ALTERNATIVE ENERGY SOURCES FOR IRRIGATION POWER UNITS

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Evaluation of Biofuel Driven Irrigation Pumps and/or Electric Generators for Use during Peak Electricity Demand

Project Abstract

The goal of this research is to support the development of a biofuel power unit industry in Nebraska to increase the use of agricultural resources, crops and the resulting biofuels that are produced in the region. Nebraska companies have developed systems to utilize denatured ethanol and other biofuels in industrial power-units. The successful validation and demonstration of these systems will support their adaptation in water pumping and electrical generation plant applications. It also will document exhaust emissions and compare operating costs with traditional engines and fuels. These systems could reduce peak load electrical energy demand resulting from electrical powered irrigation pumping stations, improve emissions compared to petroleum power irrigation pumping stations or peak load electrical generating stations, and may reduce production costs for irrigated farming operations.

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The project team includes University of Nebraska researchers representing the Industrial Agricultural Products Center, the Nebraska Tractor Testing Laboratory, and the Biological Systems Engineering Department. Industrial partners are Amerifuels Energy Solutions of Kearney, NE, CleanFlex Power Systems of Lincoln, NE, Kamterter of Lincoln, NE, and Industrial-Irrigation of Hastings, NE.

Project Goals

The goals of this two year research project (2009 and 2010) are to: support the development and adoption of biofuel-driven stationary power units by: 1) providing third party evaluations, field demonstrations, and educational materials, 2) identifying current constraints and limitations to acceptance, and 3) outlining potential statewide impacts.

Description of Systems

Amerifuels Energy Solutions supplies an 8.1 L GM spark ignition engine equipped with port injectors to electronically inject denatured ethanol in place of traditional fuels such as natural gas or liquid petroleum (LP) gas. In some cases a dual fuel system provides ethanol to supplement natural gas when supplies are limited in the natural gas distribution lines. Further information regarding this system is available directly from the supplier at http://www.amerifuels.com/ or 877-756-1117 (toll free).

CleanFlex Power Systems uses an aftermarket modification for compression ignition (diesel) engines to fumigate hydrated denatured ethanol (60% alcohol by weight) into the air intake after the turbo charger and intercooler, but just before the manifold. The system uses a computer controlled injection spray nozzle and boost pump to replace approximately 20% of the energy normally supplied by diesel fuel with hydrated denatured ethanol. Compression continues to provide the ignition source for the fuels. Further information regarding this system is available directly from the supplier by contacting Ronald Preston at rpreston@vsrfin.com or 402-480-0346.

Kamterter uses an aftermarket modification for compression ignition (diesel) engines to fumigate hydrated denatured ethanol (60% alcohol by weight) into the air intake before the turbo charger and intercooler, but after the air filter. The system uses a very low pressure atomization nozzle and volumetric pump to replace approximately 20% of the energy normally supplied by diesel fuel with hydrated denatured ethanol. Compression continues to provide the ignition source for the fuels. Further information regarding this system is available directly from the supplier by contacting John Eastin at http://www.kamterter.com/ or 402-466-1224.

Key Findings in Year 1

Evaluations compared traditional systems and fuels with the modified systems and fuels. Key comparisons were fuel consumption per hp-hr, energy or Btu consumption per hp-hr, overall thermal efficiency and estimated grams of emissions (CO, CO2, O2, NOx, and total hydrocarbons) per hp-hr.

Key observations regarding the use of denatured ethanol in place of LP gas in the spark ignition engine is that denatured ethanol increases power output, lowers energy (Btu) consumption per hp-hr, dramatically reduces CO and CO2

emissions per hp-hr, and shows potential to reduce HC and NOx emissions per hp-hr as well.

Key observations regarding fumigation of hydrated denatured ethanol with diesel fuel injection in compression ignition engines are that hydrated denatured ethanol fumigation shows potential to reduce NOx emissions while increasing power output per energy consumed. However, as of the time of testing (summer 2009), further development of the systems may improve control of fuel delivery volumes, atomization, and timing.

Key observations regarding the comparison of B5 biodiesel and #2 diesel fuel revealed that both fuels provided essentially the same fuel efficiency and emission profiles when evaluated with the available testing equipment.

A field demonstration was intended to provide some insight to long term operations and durability in the commercial application environment. The spark ignition system from Amerifuels Energy Solutions was selected for field demonstration in July and August 2009. The system was operated at the University of Nebraska Southwest Research Farm near Curtis, NE for 95.4 hours over the period, consuming 970 gallons of denatured ethanol to pump 7,895,000 gallons of water and gave no indication of engine wear beyond typical engine break-in. This system from Amerifuels Energy Solutions also was in commercial use at numerous irrigation pumping plants in south-central Nebraska.

Further Research – Year 2

The second year of this project will allow for:

- further evaluation as the systems continue to develop;
- further field demonstrations;
- opportunities to identify constraints to the adoption of the systems, for example “Who will be regulating what?”;
- opportunities to access statewide impact of adopting the systems, for example “How much ethanol could be consumed and what energy sources would the systems most likely replace?”; and
- further development and dissemination of educational materials and programs.