USFS Wood Innovation Grant: Biochar vs. GAC

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SOCWA
CWEA & CASA INNOVATIVE BIOSOLIDS SEMINAR
SEPTEMBER 17, 2019
LOS ANGELES, CA
Agenda

• Project Introduction
• Regulatory Drivers
• Media Types
• Media Performance
• Next Steps
Project Introduction

1. COMPLIANCE WITH REGULATIONS
2. CREATE A LOCAL SOURCE OF ENERGY
Gas Cleaning System

TWO ACTIVATED CARBON IN SERIES, CHILLER, MOISTURE REMOVAL, TWO ACTIVATED CARBON IN SERIES, PARTICULATE FILTER
Project Introduction

COGEN

INTERNAL COMBUSTION ENGINE, GE JENBACHER FUELED BY:
DIGESTER GAS WITH NATURAL GAS AS STANDBY
12 CYLINDERS, 4 CYCLES, LEAN BURN,
TURBOCHARGED, AND AFTERCOOLED
881 BHP

SCR

STEULER UNIT
12 HONEYCOMB VANADIUM CERAMIC CATALYST WITH A VOLUME OF 18.0 CU FT
OXIDATION CATALYST
4 MODULES OF PALLADIUM METALLIC CATALYST WITH A TOTAL VOLUME OF 2.0 CU FT
JB Latham Treatment Plant

SDG&E Meter # 06581600
Typical Monthly Usage: 5,000 kWh

SDG&E Meter # 06580210
Typical Monthly Usage: 9,000 kWh

SDG&E Meter # 06445430
Typical Monthly Usage: 50 kWh

SDG&E Meter # 06283991
Typical Monthly Usage: 60 kWh

SDG&E Meter # 06693222
Typical Monthly Usage: 190,000 kWh

Expected Monthly Usage: 320,000 kWh

Diagram courtesy of Jason Manning, Director of Engineering, SOCWA

JBL Typical Total Power Purchased with no Cogen

5,000 kWh
9,000 kWh
50 kWh
60 kWh
400,000 kWh
190,000 kWh

==========
524,110 kWh
JBL Typical Total Power Purchased with Cogen

5,000 kWh
9,000 kWh
50 kWh
60 kWh
190,000 kWh

204,110 kWh

Expected Average Monthly Credit

80,000 kWh

Net Power Purchased

124,110 kWh

Diagram courtesy of Jason Manning, Director of Engineering, SOCWA
Regulatory Drivers
AND WOOD INNOVATION GRANT NEXUS
Project Timeline

- California CAA Non-Attainment
  - CAA O₃ Non-Attainment
- SCAQMD 1110.2 Rule Adoption
  - 2/1/2008
- SCAQMD 1110.2 Rule Amendment
  - 12/6/2016
- Exhaust Limits 11 ppmv NOₓ
  - 1/1/2017
- Wood Innovation Grant
  - 1/2018
- Final PTO issued by AQMD
  - 9/2018

Net Result = ~1500 pounds reduction per year of NOₓ
0.070 PPM 2015-2018 OZONE STANDARD EXCEEDANCES

Regulatory Driver & Project Nexus

CALIFORNIA BIOGAS PRODUCERS AND COUNTIES COMPARED AGAINST THE 0.070 PPM 2015 8-HOUR OZONE STANDARD

Biogas Producers
- Stand-Alone Digester
- Dairy with Digester
- Landfill Collecting Biogas
- Waste Water Treatment Facility with Digester

Serious
Moderate
Marginal
County boundary

Tree Mortality
(Dead Trees Per Acre)
- >0 - 5 (Background Mortality)
- 5 - 15
- 15 - 40
- 40+

County Boundaries
Media Types

GRANULAR ACTIVATED CARBON =
LOW COST WITH HIGH SURFACE AREA AND ADSORPTIVE AFFINITY
Iron Sulfide by-product: Fe$_2$S$_3$

This process consists of wood chips impregnated with varying amounts of hydrate iron oxide (Fe$_2$O$_3$). This reacts with the H$_2$S to form Fe$_2$S$_3$.

Media can be impregnated with alkaline or oxide solids. The media is difficult to dispose as it did not pass STLC limits for Cu & Ni. SOCWA had to transport the hazardous waste material to the Simi Valley landfill.

Media is also pyrophoric. Also, the steps needed to de-activate the media would have required keeping the media wet while open venting of the media to the atmosphere (against SCAQMD regulations). Unable to transport the media until deactivated.

