Basis of Design of LAWPCA Anaerobic Digestion/Energy Recovery Facilities

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Basis of Design of LAWPCA Anaerobic Digestion/ Energy Recovery Facilities

- Introduction
- Existing Biosolids Practices
- Project Drivers
- Reasons for Anaerobic Digestion
- Digester Operational Modes
- Digester Types, Mixing Systems
- Description of LAWPCA Digesters
- Description of Combined Heat and Power

Existing Biosolids Management Process

Waste Activated Sludge

New Gravity Belt Thickeners

Thickened Sludge Storage

Primary Sludge

Gravity Thickeners

Composting

Lime Conditioning and Land Application

Landfill

Belt Filter Presses

Project Drivers

- Biosolids Management Issues
  - Production exceeds capacity of Composting Facility (18 years old)
  - Remaining biosolids land applied or landfilled
  - Sites for land application are harder to permit and farther from LAWPCA

Project Drivers (Continued)

- Costs are increasing:
  - Amendment for composting
  - Lime for Class B Land Application
  - Fuel costs to transport to land application or landfill
  - Landfill tipping fees

Why Anaerobic Digestion?

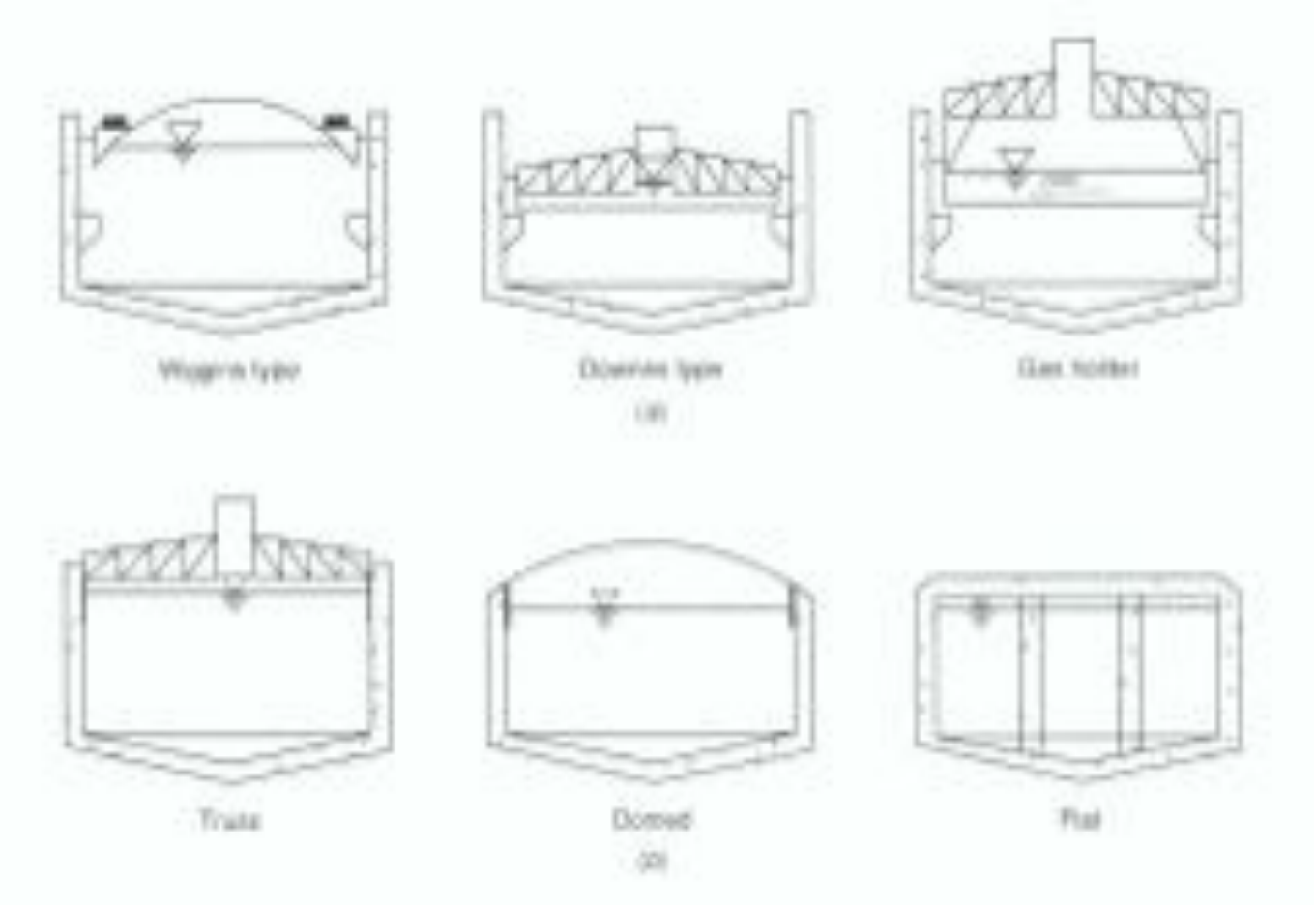
- AD is well established technology
- Thousands of operating installations
- AD meets Authority's goals:
  - Reduces biosolids by significant amount (~40%)
  - Reduces amount of electricity purchased from the grid

