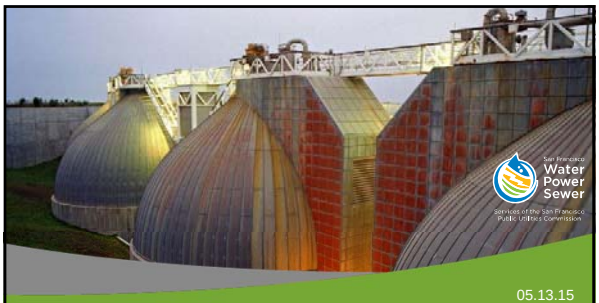


05.13.15

Anaerobic Digestion Overview

Bay Area Clean Water Agencies - Air Committee Meeting

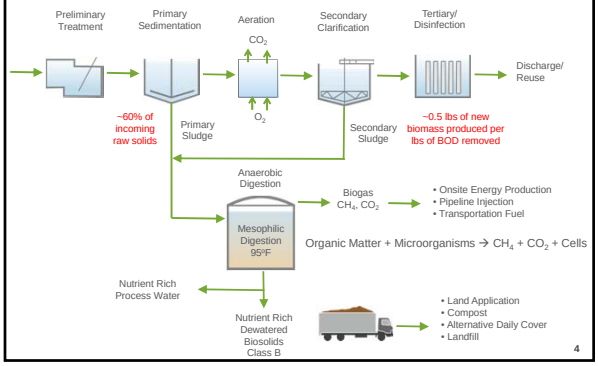
Agenda

1. Wastewater Treatment Overview
2. Anaerobic Digestion Overview
3. Anaerobic Digestion in California
4. Enhancing Biogas Production & Biosolids Quality
5. San Francisco Oceanside Experience

San Francisco
Water
Power
Sewer
Services of the San Francisco
Public Utilities Commission

WASTEWATER TREATMENT OVERVIEW

Typical Wastewater Treatment Plant



4

San Francisco Water Power Sewer
Services of the San Francisco Public Utilities Commission

ANAEROBIC DIGESTION OVERVIEW

5

Purpose/benefits of Anaerobic Digestion in WWTP

- Break down solids generated by the primary and secondary systems.
- Reduce the volume of sludge generated by the plant by up to 65%.
- Stabilize the sludge by reducing the amount of biodegradable volatile solids to reduce vector attraction.
- Reduce the pathogen concentration so it safer to handle.
- Produce nutrient rich biosolids that can be used as a fertilizer.
- Produce biomethane

6

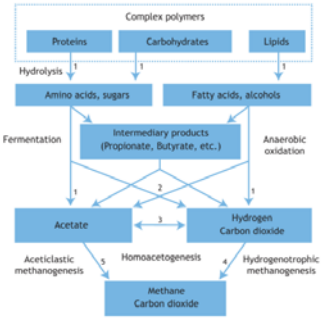
Typical Anaerobic Digester Operation
Mesophilic – Class B biosolids Production

- Sealed reactor continuously mixed and heated at 95-100ºF (no oxygen)
- Contains microorganisms that convert solids into biogas (CH_4 and CO_2)
- Net energy producer
- Feed sludge concentration: ~6% TS @ ~80% VS
- Detention time has to be at least 15 days
- Digested sludge concentration: ~2.5% TS @ ~65% VS
- ~50-60% volatile solids reduction
- ~10-15 scf of biogas produced per lbs VS reduced
- Significant reduction of pathogens
- Digested sludge is dewatered to ~15-25% TS

7

Anaerobic Digestion: A Step-by-Step Process

Hydrolysis is the rate limiting step



8

Biogas Yield Depends on Feed Source

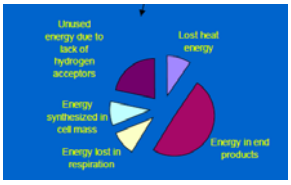
Substrate	Composition	Energy Content Kcal/gram	CH_4 yield cf/lbs $VS_{destructed}$	Biogas CH_4 content	Biogas yield cf /lbs $VS_{destructed}$
Carbohydrates	$(C_6H_{10}O_5)_n$	~ 4.1	6.6	50	13.3
Proteins	$C_5H_7NO_2$	~ 4.1	7.9	62.5	12.7
Lipids	$C_{57}H_{104}O_6$	~ 8.8	16.2	70	23.2

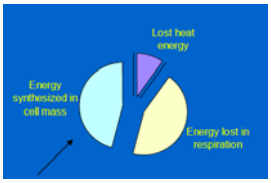
- The energy density of food lies mainly on the proportion of carbon, hydrogen and oxygen atoms in the molecules.

- Also note that the substrate present in the primary sludge (raw sludge) are more rapidly available than the substrate present in the secondary sludge (bacteria) because of cells wall structure.

9

Where Does the Energy Contained in the Feed Goes To?