Unison:
UNI-CH₂S – Wood Based 4mm Activated Carbon
Installed April 2018

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apparent Density (ASTM D-2854), g/cc</td>
<td>0.44-0.46</td>
</tr>
<tr>
<td>Density, lb/ft³</td>
<td>27 - 28</td>
</tr>
<tr>
<td>Hardness, Min. (ASTM D-3802)</td>
<td>97.0</td>
</tr>
<tr>
<td>Particle size</td>
<td>4 mm</td>
</tr>
<tr>
<td>Standard packaging</td>
<td>55 lb. bags</td>
</tr>
<tr>
<td></td>
<td>1,100 Super sacks</td>
</tr>
</tbody>
</table>
# Carbon Media Review – H2S Removal

<table>
<thead>
<tr>
<th>Media Type</th>
<th>UNI-H2S</th>
<th>SULFATREAT 410CHP</th>
<th>IRON SPONGE</th>
<th>UNI-CH2S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material Size</td>
<td>2-4 mm</td>
<td>Granular, 4X10 mesh</td>
<td>Variable</td>
<td>4 mm</td>
</tr>
<tr>
<td>Chemistry</td>
<td>FeO(OH) Iron Hydroxide</td>
<td>Clay substrate with FeO&lt;sub&gt;3&lt;/sub&gt;, proprietary blend</td>
<td>Wood substrate with Fe&lt;sub&gt;2&lt;/sub&gt;O&lt;sub&gt;3&lt;/sub&gt;, NaCO&lt;sub&gt;4&lt;/sub&gt;, CaCO&lt;sub&gt;3&lt;/sub&gt; &amp; H&lt;sub&gt;2&lt;/sub&gt;O</td>
<td>Specially activated carbon, wood base</td>
</tr>
<tr>
<td>Estimated percent by weight removal of H2S*</td>
<td>20-40%</td>
<td>15-25%</td>
<td>10-15%</td>
<td>40-66%</td>
</tr>
<tr>
<td>pH requirements</td>
<td>None</td>
<td>None</td>
<td>8-10</td>
<td>None</td>
</tr>
<tr>
<td>Initial conditioning process</td>
<td>Yes, gas temperature rises 30-50° upon exposure to CO2</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Spent media characteristics</td>
<td>Sulfur remains inside pores, stays granular</td>
<td>Stays granular, minimal clumping</td>
<td>Major clumping of media</td>
<td>Sulfur remains inside the pores, stays granular</td>
</tr>
</tbody>
</table>
Siloxane Removal

Two 4’ diameter x 8’ straight wall stainless steel tanks

Contains 2,000 lbs of Cabot virgin lignite coal carbon per tank

Siloxanes are basic oils used for cosmetic products (make-up, shampoos, creams, deodorants, etc.), foam inhibitors in detergents and cleaning products, alkaline earth metal cation chelating agents in detergent processes (zeolites), substances for the impregnation of paint in construction, products for cleaning leather and cars, excipients in medicines, microelectronic components, food additives, etc.¹

In the gaseous form, siloxanes precipitate as solids, depositing on valves, cylinder walls, liners, blockages of pistons, cylinder heads, and valves. The glassy residues can deactivate the surface of emission control systems and deactivate the surface of the SCR catalyst.
Sampling & Operating Limits

Vessel 1
- 100 ppm (RAW) H₂S
- 5 PPM (Outlet) H₂S

Vessel 2
- 5 PPM (Inlet) H₂S
- <0.2 PPM (Outlet) H₂S

Vessel 3
- 0.2 PPM (Inlet) H₂S
- <0.2 PPM (Outlet) H₂S

Vessel 4
- <0.2 PPM (Inlet) H₂S
- <0.2 PPM (Outlet) H₂S

JEROME METER
SAMPLE PORT
COMPLIANCE SAMPLE PORT
Biogas Analytical Results of NOx
Raw Digester Gas H2S – Inlet to Digester Gas Cleaning System
H$_2$S Outlet to Lag Vessel

5ppm H$_2$S = Breakthrough
Siloxanes: ~9 Primary Compounds

When the SiO$_2$ Sum = 1000 ppbv$^2$ then Breakthrough is occurring (Media Change Out)

**GASEOUS SiO$_2$ COMPOUNDS $\rightarrow$ OXIDE PRECIPITATES RUIN SCR**

Fig. 1. Structures of common siloxane compounds, adapted from Schweigkofer and Niessner [1].
EPA TO-15
Gas Chromatography/Mass Spectrophotometry

VOLATILE ORGANIC COMPOUNDS IN AIR
Decamethylcyclopentasiloxane (D5) Inlet to Lead
Decamethylcyclopentasiloxane (D5) Outlet to Lag

- 8/4/2019
- 6/22/2019
- 5/10/2019
- 3/28/2019
- 2/13/2019
- 1/1/2019
- 11/19/2018
- 10/7/2018
- 8/25/2018
- 7/13/2018
- 5/31/2018
- 4/18/2018
- 3/6/2018
- 1/22/2018
- 12/10/2017
- 10/28/2017
- 9/15/2017
- 8/3/2017
- 6/21/2017
- 5/9/2017
- 3/27/2017
- 2/12/2017
Octamethylcyclotetrasiloxane (D₄) Inlet to Lead
Thank you!

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Sources: