FCE Forcier Consulting Engineers, PC

Lee Enterprises Consulting, Inc. Accredited Member

Practical Design Realities

2020 Anerobic Digestion Process and Fundamentals Shortcourse
Cornell University – January 16, 2020

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Member of Lee Enterprises Consulting

Your Organics to Energy Experts

Practical Design Realities

Sand and Grit Removal:

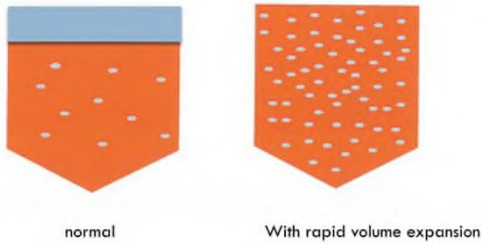
- Avoidance:
  - For Agricultural- Convert to bedding other than sand
- Removal Examples:
  - Sand removal in NY

  - Sand removal in CA
  - Grit removal/grit cyclone

Practical Design Realities

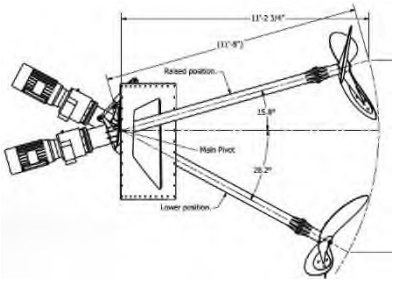
Foaming:

- Causes: Unstable operating conditions such as:
  - Organic overloading
  - Temperature fluctuation
  - Inadequate mixing
- Effects:
  - Foaming, crusting
  - Clogging of biogas piping to CHP, flare, PRV
  - Reactor Rapid Rise Sludge (extreme cases)



Practical Design Realities

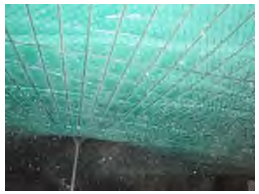
Foaming (continued):



- Control (of effects):
  - Froth Spray
  - Anti-Foaming Agents
  - Articulating/Surface Mixer
  - Buffering Agents-Like cow or calf manure

- Avoidance of Causes:
  - Monitoring and controlling critical parameters:
    - Temperature, pH, VFA/TA ratio, toxicity, etc.
  - Level transducer (for liquid level)
    + Radar (for foam level)
  - Sludge Blanket Level Detector (Detects density differences)

Practical Design Realities



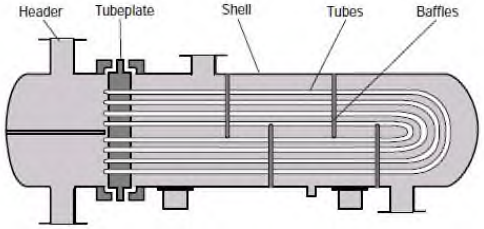
Odor Control/Gas Cleaning:

- Filters:
  - Iron Sponge
  - Activated Charcoal
  - Biofilters
- Internal AD Chemical/Biological Treatment:
  - Inject air/oxygen in gas zone
  - Surface for biological scum (netting, wood, etc.)
  - Detention time
  - For H_2S, precipitates elemental S + H_2O
- Chemical Feed Systems:
  - Ferric Chloride
  - Ferrous Chloride
  - Iron Hydroxide

Practical Design Realities

Heating & Insulation:

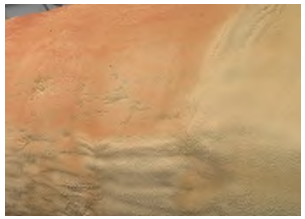
- Common Heating Methods:
  - External heat exchangers

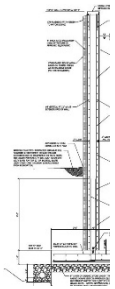


  - Imbedded PEX tubing

  - Interior rack-mounted 316 SS piping

Practical Design Realities





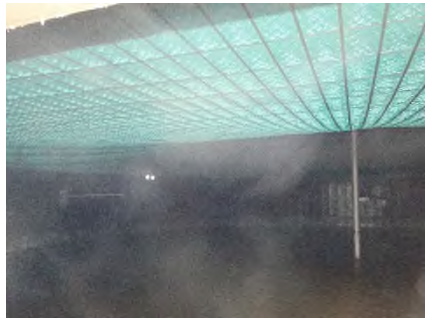
Heating & Insulation (continued):

