Energy Resources Center

Technical Education and Analysis for Community Hauling and Anaerobic Digesters

TEACH AD

Project Profile

Des Moines Metropolitan Wastewater Reclamation Authority, Iowa

Background:

The goal of the Des Moines Metropolitan Wastewater Reclamation Authority (WRA) is to protect public health and the environment by removing pollutants from wastewater and recycling clean water and bio-solids back into the environment. The WRA serves 18 member communities in the metro Des Moines, Iowa area encompassing approximately 500,000 residents, including over 2,500 commercial and industrial customers. Its wastewater reclamation facility (WRF) operates a sewer system with over 125 miles of sanitary sewer lines and processes an average daily flow of 65 MGD with a maximum flow capacity of 200 MGD. The fully treated water is discharged into the Des Moines River and the bio-solids are land applied as a soil amendment fertilizer.

HIGHLIGHTS

LOCATION: Des Moines, Iowa

SECTOR: Wastewater

DIGESTER Complex: Five primary and one secondary. Mesophilic digesters operating between 98° and 100° F.

FEEDSTOCK: Co-digesting up to 40% high strength wastes with municipal solids (sludge).

BIOGAS YIELD: Approximately 1.6 million ft^3/day

Renewable Natural Gas Production Process:
Pressure Swing Adsorption (Unit Specs):
- Max Biogas Input: 3.2 million ft^3/day
- Max RNG Output: 1.9 million ft^3/day (approx.. 60% efficiency)

RNG Yield: Approximately 976,200 ft^3/day

Approximate Revenue Streams:
Tipping Fees: $3,000,000 per year
RNG Sales: $6,000,000 per year (10 year contract)

Anaerobic Digester Upgrades:

In 2009, the WRA embarked on a five year project to upgrade their anaerobic digester complex. The WRA operates a total of six digesters, five primary digesters each with a capacity of over 3 million gallons of waste, and a secondary digester that can hold a maximum of 2.6 million gallons. The five primary digesters were each refitted with a fixed concrete cover and five mixers to keep the content well mixed, optimizing the biogas production. The mesophilic digesters are kept at an operating temperature between 98° and 100° F. The secondary digester has a gas storage dome capable of storing up to 400,000 ft^3 of biogas.

Digester Complex Des Moines WRF
Source: Des Moines Wastewater Reclamation Authority

The project also included the installation of an organic waste receiving station to support local industries and neighboring communities by accepting and processing their organic wastes. The facility includes a 140,000 gallon tank used to equalize the 60 to 70 truck-loads per day of approved high strength wastes which are then blended with the municipal solids or sludge from the wastewater process and fed into the digesters. The receiving station is accessible to authorized waste haulers 24/7 and operates a computerized scale system for easy and efficient disposal transactions. By 2015, the WRF was producing over 1.6 million ft^3 of biogas per day and had upgraded their CHP capacity to 4.6 MW of utility grade power.

Approved **Co-Digestion Waste Sources**

- **Restaurant Grease Trap /Interceptor Waste**
- **Dairy Waste**
- **Biodiesel Waste**
- **Slaughterhouse /Meat Processing Waste**
- **Lutein / Protein Waste**
- **Waste Soy Oil**
- **Sewage Sludge**
- **Sugar Waste**
- **Rendering / Gelatin Waste**
- **Corn Syrup / Mash**

Source: 12/8/21 Presentation WRA – Hutchens

Renewable Gas Production:

Although the high level of gas production resulted in the facility flaring the excess biogas, the high level production capability presented an exciting economic opportunity for the WRA: convert the biogas to renewable natural gas (RNG) bio-methane and sell it for injection into the natural gas pipelines.

After a comprehensive economic analysis, a review of EPA's Renewable Fuel Standards for advanced biofuel credits, and a detailed study of the biogas conditioning technology necessary to produce RNG, the WRA decided to invest in a five year, $20 M program to upgrade the byproduct of wastewater treatment (biogas) to RNG for pipeline injection. The project objectives included maximizing the production of RNG, maximizing the return on investment and renewable energy revenues, and beneficially utilizing their existing infrastructure. The technology selected to convert biogas into pipeline quality RNG was Pressure Swing Adsorption (PSA).

