

Case Study: Redhook Brewery Portsmouth, NH

Anaerobic Digestion and Biogas Reuse Presented by: Alex Ramsey, Tietjen Hynes, Operations Project Engineer



Redhook Brewery

Redhook was founded in Seattle, WA in 1981.

Redhook expanded from a former transmission shop to an old trolley barn, then in 1994 to a custom built 220,000 barrel brewery in the Seattle suburbs.



In 1996, Redhook expanded to the East Coast with a new brewery built with the same plans in Portsmouth NH.



Craft Brew Alliance

In 2008, Redhook merged with rival Widmer Brothers Brewing from Portland, OR to become the Craft Brew Alliance (CBA).











CBA added Kona Brewing Company to the family in 2012, followed by the launch of Omission and Square Mile Cider, and partnerships with Appalachian Mountain Brewing, Cisco Brewing, and Wynwood Brewing followed.











Original Design Parameters (1996)

- Average of 72,000 gpd of wastewater.
- COD concentrations average around **8,000 mg/L**, although they can reach double that.
- Incoming solids average 1,300 mg/L after screening.
- Additionally, the wastewater pH fluctuates significantly from the cleaning chemicals in use throughout the facility.
- The temperature of the wastewater can also be variable, although generally within the requirements of conventional wastewater treatment.
- Wastewater is only generated 4 days per week



Wastewater Treatment Plant

As Originally Constructed, 1996



800-847-5303 Influent Screen

1996 Installation



Preassembled anaerobic reactor.

Veolia's Biothane anaerobic technologies

Anaerobic Granular Systems



Biobed[®] Advanced EGSB

High rate anaerobic treatment system is not designed for TSS removal

REDHOOK Weekly Average TSS



Redhook Weekly Average TCOD



Redhook Weekly Average TCOD





Date

Loading in 2004-2006 was greater than original design basis of anaerobic system. The key design parameter for an anaerobic system is Volumetric Loading Rate.



REDHOOK Daily Volumetric Loading Rate

Wastewater Treatment Plant - As Upgraded 2007



start up

2007 Upgrade Installation



Mechanical Process Control

- Parameters directly in our control:
 - pH- addition of NaOH or H₂SO₄
 - Flow rate to reactors
 - Temperature
- Parameters outside our control:
 - Influent concentration
 - Flow rate to treatment plant
 - Incoming solids loading
 - Chemical dumping



Process Control

Other Control Strategies

- Improved testing
- Improved notification
- Behavioral controls in brewery
- Communication







Behavioral Process Controls

- Recipe changes, partner brews, and increased efforts to conserve beer and water all increase our solids ratio.
- Make sure wastewater is involved in all high level conversations.
- Attempt to harvest solids before they go down the drain using solids totes, diaphragm pumps, and increased labor

Treatment Plant Performance



- System is excellent at removing soluble COD (SCOD) – average 92% removal. BOD removal average 89%.
- Total COD (TCOD) reduction is lower due to TSS in effluent – average 81% removal
- System is still not designed to remove solids – average TSS removal 27%.



Evolution of flow and loading to plant



Methane Generation



140,000 CFM of biogas produced each week, on average.

Biogas production extremely dependent on organic loading, brewery production schedule.

90 kW generator selected with IC engine for optimal turn-down.

Resource Recovery





Cogeneration System

Biogas analysis indicated up to 320 ppm of H₂S in the gas stream.

Redhook biogas ranged from 68-78% methane, depending on the feedstock quality.

Redhook selected a 90 kW generator with sulfur removal (activated carbon) for biogas reuse.



Cogeneration System

Liebherr 4-cylinder derated natural gas engine

Leroy-Somer 90 kW generator set.

Dual fuel system powered by either biogas or natural gas.

Blower to bring low pressure gas up from 26mBar to 50 for combustion.

Packaged system with controls provided by Tech3



Heat Recovery









Permit Challenges

- City of Portsmouth: (2 weeks)
 - Foundation
 - Plumbing
 - Electrical
 - Fire
- State: (2 months)
 - NHDES required amended Air Resources permit because system is part of the Pollution Control system.
 - Compliance with TierIII emissions is mandated despite output <100 kW
- Other: (10 months) Eversource, the electrical utility, required full Interconnection Study and permitting. Because they did not have any precertified Utility Protective Relays available for synchronous generators, had to have Basler Relay studied.



Operating Challenges



Early problems with:

- Automatic generator controls
 - Start/stop control based on tight biogas pressure range
 - Analog control of generator run rate based on fuel availability.
 - Fault reset for generator shutdown.
- Warranty repair issues
 - Oil pressure
 - Jacket water pressure
 - Turbocharger
- Conflict between TSS reduction program and biogas generation.

Questions?