- Insulation:
  - Exterior rigid insulation
  - Spray foam insulation
  - Underslab (high density) rigid insulation
  - Underground tankage (partial or full) for insulating value
- Heat Calculations- Design for Worse Case:
  - Start-up during winter

Practical Design Realities

Corrosion Protection:

- AD Gas Zone:
  - Metals- 316 SS
  - Concrete Walls- 4,000 psi with:
    - Waterproofing to 12” below lowest liquid level
      or
    - Crystalizing agent-
      - Surface applied to 12” below lowest liquid level
        or
      - Concrete additive
- AD Digestate Zone:
  - Metals- 304 SS
  - Concrete (slabs and walls to 12” below liquid level)- 4,000 psi



Practical Design Realities

Corrosion Protection (continued):

- Receiving Tanks:
  - Metals- 316 SS or G90 Galvanizing
  - Concrete (all)-
    - Crystalizing agent-
      - Surface applied

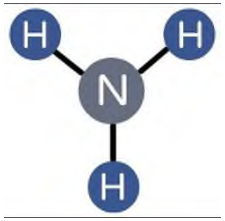
        or
      - Concrete additive
- Process Piping:
  - Corrosion resistant- HDPE, CPVC, PVC, SS, etc.

Practical Design Realities

Bypass, Flexibility, Effluent Storage, Recycling:

- Bypass- Allow for bypass of tanks for maintenance
- Influent Storage- 3 to 5 days
- Effluent Storage-
  - Agricultural- Up to 6 months- Lagoon, etc.
  - Municipal- Up to 30 days

- Recycling-
  - Separated Liquid Effluent-
    - For diluting manure or sludge for ease of pumping
    - For diluting of food wastes/organics to produce optimum density for AD-
      - But, be careful with toxicity!



Practical Design Realities

Table 6.2.2(a) *Continued*

Row[a]	Line[a]	Location and Function	Fire and Explosion Hazard	Ventilation[b,c,d]	Extent of Classified Area	NEC Area Electrical Classification (All Class I, Group D)[d]	Materials of Construction[e]	Fire Protection Measures
16	a	ANAEROBIC DIGESTERS, BOTH FIXED ROOF AND FLOATING COVER Generation of sludge gas from digesting sludge	Leakage of gas from cover, piping, emergency relief valves, and appurtenances	Not enclosed, open to atmosphere	Tank interior; areas above and around digester cover; envelope 3 m (10 ft) above the highest point of cover, when cover is at its maximum elevation, and 1.5 m (5 ft) from any wall	Division 1	NC	H and FE
	b			Not enclosed, open to atmosphere	Envelope 4.6 m (15 ft) above Division 1 area over cover and 1.5 m (5 ft) beyond Division 1 area around tank walls	Division 2	NC	H and FE
	c			A	For digester tanks enclosed in a building: tank interior; entire area inside building	Division 1	NC	CGD if enclosed in building
	d			B	For digester tanks enclosed in a building: tank interior; areas above and around digester cover; envelope 3 m (10 ft) above highest point of cover, when cover is at its maximum elevation, and 1.5 m (5 ft) from any wall of digester tank	Division 1	NC	CGD if enclosed in building
	e			B	Remaining space in enclosed area	Division 2	NC, LC, or LFS	CGD if enclosed in building
17	a	ANAEROBIC DIGESTER CONTROL BUILDING Storage, handling, or burning of sludge gas	Leaking and ignition of sludge gas	A	Entire building	Division 1	NC	CGD, H, and FE
	b			B	Enclosed areas that contain gas handling equipment	Division 2	NC, LC, or LFS	CGD, H, and FE
	c			C	Physically separated from gas-handling equipment	Unclassified	NC, LC, or LFS	CGD, H, and FE
18	a	DIGESTER GAS-PROCESSING ROOMS Gas compression, handling, and processing	Sludge gas ignition	A	Entire room	Division 1	NC	CGD, H, and FE
	b			B	Within 1.5 m (5 ft) of equipment	Division 1	NC, LC, or LFS	CGD, H, and FE
	c			B	Entire room	Division 2	NC, LC, or LFS	CGD, H, and FE

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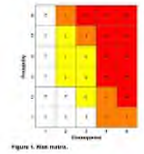
2016 Edition

Safety:

- NEC Area Electrical Classification- NFPA 820-25
- Hazard & Operability Study (HazOp)



- Initial Safety Devices- CHP, Flare, PRV's

- Signage

- Fencing

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