AGRICULTURE

Project Fact Sheet

ANAEROBIC PUMP

A NEW BIOMASS ENERGY CONVERSION TECHNOLOGY YIELDS METHANE FOR POWER GENERATION

Benefits

- Applies to a wide range of wet biomass wastes
- Requires no drying and prethickening facilities
- Has an 11:1 energy output-to-input ratio at 20°C
- Increases the conversion of wet biomass wastes from the typical 20% to 40% to about 90%
- Mitigates groundwater contamination associated with land disposal of wet biomass wastes

Applications

Provides a simple, efficient method of producing methane from water treatment, industrial and agricultural waste streams.

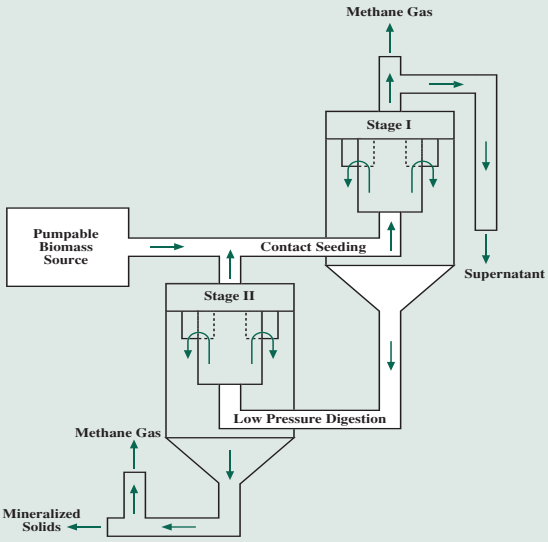
"The Anaerobic Pump could easily save the nation a few million to several tens of million barrels of crude oil per year."

– Howard E. Robb
National Institute of Standards and Technology

Biomass wastes are a potential energy resource; however, most biomass wastes are too wet to burn. Anaerobic bacteria can break down or digest wet biomass wastes and convert them to methane and CO_2. In the conventional anaerobic digestion process, wet biomass and anaerobic bacteria are mixed in a stirred tank with considerable headspace to collect the gases. When gas production drops, the supernatant is decanted, and the undigested solids are pulled off the bottom of the tank and sent to land disposal. This crude process digests 20% to 40% of the solid feed.

The Anaerobic Pump provides efficient two-stage digestion of wet biomass. The process converts about 90% of the solid feed to methane and CO_2. In the first stage the biomass is rapidly seeded with anaerobe populations and becomes buoyant from rapid gas production as easily degradable polymers are digested. The gases produced are continuously removed. The undigested solids overflow the inner reactor, separate from the liquid in outer chambers, and pass to the second stage. The pressure in the second stage is continuously cycled between low and high pressure. The pressure swing enables the simultaneous plasticization and thickening of the digesting mass, which improves the process economics dramatically.

ANAEROBIC PUMP



Project Description

Goal: The goal of the grant from the U.S. Department of Energy's Inventions and Innovation Program was to determine that the Anaerobic Pump is capable of the following: 1) high digestion rate per unit volume of reactor space, 2) true continuous flow with in-reactor solids thickening, 3) exceptional resistance to hydrolysis inhibition, 4) continuous and rapid in-reactor solid/liquid/gas separation, and 5) digestion of 90% of the solids.

Progress and Milestones

A prototype of the Anaerobic Pump was developed under the Inventions and Innovation Program for converting treatment plant sludge to methane gas. Prototypes of the Anaerobic Pump and a single-stage stirred reactor (30 liters) were operated side by side. Both systems were held at 21°C and fed the same substrate at the same loading rates. Using funding from the California Energy Commission, three steady-state experiments were conducted at 20°C with the same two prototypes. Analytical data from both systems were compared and clearly show a far superior performance for the Anaerobic Pump. The Anaerobic Pump nearly tripled the methane gas production per unit of mass fed to the process. Further pilot-scale testing is needed.

Economics and Commercial Potential

The Anaerobic Pump has an 11:1 output-to-input energy ratio at 20°C. At room temperature, input energy is 900 Btu per lb of biomass input. A biomass-input unit operating at 15 tons per day would produce 69.2 million standard cubic feet per year of methane. All process equipment and parts can be constructed from off-the-shelf technologies. The installed cost for the Anaerobic Pump combined heat and power plant (the complete system includes generator set, heating boiler, etc.) is between $1/gallon and $3/gallon depending on operating temperature and detention time.

The United States produces 1 billion tons of methane-convertible wet biomass each year. Using the Anaerobic Pump, this biomass could yield about 8 trillion cubic feet of methane, which is worth about $20 billion on today's market. Assuming all this methane is converted to electricity, about 20 GW of new capacity could be brought on-line. Nationally, the 2 million farmers who produce animal and crop residuals represent about 48% of nonforestry biomass waste. The unit capital cost of the Anaerobic Pump built for power production is about $26/MWh or less than 50% of the cost of a comparable gasification unit ($60/MHw).

The Inventions and Innovation Program works with inventors of energy-related technologies to establish technical performance and to conduct early development. Ideas that have significant energy-savings impact and market potential are chosen for financial assistance through a competitive solicitation process. Technical guidance and commercialization support are also extended to successful applicants.

For project information, contact:

Keith A. Schimel
Technology Matrix Corporation
P.O. Box 11236
330 Apple Street
Syracuse, NY 13204
Phone: (315) 425-7741
Cengr@baldcom.net

For more information about the Inventions and Innovation Program, contact:

Lisa Barnett
Program Manager
Inventions and Innovation Program
Phone: (202) 586-2212
Fax: (202) 586-7114
lisa.barnett@ee.doe.gov

Visit our home page at
www.oit.doe.gov

Office of Weatherization and Intergovernmental Program
Energy Efficiency and Renewable Energy
U.S. Department of Energy
1000 Independence Avenue SW
Washington, D.C. 20585-0121

Order #I-AG-707
October 2002