Maximizing Digester Gas Production to Create More Sustainable Wastewater Treatment Facilities

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To Be Truly Sustainable, You Want to Optimize the Impacts of the Plant Inputs/Outputs

- Energy (Electricity, Gas, Fuels)
- Chemicals
- Various Supplies
- Raw Sewage, FOG, Septage, Food Waste
- Air Emissions
- Biosolids
- Solid Waste
- Treated Effluent
- Renewable Resources
Today, We Are Going to Look at One Input

Energy
(Electricity, Gas, Fuels)

How do we get to zero energy?
Can Your Plant Be Energy Neutral?
Few Wastewater Treatment Plants in the World Claim to Be Energy Self Sufficient

Strass Wastewater Treatment Plant, Austria
Treatment Process Selection Has a Profound Impact on Energy/Sustainability

<table>
<thead>
<tr>
<th>Process</th>
<th>Energy Intensity (kWh/MG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional Activated Sludge</td>
<td>3,000</td>
</tr>
<tr>
<td>Conventional Activated Sludge with Nitrification-Denitrification</td>
<td>4,000</td>
</tr>
<tr>
<td>Membrane Bioreactor (MBR)</td>
<td>6,000</td>
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</tbody>
</table>
Here’s How We Get to Zero

Gap: 11% Solar, Wind, More FOG, or Food Waste, Carbon Credits

- EMS (Energy Management System) 5%
- Resolve Overdesign 6%
- Optimize Primary Clarifier 5%
- FOG (Fats, Oil, and Grease) and Food Waste Digestion 25%
- Precondition WAS 6%
- Acid Phase Digestion 4%
- Fuel Cell Cogeneration 8%
- Conventional Cogeneration (Engines) 30%

Energy Reduction or Energy Production Ideas
First and Foremost, You Will Need Anaerobic Digestion of Biosolids

- Egg-Shaped Digesters
- Conventional Digesters
- Cambi
So... How Can You Produce More Biogas So That You Can Achieve Net Zero Energy?

1. Capture more biosolids in raw wastewater and divert to digesters
2. Don't burn up biosolids in the aeration system
3. Condition biosolids (WAS) prior to digestion
4. Anaerobic digestion optimization
5. Digester detention time
6. Co-Digestion (FOG and food waste)
But First.. How Much Biogas Will Digesters Produce?

About 10,000 to 12,000 cfd digester gas per mgd of plant flow (domestic strength)

I use 10,000 cfd

This will produce 20 to 25 kW in a cogeneration facility
1. Capturing More Biosolids - Improving Primary Clarifier Performance Can Make A Difference

- Improved hydraulics and baffling can increase suspended solids (SS) removal by 10%
- SS = BOD = Energy in activated sludge process

What Would Happen if We Removed 95% of SS Prior to Aeration?
2. Don't Burn Up Biosolids in the Aeration System

Typical sludge production of the suspended growth process (sludge production quantities at 20º C)
3. Condition Biosolids Prior to Digestion - The Wastewater Treatment Holy Grail: Destruction of WAS Cell Walls
Oh, These Poor Bugs

Pressure

Heat

Electricity

Freezing

Vacuum

Ultrasonic

Mechanical Abrasion

Cell

Just About Everything Has Been Tried, with Mixed Results
One Interesting Approach/Concept: Crown Disintegration System
Flow Schematic - Crown Disintegration System of the Biogest AG

- Thickener of the Sewage Treatment Plant
- 3% to 8% TWAS
- Relaxation Tank
- Recycle 3X
- Control Panel
- External Signal
- Macerator
- PC Pump 10 Bar
- Nozzle
- Return Pump
- Digester
- ~30%
Benefits Claimed by Biogest

- Digester foaming “eliminated”
- Biogas yield increased 16% to 40%
- Higher VS destruction; usually >20%
- Reduced sludge hauling; usually ~20%
- Dewatering improved 3% to 6%
- Guarantees are offered
Another Technology is OpenCEL: High Voltage Micropulses of Electricity

Claimed Benefits

- Biosolids Reduction
- Increased Biogas
- Carbon Source Denitrification
- Reduced Pathogens
- Reduced Odor
- Reduced Greenhouse Gas
But Wait! There is No Free Lunch…
Consider:

- All WAS pretreatment systems use electricity, and sometimes gobs of it
- Some may use chemicals
- Mechanical complexity (O&M)
- Performance claims verification

Piloting is Needed for Feasibility Analysis
4. Anaerobic Digestion Types Can Increase Biogas Production

1. Acid Phase Digestion
2. Thermophilic
3. Temperature-Phased Anaerobic Digestion (TPAD)
4. Cambi
5. Digester Detention Time - Detention Time is Impacted by Feed Solids Concentration

Higher SRT ➔ More Biogas

- 1 MG Digester
- 17,000 lbs/day Biosolids

Feed Solids (%) vs. SRT (days)

- Detention Time is Impacted by Feed Solids Concentration
- 2 to 6 SRT (days)
- 2 to 35 Feed Solids (%)

Graph shows the relationship between SRT and feed solids concentration, indicating that higher SRT results in more biogas production.
6. Co-Digestion is the 900 lb Gorilla in the Room

FOG and Food Waste
FOG Digestion and Food Waste Can Increase Biogas Production by 50 to 200%

- Virtually 100% volatile solids destruction
- Highly degradable
- Relatively easy to accept, process, and find
- Very small increase in biosolids production
- May improve volatile destruction of primary/WAS
Digester Gas Production vs. Grease Feed
(City of Watsonville Wastewater Treatment Plant)

Digester Gas
(1,000 CFD)

Grease Feed
(1,000 gallons/month)

Graph showing the production of digester gas and grease feed over the years 2001 to 2007.
We've Learned a Few Things Along the Way
East Bay Municipal Utility District (EBMUD) Has Perfected Organics Conversion to Biogas

- 90% energy neutral now, soon to be 100%
- Aggressive FOG and food waste programs
- Dedicated food waste digestion and dewatering
- Thermophyllic digestion
- Energy master plan is underway (energy use optimization and energy production)
- Three IC engines (2 MW each) and gas turbine (4.5 MW)
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