

Propane Provides Reliable Supplemental Power and Heat for Biodigesters

Helps produce usable renewable energy and decrease waste

Commercial operations that produce or process agricultural products also generate bio-based byproducts. These byproducts are traditionally sent to landfills or waste treatment plants. However, landfills are quickly filling up and the costs of waste disposal and treatment are high. Across the U.S., landfill tipping fees average between \$30 to \$65 per ton, and many large food processing plants routinely pay tens of thousands of dollars per month in sewer, wastewater treatment, and discharge fees.

Anaerobic digesters, or “biodigesters,” offer a solution to the high cost and environmental impact of traditional waste disposal, with the added benefit of producing renewable energy. This process uses bacteria to convert animal wastes, plant material referred to as “green waste,” and food waste to biogas (methane). While to an extent these systems can run on the energy they produce, biogas contains relatively high moisture levels, acidic compounds, and sulfur contaminants that will degrade engine performance and eventually damage internal components.

The University of California at Davis (UCD) and Onsite Power Systems (OPS) designed and built a biodigester that utilizes propane to serve the system's supplemental power and temperature needs. The biodigester converts up to eight tons of food and yard waste per day to both biogas and hydrogen, producing enough energy to power approximately 80 homes while reducing solid waste in landfills and greenhouse gas emissions. It relies on propane as the sole fuel source for starting up and shutting down the system, as well as for backup power. Also, because propane burns at a stable temperature, propane-fueled boilers are used to maintain reliable heat for the system.

Project Description

To further develop its biodigester system, UCD and OPS, with a grant from the Propane Education & Research Council (PERC), conducted the *Propane Assisted Biodigester Demonstration (Docket 12027)*. This project aimed to:

- Build and test the biodigester system located on the UCD campus.
- Demonstrate the conversion of green waste and food waste to both biogas and hydrogen while removing all or nearly all of the waste stream's organic materials.
- Demonstrate the use of propane as the supplemental fuel of choice.

Propane Improves Biodigester Reliability

Supplementing the UCD biodigester with propane provides a number of benefits.

Preventive maintenance. At lower temperatures, methane introduces the potential for system corrosion due to the condensation of hydrogen sulfide and water vapor. Propane mitigates this effect.

Ease-of-use. Propane's portability and ease-of-use in remote locations makes it an easy supplemental fuel source for the use of biodigesters in the agriculture sector.

Stability. Propane burns at a more stable temperature, maintaining the ideal heat needed to break down wastes.



Photo credit: KEM Engines

This CARB-certified propane engine is used in the UCD biodigester.

Testing of the Biodigester at UCD



Propane Equipment at the Project Site

- Laars "Mighty Therm" Volume Water Heater Model PW0325 ("boiler") and heat exchangers (pictured on this page)
- KEM Propane Engine (GM5700) & Generator (45 kW Series Star, 480 Volt, 3 Phase)
- Fuel system, including all parts and materials
- Critical Silence muffler package
- Electronics system governor control with shutdowns
- 500-gallon propane tank with all fittings
- 110 inches x 110 inches x 8 feet expanded metal enclosure

The engine and boiler consumed a total of 3,452 gallons of propane during the project reporting period.

Project Implementation

In October 2006, project managers ran the digester system for six weeks while researchers evaluated its performance. During this initial operational period, researchers made several system modifications, including:

- Installing a different carburetor to allow dual fuel operation.
- Demonstrating the patented self-cleaning auger system to improve liquid circulation flow.
- Testing and bringing hydrolysis tanks online.
- Replacing access covers for hydrolysis tanks with improved versions to provide a more secure seal.
- Testing and calibrating instrumentation and computer control components.

After establishing a baseline performance, the same processes were then conducted using various waste streams of food and suspended solids to develop a database on system operation and efficiencies.

Project Completion: Key Conclusions

As a subsystem to the overall UCD project, propane was amply demonstrated as the mission-critical supplemental digester fuel. Researchers determined that

- Propane improves digester subsystem performance and helps keep the genset's engine cylinders clean.
- The advanced auger system increased liquid circulation flow from about 10 gallons per minute to over 60 gallons per minute, while lowering pump and motor speeds by 25 percent.

The project won the U.S. Environmental Protection Agency (EPA) Region 9 award, which acknowledges individuals and organizations in the Pacific Southwest that have made a significant commitment and effort to protect and improve the environment.

Next Steps

Propane will continue to provide the important start-up, shut-down, and supplemental heating needs of the digester as the project continues over the next three years. Future developments may include:

- A reformer for biohydrogen production and fuel cell power generation.
- A small liquefier for the production of liquid hydrogen (LH2) and/or liquefied natural gas (LNG).
- Using propane as the system startup fuel, particularly for portable and/or temporary digester systems applied to seasonal food growers' processing areas.
- Digesters that use propane and are constructed at remote landfills or composting facilities sited to handle the wet green and food wastes (due to the usual lack of natural gas at the remote sites).

The results of this project should provide a blueprint for replicating the design and construction of hydrogen- and methane-producing biodigesters utilizing green waste and food waste as feedstocks to serve agriculture and municipal customers, and others.

The Laars "Mighty Therm" boiler and heat exchangers provide a heat source for the biodigester's gasification tank, while the four hydrolysis tanks share a separate shell and tube heat exchanger that operate off of genset waste heat.



Photo credit: Laars Heating Systems Company

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