

Understanding Design Codes and Standards for Biogas Systems



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Understanding Design Codes and Standards for Biogas Systems

WEF MOP 8, 2017 Edition Chapter 25 Stabilization

- Gas Production
- Volatile solids loading/destruction
 1. Typical AD = 13-18 cf/lb VS destroyed
 2. Fats = 20-25 cf/lb VS destroyed
 3. Proteins/Carbs = 12 cf/lb VS destroyed
- Additional factors:
 1. Temperature
 - a. Mesophilic vs Thermophilic
 - b. Single vs Multi-Staged Operation
 2. pH/Alkalinity

Optimum pH for Methane Production = 6.8 – 7.2



MOP 8

3. SRT/HRT

Solids retention time $SRT = M \text{ of solids} / \text{solids removed}$.
Hydraulic retention time $HRT = \text{volume of solids into the digester(s)} / \text{solids removed (inflow and outflow rate)}$.

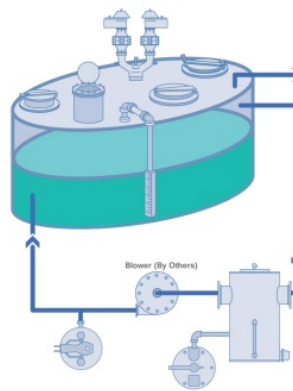
4. Mixing Efficiency

5. Organics Loading Rate and Frequency

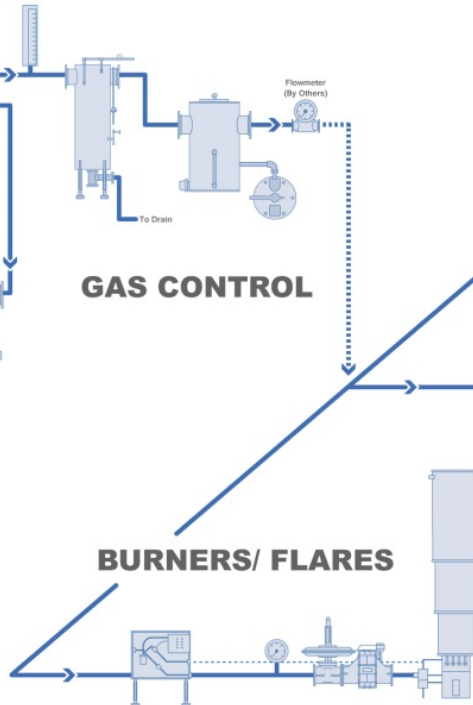
- A. Typical sustained peak VS loading rate = .12 - .16 lb VS/cf/day
- B. Typical maximum VS loading rate = .2 lb VS/cf/day

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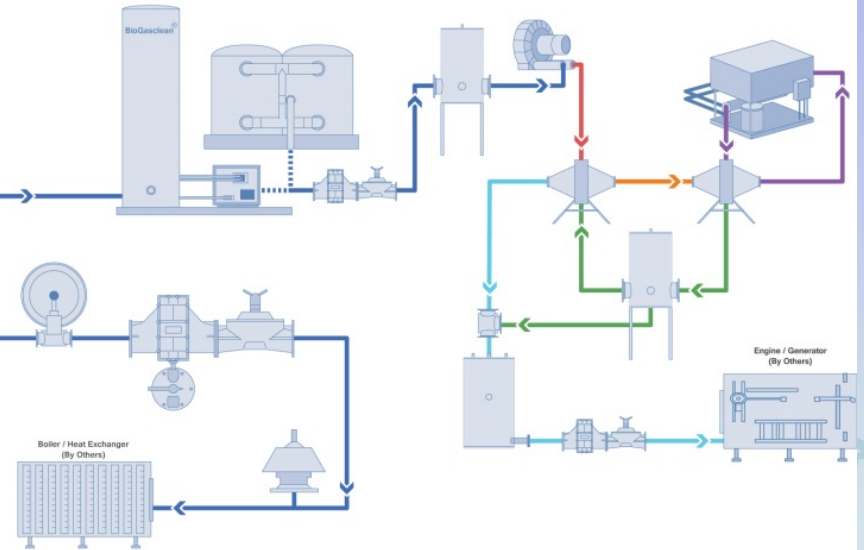
COVER EQUIPMENT



GAS CONTROL



DIGESTER GAS CLEANING/ DRYING EQUIPMENT



Color Legend:

Red	120° F (49° C)
Orange	100° F (38° C)
Purple	Water / Glycol
Green	40° F (4° C)
Blue	85° F (29° C)

