PROJECT PROFILE

Janesville Wastewater Treatment Plant

460 kW CHP System

Project Overview

The Janesville Wastewater Treatment Plant (WWTP), established in 1970, began operation of its first CHP system in 1985 and is currently on its third iteration of the system. The system initially consisted of two 150 kW reciprocating engines, with heat recovery only from the jacket water, operating on untreated biogas. In 2002, the 300 kW CHP system was replaced with a new, more efficient 400 kW CHP system that incorporated two reciprocating engines (200 kW each) fueled by biogas. In this system, heat was recovered from the engine jacket as well as from the exhaust gases. The heat recovered from the engines was used in two ways: to preheat the sludge prior to being fed to the digesters and to maintain the desired 98^{o}F in two mesophilic digesters and 130^{o}F in one thermophilic digester.

In 2011, all the engines were replaced with four 65 kW Capstone microturbines for a total CHP capacity of 260 kW and in 2012 a 200 kW Capstone microturbine CHP system was added, increasing the total CHP capacity to 460 kW. All microturbines are fueled with biogas from anaerobic digesters after it has been treated to reduce its moisture, H_2S and siloxanes content. The biogas fed to the microturbines is about 25 ppmv of H_2S. Heat is recovered from the microturbine exhaust gases for heating the anaerobic digesters.

Quick Facts

LOCATION: Janesville, Wisconsin
MARKET SECTOR: Wastewater Treatment
PLANT CAPACITY: 19.8 million gallons per day
NUMBER OF ANAEROBIC DIGESTERS: 3
BIOGAS PRODUCTION CAPACITY: 107 SCFM
BIOGAS CONDITIONING CAPACITY: 140 SCFM
PRIME MOVER: Microturbines
PRIME MOVER FUEL: Biogas
CHP GENERATION CAPACITY: 460 kW
HEAT RECOVERY RATE: 8 MMBtu/hr
USE OF RECOVERED HEAT: Heating digesters
CHP SYSTEM COST: $1,200,000
ANNUAL CHP O&M: $15,000
BIOGAS CONDITIONING COST: $500,000
ANNUAL CONDITIONING O&M: $11,000
NET ANNUAL SAVINGS: $193,700
BEGAN OPERATIONS: 2011 (260 kW)
2012 (460 kW)

The project's success was made possible due to the excellent coordination and cooperation of all the project partners: City of Janesville, Unison Solutions, Capstone, Focus on Energy, and Alliant Energy.

Reasons for CHP

The primary reason for installing the CHP system was to reduce the annual energy costs. In 2014 it generated energy cost savings and gross revenues of around $205,000 by reducing the cost of purchased natural gas and producing revenues by selling electricity to Alliant Energy. It is more attractive to sell all the electricity produced to Alliant Energy than to use it on site.

An Aerial View of the Janesville Wastewater Treatment Plant

Biogas Conditioning Skid

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 anaerobic process produces two useful products: a sludge that is ready for land application and a biogas that contains about 60% methane. Biogas is the most valuable product of anaerobic digestion. It is a fuel that can be:

- utilized in boilers for building or process heating
- utilized in CHP prime mover equipment (reciprocating engine, combustion turbine or microturbine) for electric power generation
- cleaned up to produce a fuel that is equivalent to utility-grade natural gas that can be compressed and used in compressed natural gas (CNG) vehicles or 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 WWTP, this water is aerobically treated prior to its disposal from the plant.

"The CHP system has proved to be very rewarding for the city of Janesville. It saves us about $190,000 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,
City of Janesville Wastewater Superintendent

Anaerobic digestion can be operated at one of the two temperatures: 98^{o} F (mesophilic) or 130^{o}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. The mesophilic process has a lower installed cost, requires less energy input and a lower degree of operations and monitoring. The selection of the process requires careful evaluation for each site. The Janesville WWTP operates all three digesters at mesophilic conditions.

Biogas Cleanup/Conditioning

A new biogas cleanup system by Unison Solutions at the Janesville WWTP was installed in 2010. Its processing capacity is 140 SCF/minute and is designed to remove moisture, hydrogen sulfide (H_2S), particulates and siloxanes. It uses iron sponge scrubbers, a well proven commercial technology, for reducing the H_2S content of the biogas from the anaerobic digesters. Iron sponge consists of hydrated iron oxide impregnated into 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 of exhaust gases. The system reduces the H_2S content of the biogas from 175 ppmv to 10 ppmv.

For More Information

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