Biosolids Process with Digestion

Digester Operational Modes

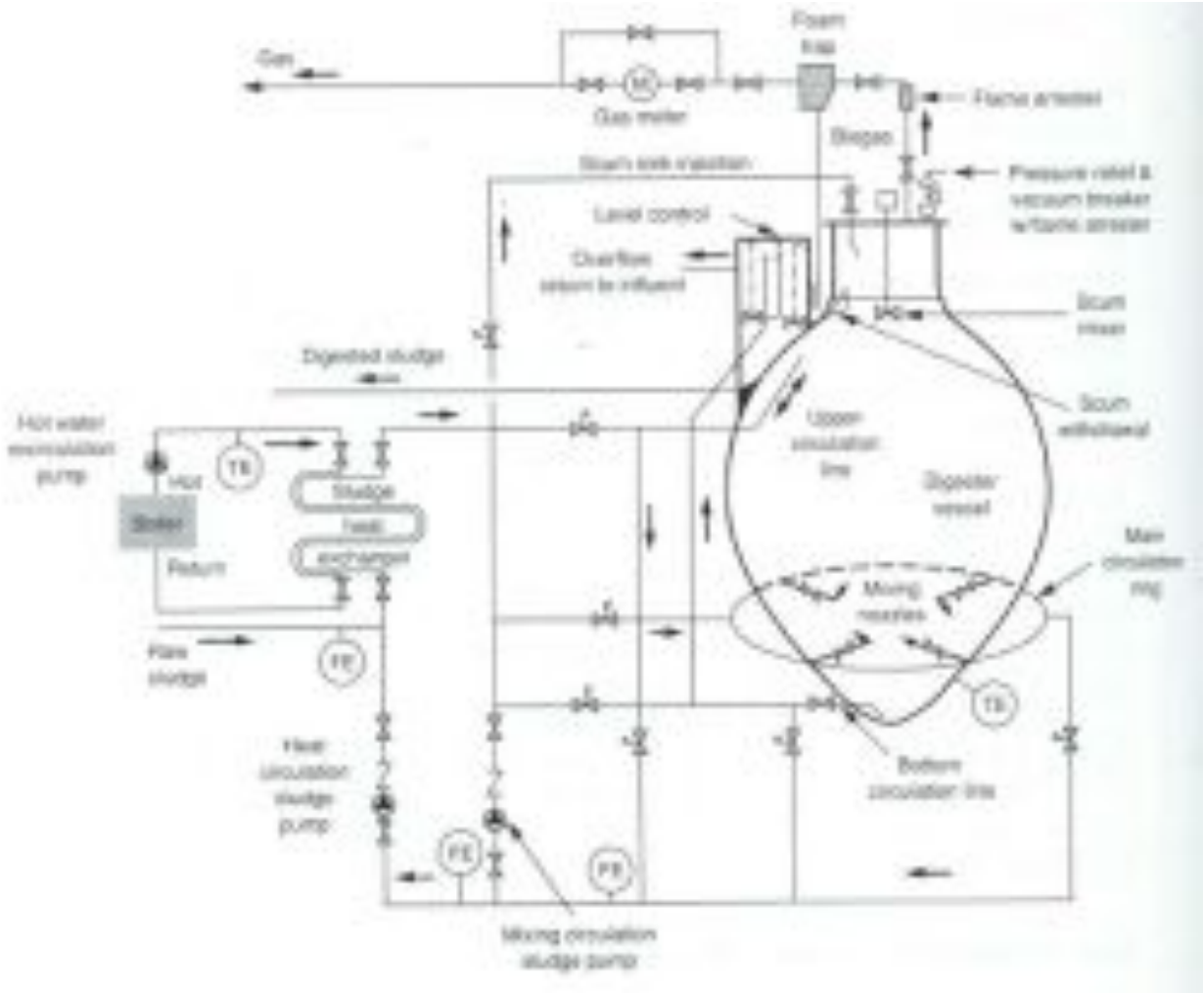
- Mesophilic Anaerobic Digestion
- Thermophilic Anaerobic Digestion
- Temperature-Phased Anaerobic Digestion
- Acid-Gas Anaerobic Digestion
- Autothermal Thermophilic Digestion
- Dual Digestion

