MIDWEST CHP APPLICATION CENTER

In Partnership with the US DOE

combined heat & power in wastewater treatment plants

Janesville Wastewater Treatment Facility

400 kW CHP Application

Project Profile

Quick Facts

Location:
Janesville, Wisconsin

Facility Type:
Wastewater Treatment

Plant Capacity:
17.8 million gallons per day

Prime Mover Fuel Type:
Digester Gas or Natural Gas

Prime Mover Type:
Waukesha Dual-Fuel Engine (#F2895G)

Electric Generating Capacity:
2x200 kW

Heat Recovered from the Engine:
1.0 - 1.2 MM Btu/h

Implementation Cost:
$910,000

Estimated Annual Energy Savings:
$150,000 per year

Simple Payback Period:
~6 years

Began Operation:
July 2002

Anaerobic Digesters:
3 digesters w/ total capacity of 2.5 MM gal.

Project Overview

The Janesville Wastewater Treatment Facility (WWTF), established since 1970, operated its first CHP system in 1985. It consisted of two 150 kW reciprocating engines (with heat recovery only from the jacket water) operating on untreated biogas produced by the facility's three anaerobic digesters operating at about 98°F. In 2002, the aging CHP system was replaced with a more efficient and larger capacity system.

The new CHP system incorporates two Waukesha reciprocating engines (200 kW each) that are naturally aspirated and are fueled by the biogas which is produced at the facility and treated to reduce its H_2S content to about 10 ppmv. Although the engines run primarily on biogas, they are started up and shutdown using natural gas for the purpose of warm up and purging out H_2S, respectively. Heat is recovered from the engine jacket water and exhaust gases to heat one 645,000 gallon digester to about 130°F (the higher digester temperature increases biogas production) and to preheat the biogas supplied to the engines (the higher biogas temperature increases engine efficiency).

In 2008, the average daily biogas production was approximately 102,000 SCF (71 scfm). The CHP system, fueled by the biogas and operating 24/7, generated 719,600 kWh of electricity, approximately 12% of the annual electric energy consumed at the facility.

Janesville Wastewater Treatment Facility

The primary reason for installing the CHP system was to reduce the annual energy costs. It is estimated to provide annual energy cost savings of $150,000 by reducing the cost of purchased electricity and natural gas.

The project's success was made possible due to the excellent coordination and cooperation of all the project partners: City of Janesville, Earth Tech, Waukesha Engine, Focus on Energy, and Alliant Energy.

Reasons for CHP – A WWTF Owner's Perspective:

- Reduces annual energy costs by utilizing the digester gas, instead of flaring it
- Provides an attractive payback period
- Improves public relations because of reduced environmental emissions and use of renewable energy (biogas) source

Waukesha Engine

Anaerobic Digesters

All wastewater treatment/reclamation plants produce organic sludge that requires treatment prior to its disposal. The treatment can be aerobic (in the presence of oxygen) or anaerobic (in the absence of oxygen). The anaerobic process presents an opportunity for biogas production.

The anaerobic digestion process breaks down the organic waste contained in the sludge in a controlled, oxygen free environment. The process produces two useful products: a sludge that is ready for land application and a biogas that contains up to 66% methane. Biogas is the most valuable product of anaerobic digestion. It is a fuel that can be:

- utilized in boilers for building / process heating
- utilized in prime mover equipment (reciprocating engine, combustion turbine, microturbine, etc.) for distributed generation (including CHP)
- cleaned up to utility-grade gas and injected into the natural gas pipeline

The process also produces a wastewater stream that is rich in nitrogen content, has high biological and chemical oxygen demands, and generally requires further treatment prior to disposal. At the Janesville WWTF, this water is aerobically treated prior to its disposal from the plant.

Anaerobic digestion can be operated at one of two temperatures: 98°F (mesophilic) or 130°F (thermophilic). The thermophilic operation has a shorter residence time, increased biogas production, and provides better pathogen and virus destruction than the mesophilic digestion process due to the higher operating temperature. On the contrary, the mesophilic process has a lower installed cost, requires less energy input and a lower degree of operations and monitoring. Therefore, the selection of the process requires careful evaluation for each site. Today, the Janesville WWTF operates two digesters at mesophilic condition (heated by natural gas-fired boilers) and one digester operated at thermophilic conditions using the heat recovered from the engines. The third digester was converted over to the thermophilic process when the new CHP system was installed in 2002 to optimize biogas production and generating capacity.

Gas Cleanup

The Janesville WWTF uses iron sponge scrubbers, a well proven commercial technology, for reducing the hydrogen sulfide (H_2S) content of the biogas from the anaerobic digesters. Iron sponge consists of hydrated iron oxide impregnated onto redwood chips. Removal of H_2S from the biogas reduces the corrosion of engine and boiler components. It also reduces the emissions of SO_X in the combustion exhaust gases. At the Janesville WWTF, this gas cleaning approach reduces the H_2S content of the biogas from 175 ppmv to 10 ppmv.

Lessons Learned

- Design sufficient capacity into the heat recovery heat exchangers to prevent rejecting excess heat to radiators.
- Design buildings with adequate space for maintenance activities.

Awards

The Janesville WWFT has been recognized with three awards for the operational excellence of the facility (including the CHP project):

- 2007 Radebaugh Award of the State Water Env. Association
- 2006 Innovation Award of the American Public Works
- 2005 George Schroepfer Medal of the Water Env. Federation

For further information contact:

Midwest CHP Application Center
851 S. Morgan Street
Chicago, IL 60607-7054

Phone: (312) 996-4382
Fax: (312) 996-5620
www.CHPCenterMW.org

"The CHP system has proved to be very rewarding for the city of Janesville, Wisconsin. It saves us about $150,000 in electricity and natural gas costs. We are so much encouraged by the success of the CHP system that we plan to move forward with more such projects in the future. "

Dennis Egge
Superintendent
City of Janesville
Wastewater Superintendent