PROJECT PROFILE

Clover Hill Dairy

480 kW CHP System

Project Overview

Clover Hill Dairy, located in Campbellsport, Wisconsin, is a family owned dairy farm of 2,000 crossbred cattle. In January 2007, the farm began operation of a mesophilic mixed plug flow anaerobic digester to assist in the treatment of animal waste in which the recovered biogas is utilized to fuel a 300 kW combined heat and power (CHP) system. Due to the success of the initial CHP system and expansion of the dairy farm from 1,250 to 2,000 cattle, the farm doubled the size of its digester vessel and expanded its CHP system with a 180 kW engine at a cost of $800,000 in 2011.

The excess electricity is sold to the local electric utility, and the waste heat recovered from the jacket water and exhaust of the engines is used to heat the farm's digester, milk house, parlor and lanes. In 2014, the farm generated 2,577,828 kilowatt-hours of electricity, but both engines had down periods for rebuilds/maintenance. It is expected the engines will generate considerably more in 2015.

Quick Facts

LOCATION: Campbellsport, Wisconsin
MARKET SECTOR: Dairy Farmer
FACILITY SIZE: 2,000 Crossbreed Dairy Cattle
DIGESTER TECHNOLOGY: Mesophilic Mixed Plug-Flow
FUEL TYPE: Anaerobic Digester Biogas
EQUIPMENT: (1) 300 kW (upgraded) Guascor MGG-355 Reciprocating Engine Generator
(1) 180 kW Mann Reciprocating Engine Generator
ELECTRIC GENERATING CAPACITY: 480 kW
THERMAL GENERATING CAPACITY: ~2.2 MMBtu/hr hot water heat recovery
INSTALLED COST: $2.0 Million
BEGAN OPERATION: 2007
EXPANDED OPERATION: 2011

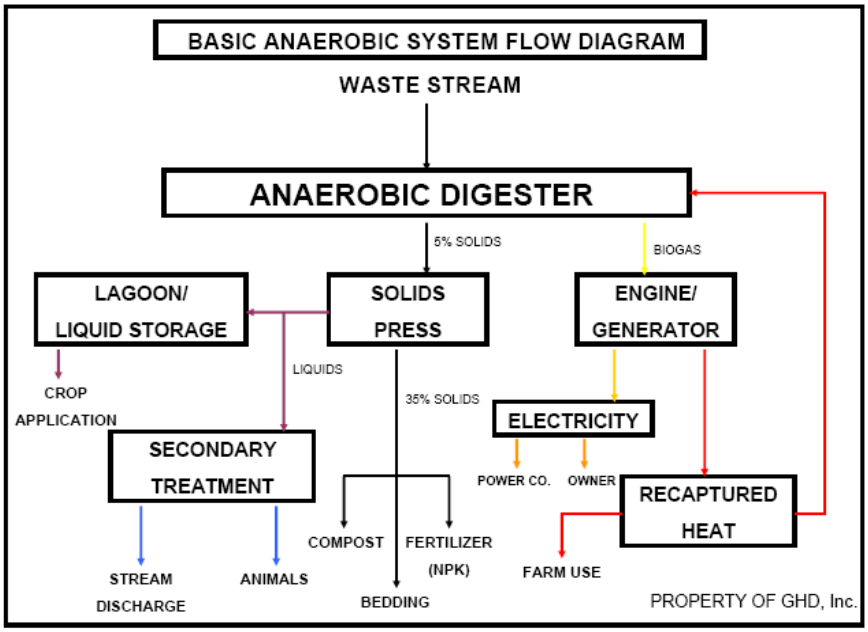
An Alternative Method for Handling Manure

Large-scale farming operations dispose of their manure in a manner that meets state and local regulations and if feasible is environmentally and odor friendly to the surrounding community. Prior to the anaerobic digester/combined heat and power project at Clover Hill Dairy, the manure was stored in open lagoons and slurrystore, a large structure filled with manure that was stored until the time of removal. Handling manure this way released large amounts of methane, a harmful greenhouse gas, when decomposed. Reviewing the various manure disposing options, it was decided to install a mixed plug flow anaerobic digester and biogas recovery system to control their manure management issues and create an additional revenue source through a renewable waste-to-energy project. Since the installation, Clover Hill Dairy has been pleased with the operation and benefits of the system. In addition, a significant reduction in odor has been realized.

300 kW Guascor MGG-355 Reciprocating Engine
Source: Energy Center of Wisconsin

The mixed plug flow digester, a U-shaped digester takes unprocessed cow manure from a receiving pit to process the manure and generate biogas for the CHP system. The digester is a two-phase system as it includes two distinct digestion zones. The first zone is the acid formation zone where volatile fatty acids are produced by bacteria. The manure then flows into the second zone where bacteria convert the fatty acids to methane and carbon dioxide. The center wall of the U-shaped digester contains hot-water piping (hot water from the CHP heat recovery) that maintains the required operating temperature of the

treated waste in the digester. The waste is treated in the digester for a hydraulic retention time of approximately 20 days.



Anaerobic Digester System Flow Diagram

Source: www.ghdinc.net

From Digestion to Clean, Renewable Power

From the digestion process, an anaerobic digester biogas is produced. The biogas at Clover Hill Dairy is collected and treated with a passive hydrogen sulfide (H_2S) removal system and a chilling unit to remove H_2S and condensate. The treated biogas then fuels the CHP system, producing electricity and useful heat. Clover Hill Dairy sells the generated electricity to the local utility, We Energies, under a power purchase agreement. By providing We Energies with electricity generated from a clean, renewable resource, Clover Hill Dairy displaces the fossil fuel used to generate electricity by the utility power plants, thereby displacing greenhouse gas emissions.

The recovered heat, in the form of hot water, is collected from both the engine jacket liquid cooling system, and from the engine air exhaust system. Approximately 30-60% of this recovered heat is utilized in the digester system to maintain the required temperature. The remaining available recovered heat is used by Clover Hill Dairy to supplement the farm's hot water production and for in-floor heating of the farm's milk house, parlor, and lanes. The staff is also investigating other opportunities to utilize the recovered heat.

The digester effluent exiting the digester is pumped from the effluent pit of the digester vessel to a manure solids separator. The mechanical manure separator separates the digested waste stream into solid and liquid parts. The liquid, now with most of the large solids removed, flows into the farm's storage lagoon. Unlike the raw manure influent, the viscosity of the liquid effluent is such that it can be pumped through an irrigation nozzle for field spreading. The nutrients are taken from an organic-state to an inorganic state, making the liquid "plant-accessible." Thus the liquid coming from the digester can be applied to growing crop without burning the leaves.

The separated solids, having the same odor and pathogen reduction characteristics as the liquid stream, are utilized by the farm for cattle bedding. Approximately 65 tons of the separated solids are used for this purpose. Another 35 tons of the separated solids are used for field fertilizer application and 30-35 tons are sold to other area dairy farms.

Digester Selection Process

The type of digester selected for a dairy farm application is dependent on the total solids content of the manure and the manure collection system. Three digester types are recommended for dairy farms per U.S. Environmental Protection Agency's (EPA) AgSTAR: Covered Lagoon, Complete Mix, and Plug Flow. Clover Hill Dairy uses a two-stage mixed plug-flow digester. The total solids content at Clover Hill Dairy is 6%.

For More Information

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