INCREASING CHP PRODUCTIVITY WHILE REDUCING BIOSOLIDS VOLUME AND CLIMATE CHANGING GASSES

EPA Region IX
Innovative Energy Management Workshop

Dick York, Retired, Superintendent, City of Millbrae, WPCP, FOG Energy Corp. CTO
Joseph Magner, Superintendent, City of Millbrae, WPCP
OVERVIEW

- Describe the Millbrae POTW
- Relate the driving and convincing factors
- Describe the system
- Relate reasons to choose grease
- Discuss the results
- Summarize
- Questions
UNDERSTANDING THE TERMINOLOGY

- **FOG:** Acronym for “Fats, Oils, and Grease,” often interchanged with trap waste
- **Yellow Grease:** Deep fryer grease or oils
- **Brown Grease:** Grease found floating in a restaurant grease trap
- **Black Grease:** Grease congealed inside sewer pipes
- **Trap Waste:** Sewage (water and organics) and brown grease from a grease trap, often used synonymously with FOG
- **IKG:** Acronym for Inedible Kitchen Grease
Proposed Receiving Station

Two digesters
THE FACILITY

- Is small and old
  - primary constructed in 1950
  - secondary in 1967
  - serves a population of 20 k
  - less than 5 acre
  - produces tertiary quality effluent
- 3 MGD capacity, 1.8 MGD annual flow
- Peak IWWF = 9 MGD; AWWF 6 MGD
- Facility is road locked
- Facility is shared with other PW crews
UNIQUE ATTRIBUTES

KNOWING your system will enable you to identify and capture the unique attributes of your plant.

Millbrae identified

- Ample Digester Capacity (2 digesters)
- Easy freeway ON – OFF (road locked)
- Need for major renovation (old)
DRIVING FACTORS

- Antiquated 20 year old ICE co-generator
  - Hard to get parts
  - Polluting
  - Extended down time
- Rising energy costs
  - No new utility generators
  - Price of fossil fuel
- Numerous POTW infrastructure needs...OLD
PROJECT SCOPE: EQUIPMENT REPLACED:

- 55 year old boiler (250 KBTU replaced with 1 MBTU)
- 34 year old stand-by diesel generator (Compressed Natural Gas Storage system and Electrical Switchgear with “basic” island mode functionality)
- 25-55 year old switchgear
- 20 year old co-generator
- 20 year old gas digester mixing system (essential for efficient production of methane from grease)
- 15 year old sludge circulation pump
CONVINCING FACTORS

- 20 years CHP experience
- Innovative – well trained staff
- Ample digester volume
- Neighboring POTW reported long term success receiving grease
- POTWs have historically processed grease
WHY CONSIDER RECEIVING GREASE?

- IKG (brown grease / FOG) found in trap waste
  - Is readily available
  - Disposal problematic
  - Grease is easily digested
  - High energy content
  - Consistent character
- Improved project economics
  - Additional digester gas produced
  - Additional revenue from tipping fees
    - $ 0.06 per gallon
BUT, WHAT IS FOG

✦ UBIQUITIOUS

✦ INSIDIOUS
BIOGAS PRODUCTION FOR VARIOUS FEEDSTOCK

# COMMON FATTY ACIDS

<table>
<thead>
<tr>
<th>FATTY ACID</th>
<th>FORMULA</th>
<th>OCCURENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetic</td>
<td>CH$_3$COOH</td>
<td>Vinegar</td>
</tr>
<tr>
<td>Butyric</td>
<td>C$_3$H$_7$COOH</td>
<td>Butter</td>
</tr>
<tr>
<td>Caproic</td>
<td>C$<em>5$H$</em>{11}$COOH</td>
<td>Butter</td>
</tr>
<tr>
<td>Caprylic</td>
<td>C$<em>7$H$</em>{15}$COOH</td>
<td>Butter</td>
</tr>
<tr>
<td>Capric</td>
<td>C$<em>9$H$</em>{19}$COOH</td>
<td>Coconut oil, butter</td>
</tr>
<tr>
<td>Lauric</td>
<td>C$<em>{11}$H$</em>{23}$COOH</td>
<td>Spermaceti, coconut oil</td>
</tr>
<tr>
<td>Myristic</td>
<td>C$<em>{13}$H$</em>{27}$COOH</td>
<td>Nutmeg butter, coconut oil</td>
</tr>
<tr>
<td>Palmitic</td>
<td>C$<em>{15}$H$</em>{31}$COOH</td>
<td>Animal and vegetable fats</td>
</tr>
<tr>
<td>Stearic</td>
<td>C$<em>{17}$H$</em>{35}$COOH</td>
<td>Animal and vegetable fats</td>
</tr>
<tr>
<td>Arachidic</td>
<td>C$<em>{19}$H$</em>{39}$COOH</td>
<td>Peanut oil</td>
</tr>
</tbody>
</table>
ANAEORBIC BREAKDOWN OF FATS AND OILS

- Final reaction:
  \[ \text{CH}_3\text{COOH} \rightarrow \text{CO}_2 + \text{CH}_4 \]
- Breakdown is complex
- Different microorganisms
- A WW anaerobic environment ideal

**BIOAVAILABILITY IS KEY**
HOW DID WE BOOST BIOAVAILABILITY?

1. Automated Preconditioning
   + Treatment begins immediately as FOG is off loaded.
   + FOG is combined with actively digesting sludge in a precise ratio.

