

CST INDUSTRIES, INC.



## Digester Tanks Fundamental Design Considerations



ENGINEERED STORAGE  
PRODUCTS COMPANY

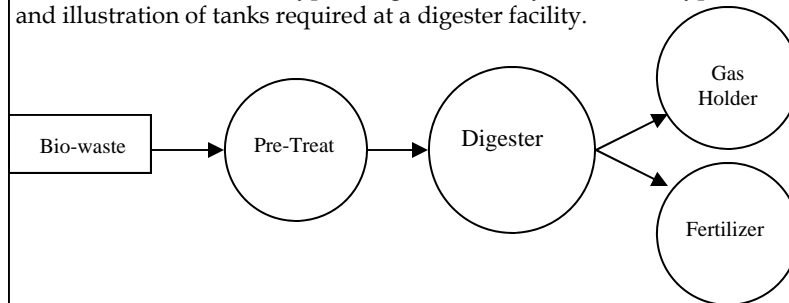


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## Introduction

This booklet is designed to introduce pre-engineered, sectional steel storage tanks for use with digestion processes of organic waste materials. This concept has been widely used in Europe since 1973 in the municipal and industrial sectors. These tanks are also commonly used for the ancillary tanks and gas-holders associated with a typical digestion facility. Below is a typical flow chart and illustration of tanks required at a digester facility.



Engineered Storage Products Co. (E.S.P.C.), a division of CST Industries, invented the process of chemically and physically fusing glass to steel (G.F.S.) for use in the sectional tank and silo industry in 1949. The resulting products have since been used as the storage solution in more than 120 countries. CST Industries is the world's largest designer and manufacturer of factory-coated steel tanks and, with its various operating divisions has the widest choice of coatings and finishes including glass-fused-to-steel, modified thermoset epoxies, hot dipped galvanized, and stainless steel. This wide range ensures that the correct specification finish is readily available for a wide range of storage applications - this is particularly important in the field of anaerobic digesters where the operating conditions can vary widely - from the extremely aggressive gas phase to the inert non-corrosive liquid phase.

Anaerobic digestion is a simple process which has been widely used in its simplest form for over one thousand (1,000) years in China and India as a means of breaking down organic waste with the use of naturally occurring bacteria; this process has a number of beneficial by-products, including biogas (for energy), digested solids (for fertilizer), and treated water (for low-grade uses such as irrigation or for further treatment to industrial or potable-grade water). Also, because it is a sealed system, bad odors are contained and controlled.

The first known glass-fused-to-steel anaerobic digesters were designed and manufactured using our glass technology and sectional tank design principles in 1973 for Severn Trent Water (sewage), Rowatt Institute (pig manure), and Chediston Farm (dairy cow manure). Since that time, glass-fused-to-steel bolted and thermally applied epoxy coated steel tanks have been successfully used in North America, Europe, Africa, Asia, and Australasia. They have been shown to offer long, minimal maintenance life which is a direct result of the roof systems and tank walls benefiting from having high-quality coatings applied in ideal conditions in the factories - coating applications and steel preparation are the keys to a long operational life. In addition, a wide range of stringent tests and inspections are carried out on the coated components before they are released to be packed in high-specification export skids for loading into containers for shipment across the world. These quality factory-coated systems give real performance benefits to operators and owners in terms of extremely low maintenance and much reduced shutdown times when compared to the traditional methods of tank construction which rely on site-applied coatings in the aggressive internal gas zones. Other benefits for the sectional tank concept are that they are designed by the manufacturer, complete compatibility for different mixing systems, shipped in a timely manner, constructed by local labor under skilled supervision, and considerable construction program savings.

### **Digester Process Comparisons**

The digestion of organic waste can occur in environments with or without the presence of oxygen. Below are some comparisons between anaerobic vs. aerobic and mesophyllic vs. thermophyllic digesters. E.S.P.C. tanks can be used in both applications.