Anaerobic Digestion Vs Aerobic Digestion

- Little energy goes to cell growth
- Little energy lost in respiration
- Most of the energy goes to end products

- Lots of energy goes to cell growth
- Lots of energy lost in respiration
- No energy in end product

10

ANAEROBIC DIGESTION IN CALIFORNIA

11

Anaerobic Digestion in California

Data compiled by CASA

- 238 POTWs treat more than 1 MGD
- 153 of those facilities use anaerobic digestion to stabilize sewage sludge
- 94% of the sewage sludge produced in CA is digested
- 72% of POTWs beneficially use the biogas generated by anaerobic digestion
- It represents more than 87% of total wastewater flow treated in CA

12

Anaerobic Digestion is a Renewable Electrical Energy Producer

- 600,000 MWh/Yr produced from POTW biogas in CA
- And additional 300,000 MWh/Yr could be produced *(assuming 26kW/MGD – EPA CHPP 2011)*

13

Anaerobic Digestion Can Also Help Reduce Carbon Intensity of Transportation Fuel

- AB32 Assembly Bill sets a state wide goal to reduce the CI of transportation fuel by at least 10% by 2020
- CARB Staff has developed two Low Carbon Fuel Standard (LCFS) pathways for the production of biomethane from the mesophilic anaerobic digestion of wastewater sludge

Gasoline	Biomethane from POTW treating 5 to 20 MGD	Biomethane from POTW treating more than 21 MGD
95.86 gCO_2eq/MJ	10.86 gCO_2eq/MJ	-65.27gCO_2eq/MJ

14

Anaerobic Digestion Can Also Help Reduce Carbon Intensity of Transportation Fuel

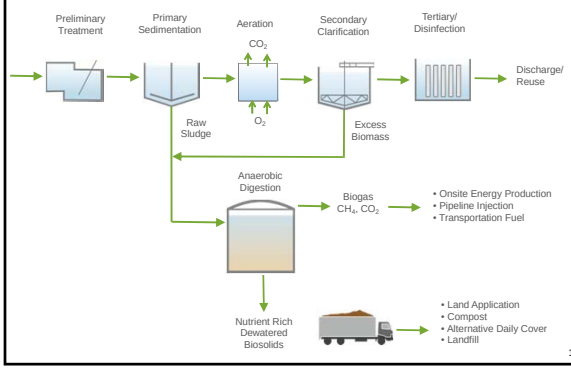
- Current electrical production could produce 18 million gasoline gallon equivalents (GGE) or 16.2 million diesel gallon equivalents (DGE)
- Current Thermal energy production could produce 20.2 GGE or 18.3 million DGE