2. ‘Bioreactor’ Storage
   + FOG-Sludge Mixture Blended into miscible, stable slurry. **NO separation, NO clogs.**
   + Chemical composition is changed, surface area maximized.

3. Continuous introduction
SOME GREASE TRAP PRODUCTION RATES

- National Avg. = 16 lbs / year / person*
- **4.6 billion** lbs / year
  
  At 1 kW per pound added, that’s equivalent to a generating about **4,600 GWh** annually in the US alone (1 GW = 1 billion watts)

  That’s about 525 MW of new generating capacity
  
  (Millbrae system has achieved 3.22 gross, netting 1.22 kW w/microturbine)

- Sacramento, CA Ave. = 11.2 lbs / year / person*
- Provo, UT Ave. = 26.6 lbs / year / person*

MILLBRAE BENEFITS

- Facility improvements worth $6.3 M, w/ $3.2 M of other critical POTW needs
- No new cost to the ratepayer
- New revenue (tipping charges; $0.06 / g)
- Utility savings = $204,600
  - 1.1 million kWh per year @ $0.186 / kWh
  - last year, $0.165 / kWh, up @11%
- System configured to serve as standby power
- Increased biosolids destruction more than 25 %
- Reduced biosolids dewatering and disposal costs
ENVIRONMENTAL BENEFITS

- Clean air
- Less GHG
- Renewable energy
- Reduced landfill disposal
- Less biosolids
- Local grease disposal facility
- No residual waste
- Less trucking
- No chemicals used
To Clean

RESULTS

FROM CLOGGED
Average monthly loads

Average monthly loads, **BEFORE**

Years 93 - 07

Average monthly loads, **AFTER**

Years 07 - 09

32% Fewer Loads
Residual Biosolids Reduction

BEFORE GREASE, 131.23, metric tons

AFTER GREASE, 98.79, metric tons

25 % Weight Reduction
Digester Stability

- Weight of sludge fed per day/5000
- Ratio of grease to sludge
- Digester 1 VA/A
- Design Minimum, gpd
- Design Maximum, gpd
- Trap waste delivered daily, gallons
- Linear (Digester 1 VA/A)

- Started Feeding Grease
- No Grease Delivery
- Heavy Rain
- Still below design load

MAXIMUM 6,000 GPD
MINIMUM, 3,000 GPD

- Shock Load
- Heavy Rain
- Collection System

- Collection System
- Heavy Rain
- Shock Load

- COLLECTION SYSTEM SHOCK LOAD
- HEAVY RAIN
- STILL BELOW DESIGN LOAD
SYSTEM PERFORMANCE

- 54X Energy Production Ratio
- 98% energy conversion efficiency
  - Energy used for powering pumps and system controls only

Actual FOG Energy Operating Performance

Gross Energy: 92,360 BTU/gallon
Net Energy: 90,664 BTU/gallon
Spent: (1,696) BTU/gallon

Note: Energy units are expressed as BTU per gallon of brown grease.
TAKE HOME MESSAGES!

BIOAVAILABILITY IS KEY

“OPERATOR APPROVED”

“NO DOWN SIDE”

BIOAVAILABILITY
WHY NOT?

Replicate the Millbrae experience around the US to dispose all Fat Oil Grease to help reduce the GHG impact by 20 million metric tons per year.

IMAGINE THE WORLD!
THAT’S LIKE ELIMINATING

- **About 3.7 million cars**
  
  Taking that many cars off the road will definitely improve the traffic

- **Growing pine trees on an area equal to more than two Yellow Stone Parks (park is 2.2 million acres)**

- **The electricity used in 1.8 million homes.**
  
  That is a pretty dense urban area, like the 9 county San Francisco Bay Area in California

*Equivalency Source: http://www.epa.gov/RDEE/energy-resources/calculator.html*
SUMMARY

- Smooth operation
- Benefits of reduced dewatering
- Encourages proper grease disposal
- Helps solve the FOG problem
- Makes electricity from waste
- Cleaner air
- Exceptional results
- Saves money!!!
QUESTIONS ???

CONTACT INFORMATION:

Dick York, Retired, Superintendent
City of Millbrae, WPCP,
FOG Energy Corporation, CTO
405 Paine Road
Castle Rock, Washington, 98611
E-mail: dick@FOGEnergycorp.com
www.fogenergycorp.com
END