	<b>Anaerobic</b>	<b>Aerobic</b>
<b>Oxygen</b>	Absent	Required
<b>By-products</b>	Valuable methane and nutrient-filled sludge	Sludge
<b>Odor</b>	Controlled in sealed digester	Not controlled, may be a problem
<b>Concentration of Wastewater</b>	Preferred for higher concentrations	Preferred for lower concentrations
<b>“Footprint” of holding tank</b>	Smaller tanks required, typical height-to-diameter ratio 1:1	Large surface area required, large diameter, lower height
<b>Speed of Digestion Process</b>	Faster (controlled environment)	Slower, longer retention time
<b>Environment for Microbes</b>	Controlled	Subject to cold weather and dilution
<b>Excess Sludge Production</b>	Low	High
<b>Toxicity of Organic Waste</b>	No toxic components	Some toxic components under certain conditions
	<b>Mesophyllic</b>	<b>Thermophyllic</b>
<b>Temperature Range</b>	10-40°C (50-104°F)	60-80°C (140-176°F)
<b>Methane Production</b>	Lower, due to slower decomposition	Greater, due to higher temperatures
<b>Retention Time</b>	Longer	Shorter
<b>Weed &amp; Plant Seeds</b>	No effect	Kills most

**Digester Tank Roofs**

Engineered Storage Products Co. defines 3 standard roof designs, including Light, Medium, and Heavy, based on tank dimensions, operating pressures, and roof loads. Each can be designed to accommodate roof- or wall-mounted mixers.

	Test (mm/in-water column)	Operating (mm/in-water column)
Light Design Pressure:	300mm (12")	200mm (8")
Light Design Vacuum:	50mm (2")	25mm (1")
Medium Design Pressure:	450mm (18")	300mm (12")
Medium Design Vacuum:	50mm (2")	25mm (1")
Heavy Design Pressure:	600mm (24")	450mm (18")
Heavy Design Vacuum:	100mm (4")	50mm (2")

E.S.P.C. standard roof slope is 12.5°. Gas take-off, pressure relief, viewing ports, sampling ports, etc. are positioned in the roof center cap. This is a flat, level area and putting the fittings in this one central location simplifies the access arrangement. External support members to reduce condensate traps, minimizing potential corrosion points.



## Tank Walls

Tank walls can be fabricated from glass fused-to- steel, epoxy-coated steel, stainless steel, or black steel

Vitrium - E.S.P.C.'s high specification 3-coat glass fused-to-steel coating entirely suitable for the very aggressive gas zone - high performance, low maintenance

Kuolon™ - E.S.P.C.'s proprietary thermoset epoxy coating with exceptional resistance to low pH, ideal for the very aggressive gas zone - high performance, low maintenance

Stainless Steel - Grade 316 - Excellent resistance in the gas zone

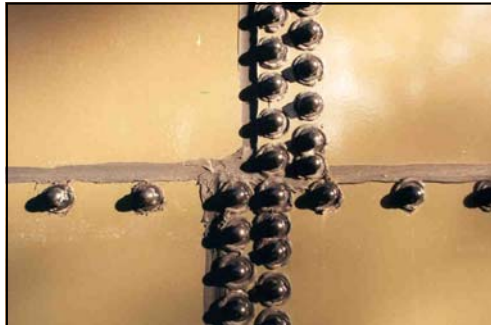
Black Steel - Carbon steel is an option for the non-corrosive liquid zone where no oxygen is present, thus, no corrosive activity.

The quality and operational performance benefits of applying coatings in strict factory conditions with stringent test and inspection regimes are well recognized.



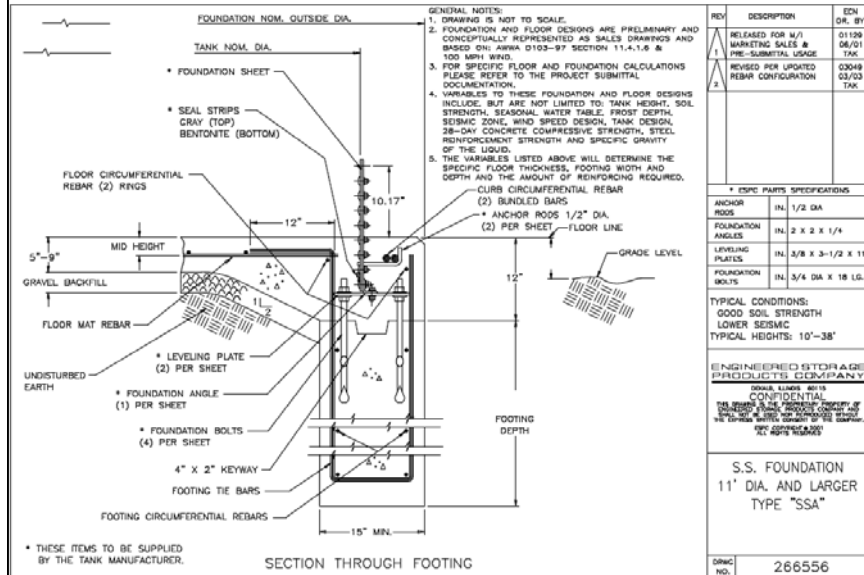
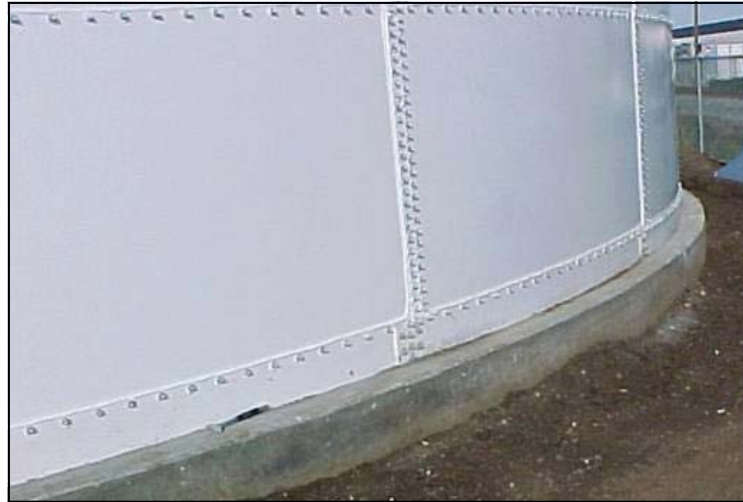
Typical E.S.P.C. jack-lifting tank during construction.