PSA is a physical separation process in which the biogas is passed thru several large vessels containing adsorption media at high gas pressure. The gases to be removed are selectively adsorbed onto the media. To regenerate the media, the gases are then removed by "swinging" the media to low pressure. The specific type of PSA system installed at the WRF uses an adsorption media known as Molecular Gate Adsorbents, which are designed to effectively adsorb gases with smaller molecules, such as CO_2 and N_2, while allowing larger molecular gases such as Methane (CH_4) to pass through. The system also includes a thermal oxidizer, (a large furnace) that burns off any residual gases left after the process. The result of the PSA process is a RNG (bio-methane) that meets or exceeds all pipeline quality specifications as shown in Table 1. WRA completed the installation of the PSA system and started producing RNG in 2020.

Component	Biogas	Pipeline Spec	System Operation (May 2020)
BTU Content	660 BTU/scf	>970 BTU/scf	>990 BTU/scf
CO2	35%	<3% by vol.	0.2% by vol.
N2	0.7%	<4% by vol.	0.03% by vol.
N2 + CO2	36%	<5% by vol.	0.25% by vol.
O2	<0.2%	<0.3% by vol.	<15 ppm
Water	Saturated	<5 lb/mmscf	ND
H2S	50 – 600 ppm	<0.25 grain/Ccf	0 ppm
Total Sulfur	N/A	< 20 grain/Ccf	ND

Table 1: PSA System Performance vs Pipeline Design
Source: Dec. 8th Presentation WRA – Hutchens (WRA Director

Overall Project Outcome:

Today, the WRF is operating its digesters with 40% high strength waste co-digestion, producing, on average, 1.627 Million ft^3/day of biogas. The PSA system is converting the biogas into (on average) 976,200 ft^3/day of RNG. The PSA system is housed in the facility that previously contained the original three 600 kW CHP engine/generator sets. The additional engine/generator CHP units are now utilized as emergency/backup generators. The WRA purchases all its electricity from the local utility, utilizes natural gas purchased from the local utility to keep its digesters at the proper operating temperatures, and converts up to 100% of its biogas production to RNG, selling the RNG into the natural gas pipeline.

In 2021, the WRA negotiated a ten year fixed price contract to sell all the RNG it can produce. On an annual basis, the WRA generates approximately $6 M in gross revenues from the sale of RNG, and an additional $3 M annually in tipping fees from accepting high strength waste from regional businesses. After all expenses relating to the expansion into RNG production (added electricity and natural gas costs and O&M costs related to the PSA system), the WRA anticipates a less than 5 year payback on its $20 M investment.

"Our facility is the largest wastewater treatment plant in the state of Iowa and one of the first to implement a project of this kind. We are also the first to inject renewable natural gas (bio-methane) into the natural gas pipeline. It's been a long time coming, but the collective hard work of many individuals has allowed this to be a very special and historical moment for both our Authority and our customers."
Scott Hutchens
Des Moines WRA Director

Lessons Learned:

- Convincing the twenty two member WRA Board that a $20 M investment would payback in less than 5 years was more difficult than expected. How to deal with EPA Renewable Fuel Standards, carbon credits, and dealing with annual carbon intensity scores were all unfamiliar areas for a wastewater reclamation authority. Providing the expertise to efficiently and thoroughly address these issues is imperative.
- Likewise, negotiating with the natural gas company on required pipeline gas specifications as well as the terms/conditions of a long term contract (including the sale price and the handling of the environmental offsets for example) required legal expertise that is not necessarily readily available in a wastewater reclamation authority. Securing adequate representation to negotiate with a utility legal staff that deals in these issues regularly was a challenge.
- Startup issues with the PSA system, like any other high tech installation, must be expected. Proper training of staff, planning for the commissioning of the system with adequate support during the transfer and startup is essential.

For More Information

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