2017 MOP 8, Chapter 25, Fig. 25.33 Diagram of a gas control system

MOP 8

Design Parameters

1. **Gas Velocity = 12 fps**
2. **Digester Cover**
 - a. **PRV Valve/Flame Arrester redundancy (fixed or floating)**
 - b. **Secondary pressure relief system**
 - c. **Appurtenances for access and sludge sampling**
3. **Gas Holder – membrane gas holder; balance system and maintains system operating pressure**

MOP 8

Design Parameters

4. Moisture Removal

a. Sediment Traps and drip traps



b. Gas Drying Systems –

- Coalescing filter – remove particulates
- glycol chiller - cool the gas to desired temperature
- compressor - reheat gas creating a dew point barrier so that no additional moisture can form.

MOP 8

Design Parameters

5. H₂S Removal

- a. Chemical addition
- b. Polishing using media – example: iron sponge



Iron sponge regenerated:



MOP 8, FIG. 25.37

MOP 8

Design Parameters

c. Biological Treatment –

1. The sulfur oxidation bacteria thrives and multiplies on a packed media inside a closed acid-proof tank.
2. sulfur from the H_2S
3. carbon from the CO_2
4. oxygen from atmospheric air
5. nutrients (nitrogen, phosphorus and potassium) from the treated effluent
6. Temperature between 86-130°F (30-55°C).

The sulfate is discharged with the effluent from the gas cleaner which contains up to 8% SO_4 .

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Design Parameters

c. Biological Treatment –



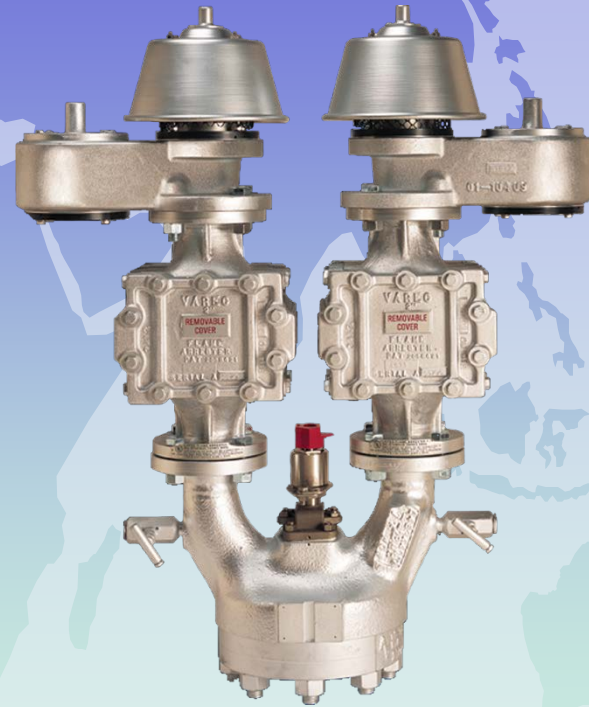
MOP 8

Proper Selection of Safety Equipment

1. Pressure/Vacuum Relief Valve and Flame Arrester – Relieves the digester of an overpressure or vacuum condition.



**Pressure/Vacuum Relief
Valve and Flame Arrester**

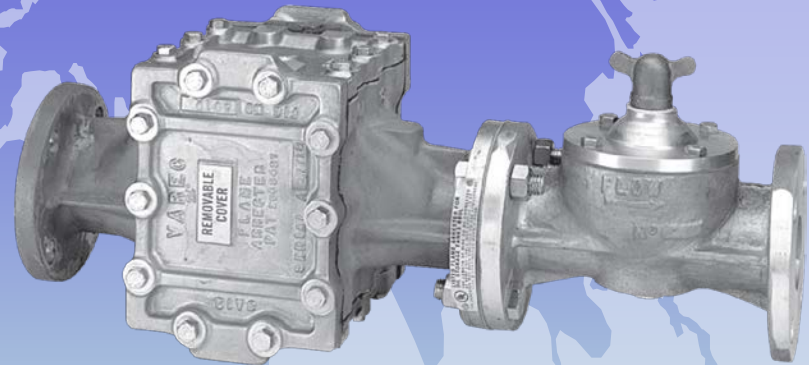


MOP 8, Fig. 25.37

MOP 8

Proper Selection of Safety Equipment

2. Flame Arresters, Flame Trap Assemblies – Must be installed within 15 feet of a potential flame source.



Thermal shut-off valve with flame arrester
– flame trap assembly

Flame arresters installed within
15 feet of potential flame source.

MOP 8, FIG. 25.34



Flame Arrester

Proper Selection of Flame Arrester



Core assembly inside fixed housing.
Between two end housing held together with bolts.
Access core assembly using jacking bolts.



MOP 8

Proper Selection of Safety Equipment

3. Waste Gas Burner – Safe and effective method of combusting excess biogas produced. Two types:



**Open-Type or Candle-stick
Flares**



**MOP 8, FIG. 25.36
Enclosed Flares**

MOP 8

Proper Selection of Safety Equipment

3. Referenced Standards (best design practice or, in some jurisdictions, code):

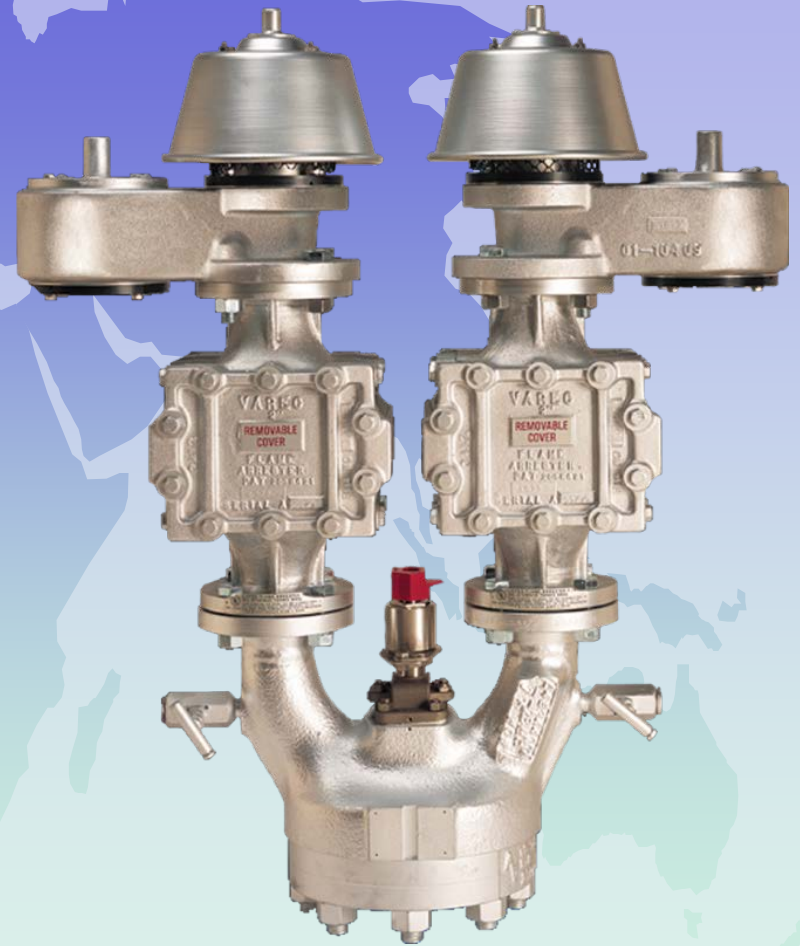
- **ANSI/CSA B149.6-15 Code for Digester Gas, Landfill Gas, and Biogas Generation and Utilization;**
- **NFPA 820 Standard for Fire Protection in Wastewater Treatment and Collection Facilities; and**
- **Great Lakes – Upper Mississippi River Board GLUMRB - (Ten States Standards) Recommended Standards for Waste Water Facilities or applicable local Design Standard**

ANSI/CSA B149.6

9. Digester s and Gas Storage Tanks,
Gas Storage tanks or spheres >15 psi;
membrane gas holder

Redundancy: A pair of flash-back
(flame) arrester and pressure/ vacuum
relief valves.

- a) connected to the digester roof, as
close as practicable to the digester
holding space;
- b) piped in parallel, with a three-way
manual change-over valve.
- c) Vented separately when inside an
enclosure.
- d) equipped with the flash-back (flame)
arresters installed upstream from the
pressure/ vacuum relief valves
- e) And tested before going into service.



ANSI/CSA B149.6

9.7.2

Suitable protection against weather either with insulated enclosure with ventilation and accessibility for Servicing or with jackets.



ANSI/CSA B149.6

9.7.3

No Isolation valves or any obstructions (except for flame arrester) in the gas connection between the digester gas holding space and the *digester* excess gas *pressure/ vacuum relief valve*.