Digester Types

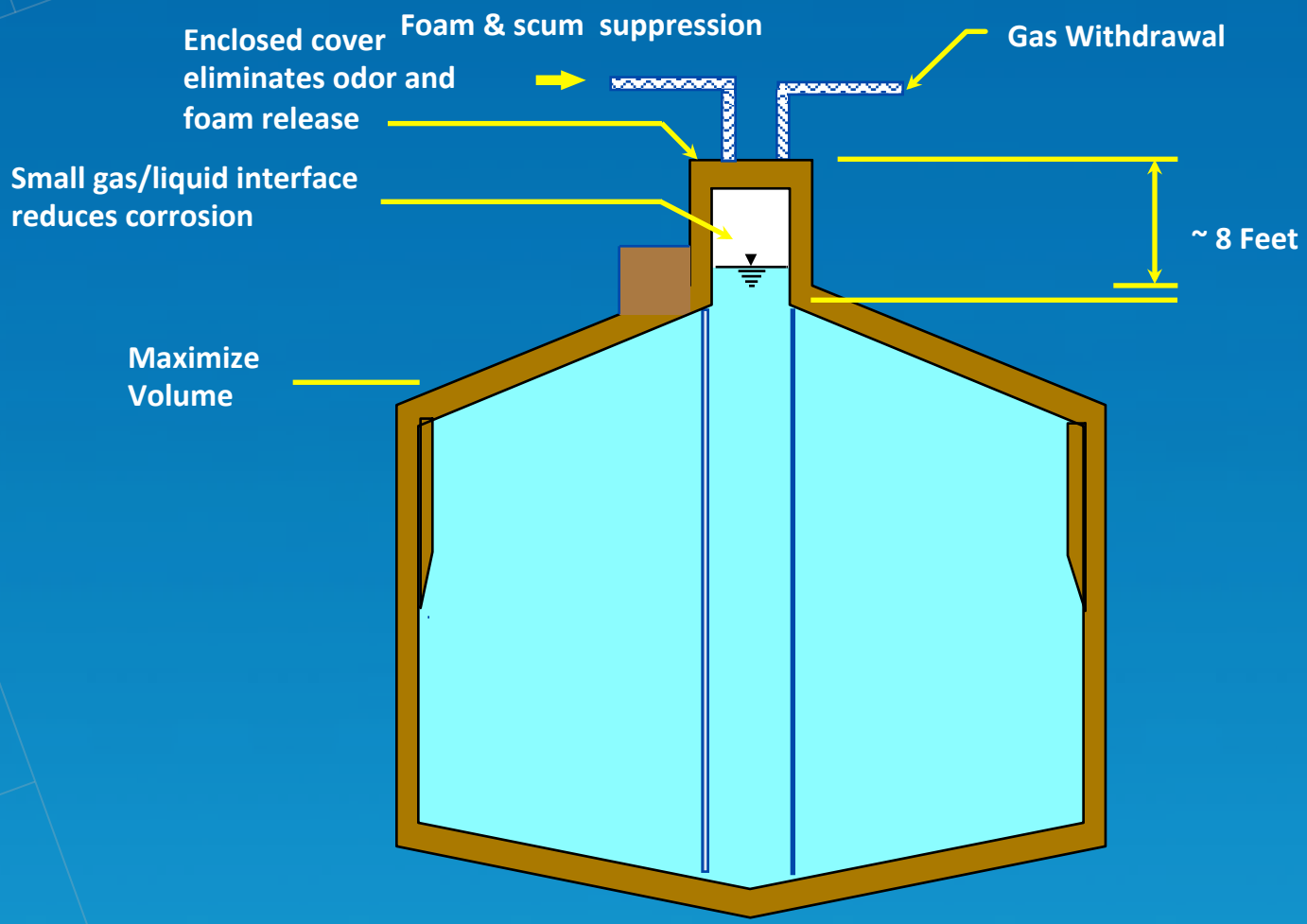



Gasholder Cover - Model GX by OTI 110-ft dia.
Toronto, Ontario
Designed for 30-in w.c.
Gas storage of 66,000 ft3