15

ANAEROBIC DIGESTION
ENHANCING BIOGAS PRODUCTION & BIOSOLIDS QUALITY

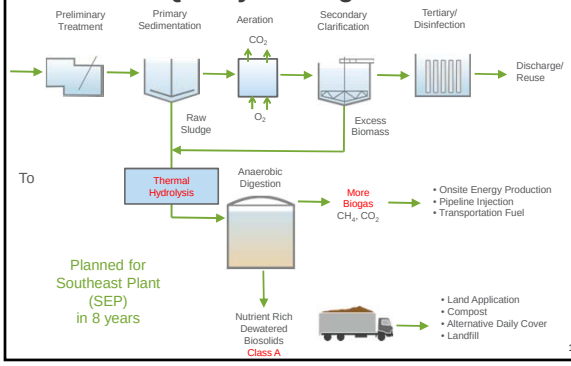
16

Typical Wastewater Treatment Plant

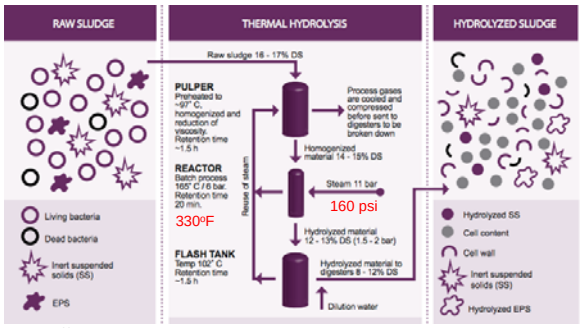


17

Enhancing Biogas Production & Biosolids Quality – Sludge Pretreatment



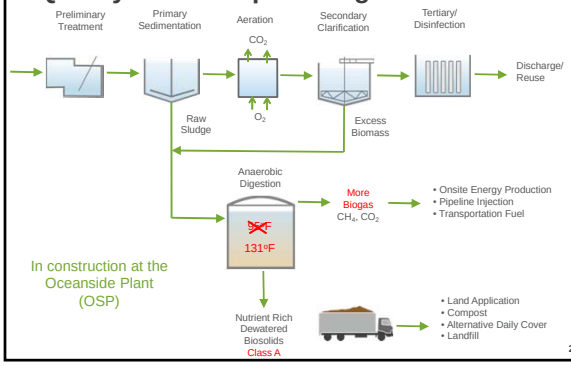
18



Source: cambi

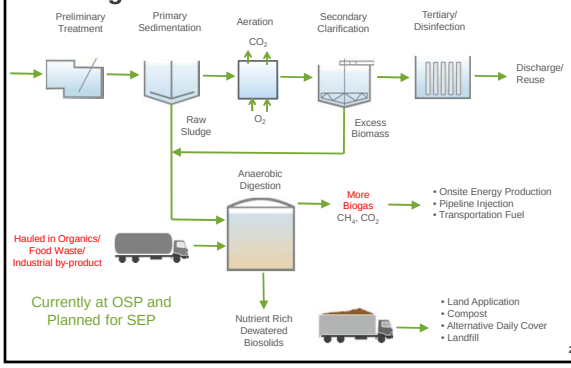
19

Enhancing Biogas Production & Biosolids Quality – Thermophilic Digestion



20

Enhancing Biogas Production Co-Digestion



21

OSP CO-DIGESTION EXPERIENCE

22

OSP Co-digestion Experience

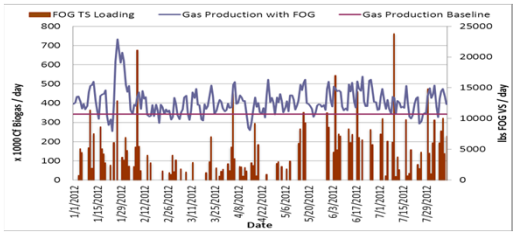
- Grease Trap Waste Receiving Facility capable of processing 30,000 gallons per day
- Commissioned in 2010 as part of a demonstration project sponsored by CEC, DOE and EPA

23

Impact of GTW on Biogas Production

6-month evaluation of injection to all three digesters (daily total data)

Services of the San Francisco Public Utilities Commission



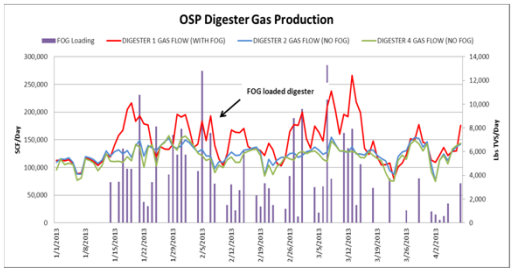
- ~ 9,500 gal/day of GTW **fed to all 3 digesters equally**
- ~ 6% increase in digester TVS loading due to GTW
- ~ 19% increase in biogas production
- ~ 27% increase in CH_4 gas production because of higher gas CH_4 content

SEWER SYSTEM IMPROVEMENT PROGRAM | Grey. Green. Clean.

Impact of GTW on Biogas Production

4-month evaluation of injection in one non-acclimated digester only

Services of the San Francisco Public Utilities Commission

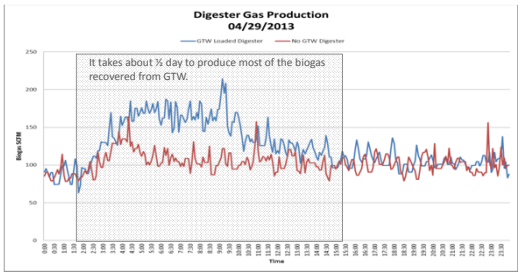


- ~ 10,000 gal/day of GTW **fed to digester 1 only**

Impact of GTW on Biogas Production

1 day evaluation of injection to one acclimated digester only

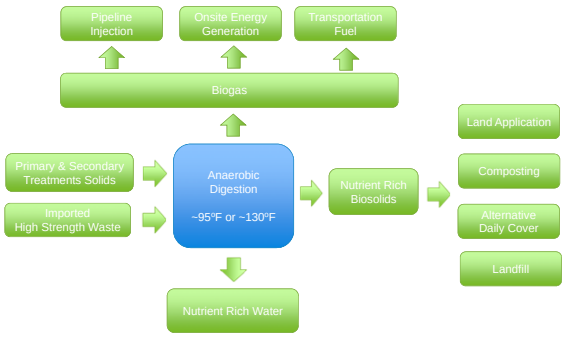
Services of the San Francisco Public Utilities Commission



- 16,000 gal. of GTW fed **to digester 1 only** between 00:45am and 7am

SEWER SYSTEM IMPROVEMENT PROGRAM
Grey. Green. Clean.

THANK YOU.



28

Typical Anaerobic Digester Operation

Mesophilic – Class B biosolids Production

- Sealed reactor continuously mixed and heated at 95ºF
- The reactor contain microorganisms that convert solids into biogas
- The solids remain in the reactor for at least 15 days
- 38-60% of the solids are destroy reducing the volume of solids generated by the plant
- Significant reduction of pathogen
- Stabilization of the solids

29