PROJECT PROFILE

MIDWEST

U.S. DOE

CHP Technical Assistance Partnerships

Rochester Wastewater Reclamation Plant

2,000 kW CHP System

Project Overview

The Rochester Wastewater Reclamation Plant has been successfully operating a CHP system since 1982. In a two-phase project initiated in 2002 and completed in 2008, the original 800 kW CHP plant (two 400 kW reciprocating engines) was upgraded to a 2,000 kW CHP plant that consists of two 1,000 kW Waukesha engines. These engines are turbo-charged, lean-burn, 20% more efficient than the older engines and have dual-fuel capability for operating on either digester gas (biogas) or natural gas. The wastewater reclamation plant can process up to 23.8 million gallons per day (MGD) and uses two anaerobic digesters to treat the sludge.

In 2014, the two continuous-mix digesters produced approximately 409,800 cu ft/day of biogas containing 66% methane. Over the years the facility has increased production of biogas by feeding more waste fats, oils and greases to the digesters. The biogas produced is sufficient for producing 550 to 750 kW of electric power (depending on the time of the year) from the CHP system. At this capacity up to 9 MMBtu/hr of heat is recovered from the engine jacket and exhaust gases in the form of hot water (180^{O}F-190^{O}F) that is utilized for keeping the anaerobic digesters at optimum operating temperature and for providing space heating in the buildings at the facility. In 2014 the CHP system saved $505,700 in energy cost for the City of Rochester: nearly $348,000, in electric energy and $157,700 in natural gas costs. The cost for maintaining the CHP system was about $169,700. The full generation capacity of 2,000 KW is utilized when backup power is needed for operating critical units, during utility grid power outages, by using natural gas or the biogas produced plus that stored in a 50-ft diameter biogas storage tank.

Quick Facts

LOCATION: Rochester, Minnesota
MARKET SECTOR: Wastewater Treatment
PLANT CAPACITY: 23.8 million gallons per day
NUMBER OF ANAEROBIC DIGESTERS: 2
BIOGAS PRODUCTION CAPACITY: 284 scfm
PRIME MOVER: Reciprocating engines
PRIME MOVER FUEL: Biogas or natural gas
CHP GENERATION CAPACITY: 2,000 kW
HEAT RECOVERY RATE: Up to 9 MMBtu/h
USE OF RECOVERED HEAT: Heating digesters and space heating of buildings
CHP SYSTEM COST: $4 million
ANNUAL NET SAVINGS IN 2014: $336,000
BEGAN OPERATION: 2008

Reasons for CHP

The primary reason for installing the CHP system was to reduce the annual energy costs. It saves energy costs by reducing the cost of purchased electricity and natural gas, and provides a reasonable payback period for the investment.

The CHP system also serves as a source of emergency backup electric power. It even helps improve public relations because it uses of renewable energy (biogas) source for electric power generation and reduces emissions compared to flaring the biogas.

Arial View of the Rochester Wastewater Treatment Plant

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 digestion process breaks down the organic waste contained in the sludge in a controlled, oxygen free environment. The process produces several outputs, a sludge that is ready for land application, a liquid high in nutrient content (mainly Nitrogen) that must be further treated, and a biogas that contains approximately 66% methane.

The biogas is a valuable fuel that can be utilized (after some clean up) to displace natural gas in boilers for heating, in engines for distributed generation (including CHP), flared (not recommended with the high cost of energy), or cleaned up to utility grade gas and used for fueling compressed natural gas vehicles or injected into the natural gas pipelines (an expensive option). At the Rochester facility, the biogas is utilized in the CHP system to produce electricity and heat, and when whether conditions dictate (very cold winter months) the biogas is utilized in boilers for space heating.

One of the Two 1,000 kW Waukesha Engines

- During fall and early winter, the cost savings are higher because more biogas is produced and used due to higher digester loadings resulting from crops being harvested during that season
- During cold weather the biogas utilization is higher (less is wasted) because more biogas is used for meeting the increased space heating load for the buildings
- There is no biogas conditioning system and the H2S content of the biogas feed to the engines is <74 ppmv, which is within the specifications for the engine.
- The project has been successful because of the good cooperation between the city personnel and design professionals from Integrated Technology Engineering and Black & Veatch

Operating Features

- Heat is recovered from the engine-jacket water (up to 2.5 MMBtu/hr per engine) as well as the engine exhaust gases (up to 2 MMBtu/hr per engine)
- One 50 ft.-diameter spherical gas storage tank (208,000 cu ft) is used for storing compressed biogas at high pressure (46 psig). During electric utility outages, the CHP system can be operated on either natural gas or the biogas stored in the sphere plus the biogas produced by the digesters.
- A helpful feature of the CHP system at the plant is that its controls are integrated with the plant SCADA system for monitoring and control.

"We are very pleased with the operation of the CHP system. It allows the city to utilize the renewable biogas produced at the plant for energy cost savings while also providing a source of emergency power. The system is also environmentally friendly because it eliminates flaring of the digester gas to the atmosphere."

- Chet Welle,
Assistant Plant Manager

For More Information

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