Note: This is a listed prohibited practice.



ANSI/CSA B149.6

Code requirements for the various accessories on the digester cover (fixed or floating);

9.3 Access holes (only fixed or floating cover)

9.3.1

Digester Roof, 50 feet and greater (15m) \geq 3 access holes. 1 pc minimum 42" size ID.

9.3.2

Digester Roof, Less than 50 feet (15m) \geq 2 access holes. 1 pc minimum 42" size ID.

9.7.4

Secondary, emergency pressure-relief system

- a) installed without the use of a flash-back (flame) arrester,
- b) set higher than relief setting of PRV Valve
- c) And tested before going into service.

ANSI/CSA B149.6



Emergency pressure relief manhole cover

42" access manway

ANSI/CSA B149.6

Important Factors for design:

1. 2% Slope for pipe
2. Gas piping and tubing systems:
 - (a) SS; (b) plastic; and (c) copper (vent lines).Cast iron pipe and fittings (including flanges) shall not be used.
3. Plastic pipe and fittings made of polyethylene or glass fiber-thermosetting resin. Only installed outdoors.
4. Plastic not subjected to 100 deg. F.
5. Copper OK for vent and bleed lines. No copper for buried piping.
6. 1/8 in thick neoprene gasket with 40 hardness

ANSI/CSA B149.6

ANSI/CSA B149.6, Clause 6.4 Waste Gas Burners

6.4.1 - waste gas burner tip = minimum 15 feet (4 m) above grade or maintenance platform level.

waste gas burner stack termination = at least 5 feet (1.5 m) above any obstruction.

6.4.3 - waste gas burner and ignitor = minimum 50 feet (15 m) from digester perimeter or other combustible gas source.

6.4.4 - open-type stack tip = minimum 25 feet (7.5 m) from any other stack tip or exhaust vent termination. Enclose-type waste gas burner stack = minimum 10 feet (3 m) clearance.

ANSI/CSA B149.6

ANSI/CSA B149.6, Clause 6.4 Waste Gas Burners

6.4.5 - Except if enclosed flare - stack location = minimum 25 feet (7.5 m) from property line or a road. Enclosed flare = 10 feet.

6.4.6 - Enclosed-type stack location = minimum 10 feet (3.0 m) road or provided with barrier to protect against damage to the stack.

6.4.7

Safety fencing minimum (25 feet) 7.5 m horizontally from the stack when accessible to public.

ANSI/CSA B149.6

ANSI/CSA B149.6 – Additional Requirements for Waste Gas Burners

Pilot fuel (Natural Gas or Propane only, and not Biogas). No sparking raw biogas.

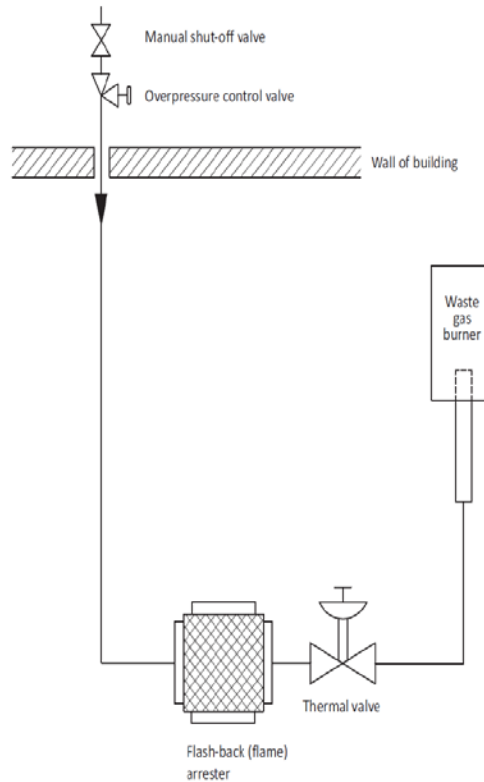


Figure B.3
Possible arrangement for waste gas flare
stack burners burning digester gas
(See [Clause D.5.](#))

Local Standards

Localized (Regional) Design Standards

1. Recommended Standards for Wastewater Facilities (10-STATE STANDARD)

MEMBER STATES AND PROVINCE: ILLINOIS, NEW YORK, INDIANA, OHIO, IOWA, ONTARIO, MICHIGAN, PENNSYLVANIA, MINNESOTA, WISCONSIN, MISSOURI

Ten State Standard

2014 edition, Chapter 84;

- **84.132 Access Manholes**

30" size allowed and will not fit a personnel with OSHA required pack entering confined space.