Egg Shape Digesters



Submerged Fixed Cover Design



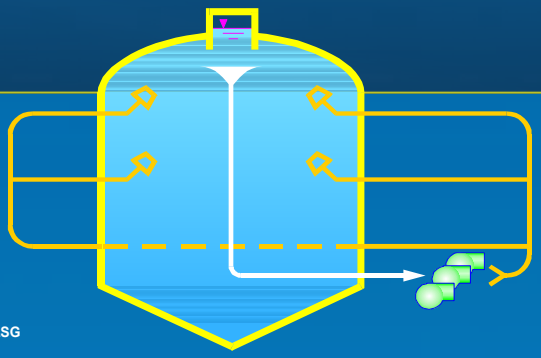
Submerged Fixed Digester Cover

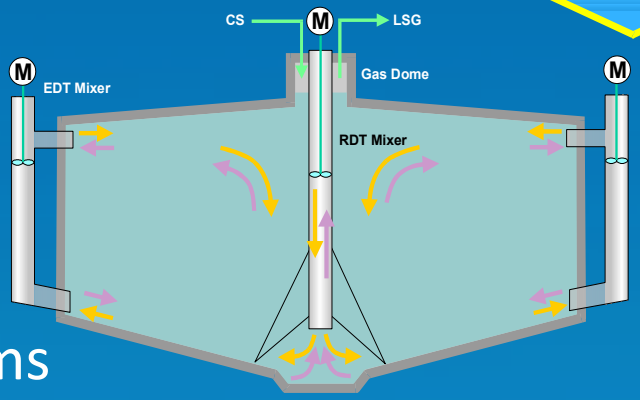
Membrane Gasholder Covers

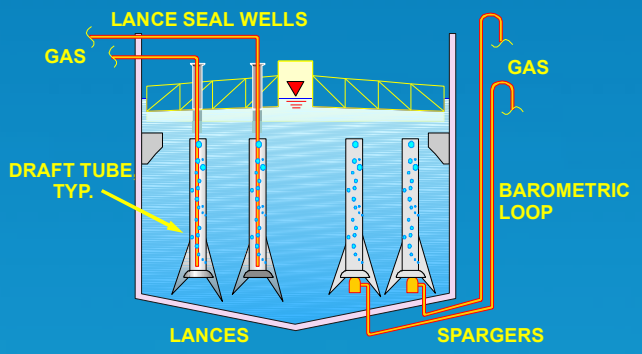
- A outer membrane
- B inner membrane
- C air flow system
- D belt system
- E anchor rail
- F non return valve
- G air blower
- H vacuum valve
- I over pressure valve
- J inspection window
- K ultrasonic

Digester Mixing Technologies Overview

- Pumped Recirculation Systems (JetMix™, Rotamix®)
- Draft Tube Mixers
- Gas 'Cannon' Mixing Systems
- Eimco LM™ (Linear Motion) Mixers





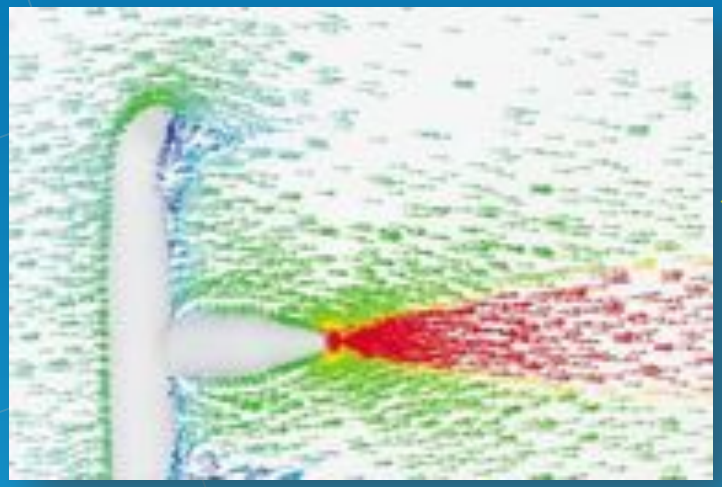


Pumped Recirculation Systems

Mixing Nozzle Assemblies:

Glass-lined Ductile Iron (RotaMix®) or Hi-Chrome Iron (JetMix ™) for abrasion resistance

- 3M™ Scotchkote™coatings & 10-year Nozzle Warranties (RotaMix®)
- Rotatable Nozzle Assembly (Optional for JetMix™ System)



← CFD model of nozzle illustrating induced Flow patterns

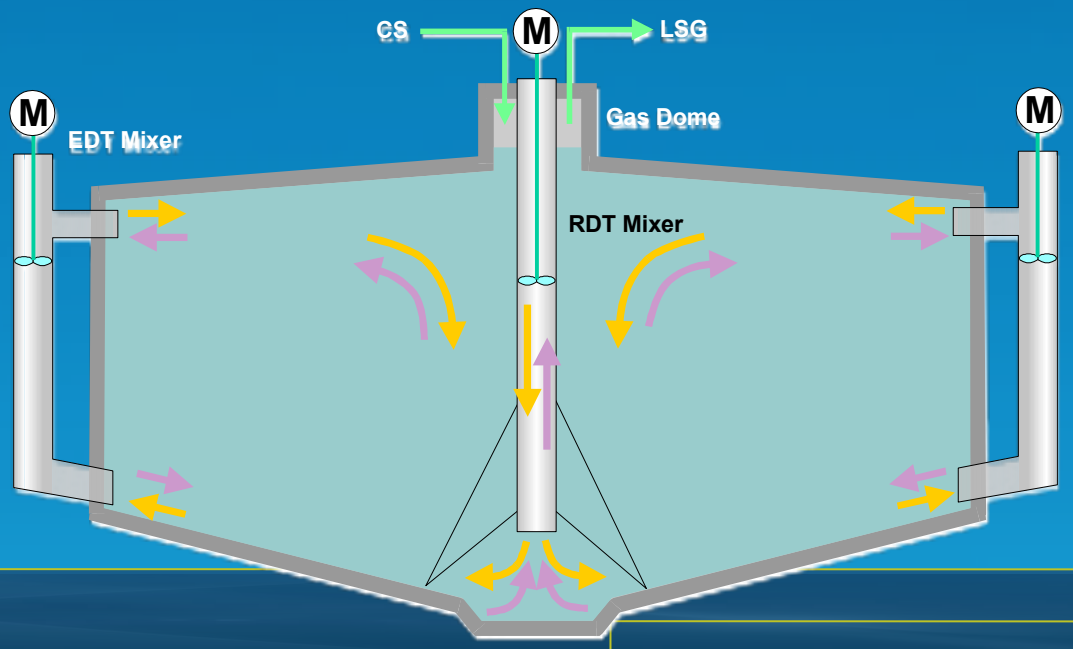
RotaMix® Double Nozzle Assembly

Draft Tube Mixing Systems

