been shown at the few parts per billion level and other aldehyde emissions similar to that of methane, propane, or kerosene combustion.

Commercialization Plan

DEC is seeking strategic partners to support DEC and NCSU in modifying the current design to commercial-scale, building a pilot plant, integrating it with a boiler, demonstrating long-duration testing using a variety of feedstock, and conducting rigorous emissions characterization. In return, the partner would receive manufacturing rights, access to the technology, and/or licensing rights, among other options. During the planned 12-month activity, the team will design and fabricate an approximately 2 – 3 MW burner at the U.S. Environmental Protection Agency (EPA in Research Triangle Park, NC) and integrate this with an existing packaged boiler that is representative of boilers widely used in industry. The team will demonstrate how the burner could be successfully integrated into such a boiler to allow for crude glycerol as the energy source for the boiler. The design will allow for the boiler to utilize natural gas or fuel oil, crude glycerol, and combinations thereof. Long duration testing will be accomplished to understand practical operations and maintenance challenges with the burner, especially as it relates to fouling of the nozzles. At least ten varieties of crude glycerol will be demonstrated (including some from operational facilities) which showcase a variety of feedstocks, alcohol levels, catalysts, and water content, among other parameters. Both the feedstock and the resulting emissions will be fully characterized using a GC/MS-FID. The EPA will collaborate in measurement of aldehyde emissions and characterization of the ash. Following the pilot plant demonstration, the glycerol burner will be ready for commercial introduction.

Preliminary economic analyses have been completed to characterize the potential value of this crude glycerol burner. Payback periods and return on invested capital appear to be very attractive for such a system. Specific details can be provided by Diversified Energy.