- **84.43**

Minimum pipe size is 4".

No float operated condensate traps.

- **84.461**

Located at least 50 feet away from any plant structure.

Sufficient height to protect personnel.

- **84.462**

Provided with an automatic ignition system with pilot sensing.

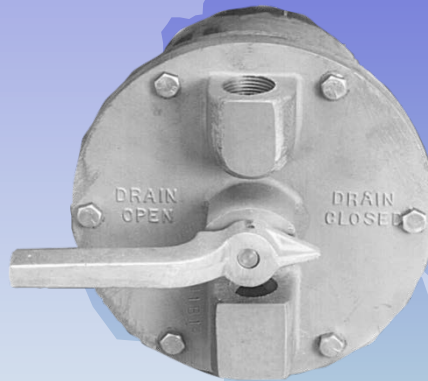
Drip Traps

Purpose

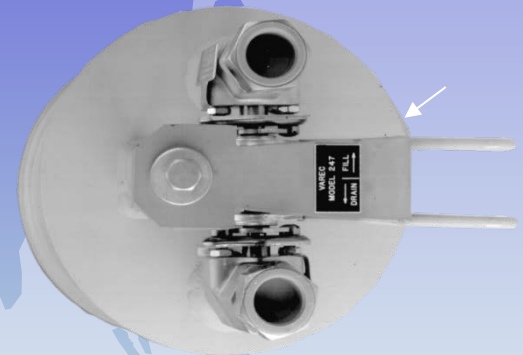
- Installed at low points in piping to remove moisture.
- Isolates gas line before draining to prevent gas from escaping.



Float operated
needle valve (25 psig max)



Low Pressure Manual (5 psig
max)



High Pressure
Manual (100 psig max)



High Pressure
Manual (100 psig max)

Dual Chamber

NFPA 820

Table 6.2.2.(a) Solids Treatment Process, Rows 10-29

Example:

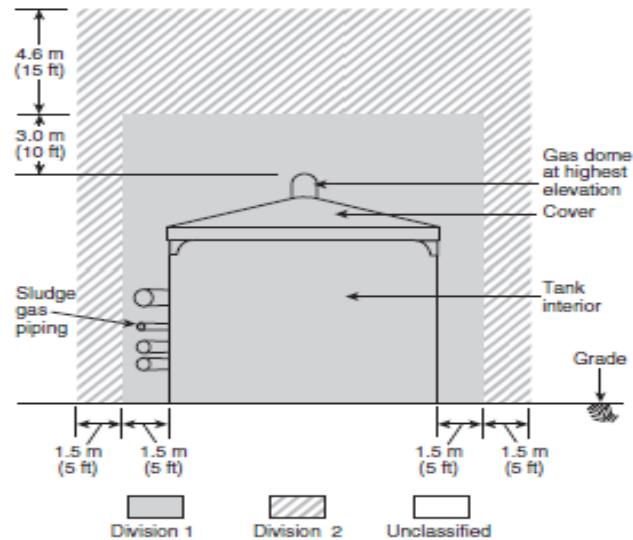


FIGURE A.6.2(a) Anaerobic Digester with Fixed or Floating Cover Above Grade Not Enclosed in a Building; Illustration of Table 6.2.2(a), Rows 16a and 16b.

NFPA 820

2016 Edition

Table 6.2.2.(a) Solids Treatment Process, Rows 10-29

Example:

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
19		ANAEROBIC DIGESTER GAS STORAGE Storage of sludge gas	Gas storage piping and handling	NNV	Within a 3 m (10 ft) envelope of tanks, valves, and appurtenances	Division 1	NC, LC, or LFS	Hand FE; CGD if enclosed in building
20	a	WASTE GAS BURNERS Combusting excess gas	Gas piping and appurtenances	N/A	Within 3 m (10 ft) envelope of all fixtures, appurtenances, and housing	Division 1	NC	NR
	b				Envelope 4.6 m (15 ft) above Division 1 envelope and 1.5 m (5 ft) on all sides	Division 2	NC	NR

Row and Line – Refers to specific figures in Appendix A.6.2.

NNV – Not normally ventilated.

NC – Non combustible; LC – Limited Combustible; LFS – Low flame spread index per Chapter 8.

Fire Protection Measure: Hand FE – Fire extinguisher; CGD – Combustible gas detection System; NR – No requirement or call fire department!