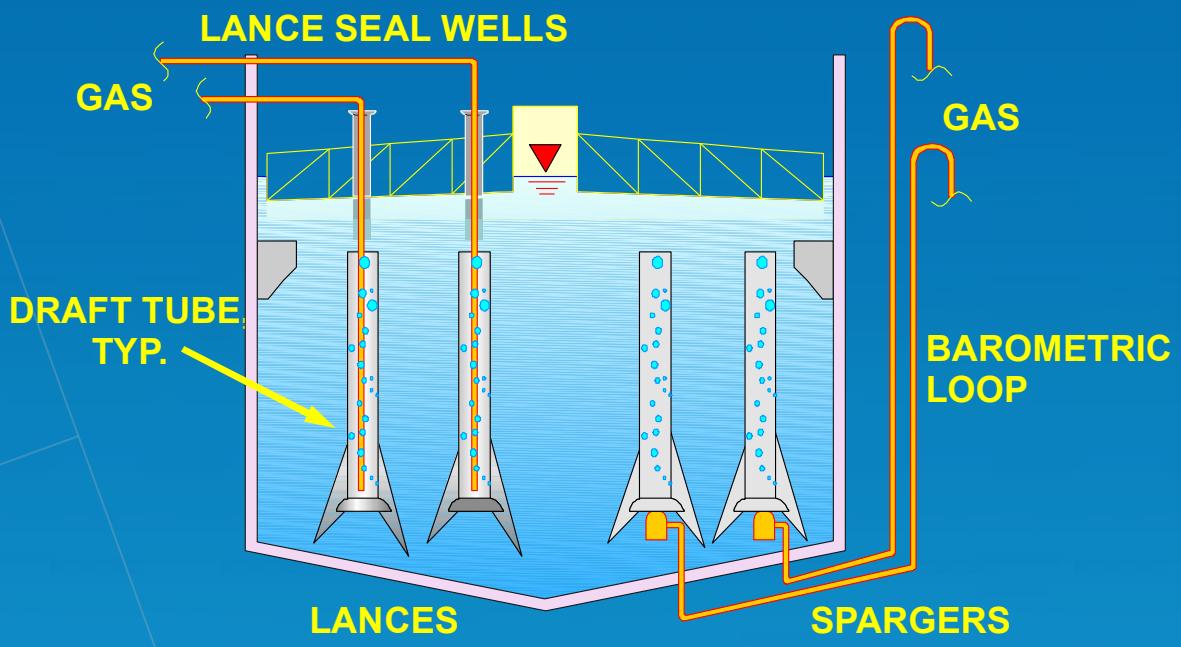
Internal vs. External Mixers

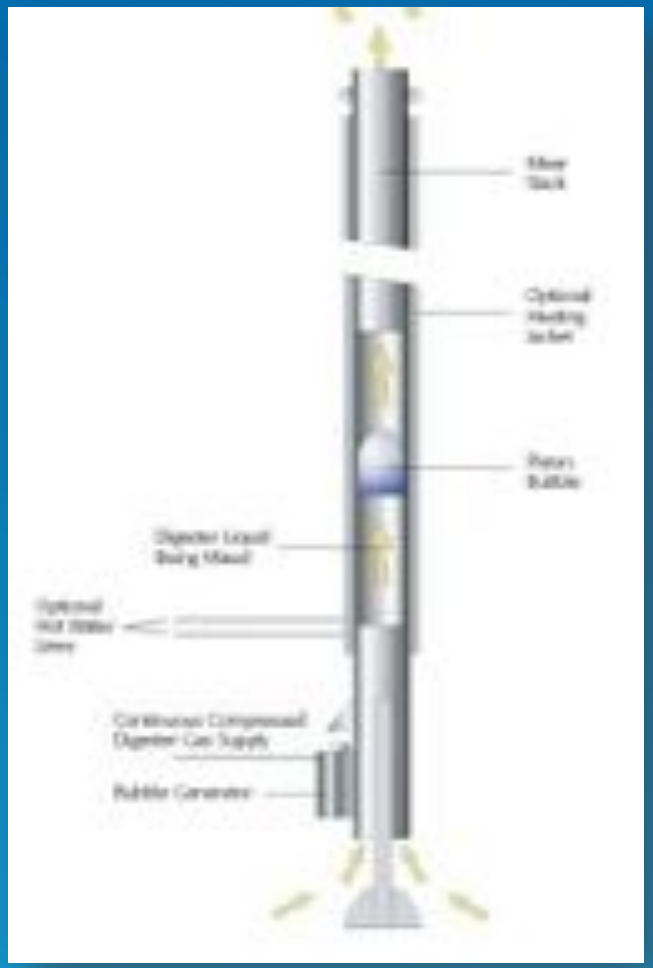
For a 115-ft diameter digester tank manufacturers have proposed three different options:

- (5) Internal draft tube mixers (All three manufacturers)
- (5) External + (1) Internal Draft Tube Mixers (WesTech & Eimco)
- (5) External Draft Tube Mixers (OTI)



Gas ‘Cannon’ Mixing Systems

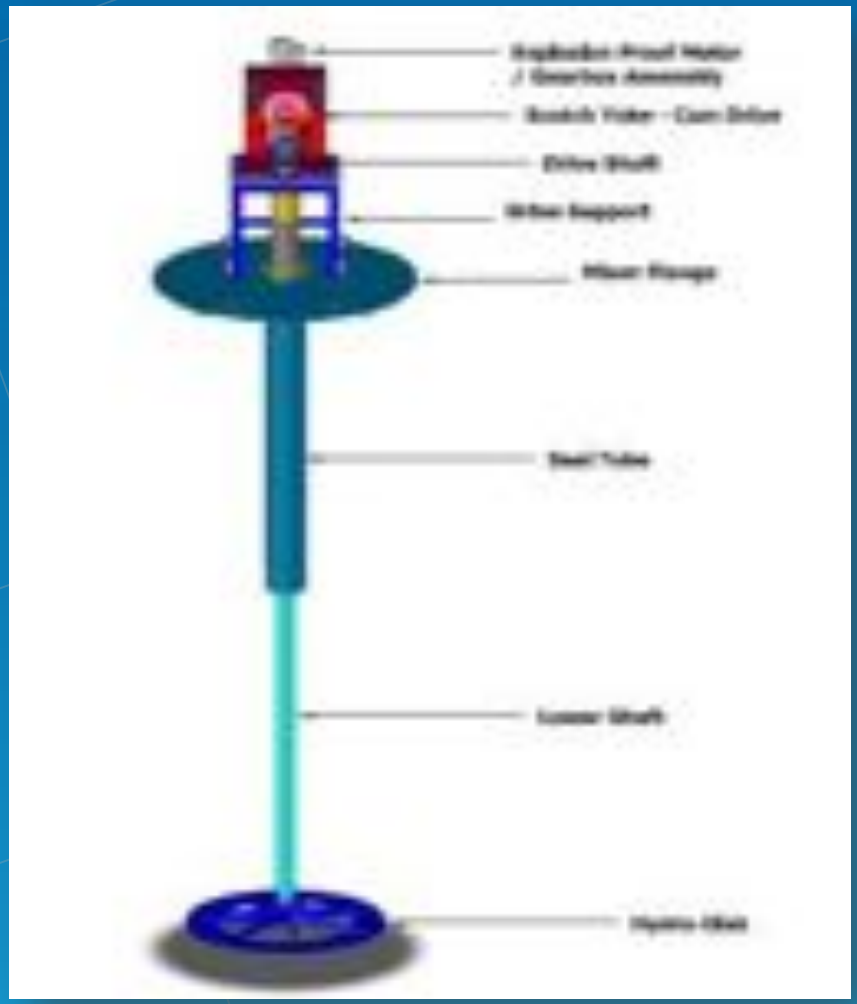




JDV Turbomixer® Digester Mixers

Linear Motion (LM™) Mixers

New Digester Mixing Design from Eimco & Enersave Fluid Mixers™



Advantages:

- Much lower power required (approx. 12.5 Hp per tank)
- Lowest mixing capital cost

Disadvantages:

- Mixing effectiveness in question
- Unproven technology; three digester installations in operation since Dec. '03
- Bearing and gearbox failures?

LAWPCA Treatment Facility

LAWPCA with Digestion Facility

System Description

- Two concrete digesters
  - 65 feet diameter, 25 foot side wall depth
  - ~700,000 gallons each
  - Sized for 15 day SRT at maximum month flows and loads
  - Concrete, submerged fixed covers
- Pump mixing system
- Sludge recirculation through HEX for heating
- Digested sludge storage tank with membrane cover
- Outside waste acceptance – modify existing septage receiving station

Combined Heat and Power (CHP) System Selection

- Estimated biogas production = 170,000 ft^3/day
- Cogeneration systems considered
  - Microturbines
  - Reciprocating Engines
- Engines selected over microturbines based on:
  - Higher efficiencies
  - Life cycle costs
  - Track record/number of operating installations
- Two – 230 kW engines (received $330,000 Efficiency Maine Grant)

CHP System Selection (Continued)

- Electricity used on site:
  - Provides all power for new digestion equipment
  - Reduces amount of power purchased from the utility for WW treatment
- Heat Reclaimed from engines
  - Provides heat for anaerobic digesters
  - Supplemental heat provided by dual fuel boilers (natural gas/biogas)

Biogas Treatment

- Biogas Treatment System
  - Foam separator and condensate/sediment removal traps
  - H_2S removal using Iron Sponge or SulfaTreat media
  - Moisture removal and gas boosting skid
  - Siloxane removal system to be added in the future, if necessary

Project Benefits

- Benefits that justify capital and O&M costs:
  - Reduces total solids by approximately 40%.
  - Eliminates the need to add lime to biosolids prior to land application.
  - Reduces biosolids odors, making land application program more acceptable.
- Eliminates transportation and tipping fees to haul biosolids to distant landfill.
- Produces biogas to generating electricity/heat for use on site.
- Potential for additional revenue from acceptance of outside wastes.