Typical E.S.P.C. 4 panel joint (exterior view)



### Typical Tank Wall-to-Foundation

Fundamentally, there are 3 components to a digester tank, including the roof, walls, and floor (foundation). Below are photos and engineering drawings of the crucial wall-to-foundation connection. Note that the bottom ring is embedded in the foundation for structural integrity and long-lasting seal.





## Why Sectional Steel Digester Tanks?

Sectional steel digester tanks are preferred over alternative storage tanks because they are:

**+Better**

Structural integrity guaranteed in design and fabrication in the factory. Factory coated in controlled environment. Easy to clean. Long life with low maintenance. Easy to retrofit additional equipment. No crevices or ledges for promoting internal corrosion.

**+Faster**

Standardized components are shipped directly to the site, factory coated, ready-to-assemble. Only basic tools are needed for the local, semi-skilled laborers.

**+More Economical**

Low-skilled laborers can be used for construction. Excluding the special jacks, only basic tools are required for tank assembly. No welding required. No field painting required.

Rapid Assembly = Low Construction Cost

**+Safer**

Tank walls are assembled and jack-raised into position. No workers on scaffolding or lifts.

**+Proven** - in large-scale municipal and industrial applications.

## Why E.S.P.C. Sectional Steel Digester Tanks?

Engineered Storage Products Co. digesters and storage tanks are preferred for these applications for the following reasons:

**+Experience**

E.S.P.C. engineers are the original developers of G.F.S. and proprietary thermoset epoxy for sectional storage tanks.

**+Stability**

Over 100 years of fabricating sectional storage tanks, international sales, fabrication, and support operations.

Engineered Storage Products Co. and its sister-companies are the leading manufacturers of bolted steel storage tanks, including tanks for pre-acidification, thickeners, sludge storage, gas holders, lime, etc.





**Request for Quotation (R.F.Q.)**  
**What We Need to Know - (And Where To Send It)**

1. Project Name
2. Project Location
3. Contact Information
4. Seismic Zone
5. Wind Speed
6. Capacity or Preferred Dimensions
7. Quantity
8. Product Stored
9. Specific Gravity
10. Product Temperature
11. Minimum and Maximum pH
12. Roof Design Live Load
13. Maximum Pressure
14. Maximum Vacuum
15. Mixer? Roof mounted? Wall mounted?
16. If there is a mixer, provide mixer weight, loads, forces, and moment.
17. Product Zone (Tank side walls): G.F.S.? Epoxy? S/S? Black steel?
18. Vapor Zone: G.F.S.? Epoxy? S/S?
19. Nozzles, Ladders, Other Accessories?

**E-mail these details to: [info@tanks.com](mailto:info@tanks.com)**

## Glossary of Terms

**Aeration** - A process in which air is added to a solution. In aerobic wastewater treatment, air is introduced with mechanical action or submerged diffusers.

**Aerobic Digestion** - An open system that utilizes oxygen and biologically treats waste with naturally occurring organisms

**Anaerobic Digestion** - A completely closed system (oxygen-free) that biologically treats waste with naturally occurring organisms

**Baffle** - Fixed plate mounted to the digester tank wall to enhance turbulence of the slurry being agitated

**Biogas** - Corrosive vapor composed of approximately 60% methane and 40% carbon dioxide, including 0.2-0.4% hydrogen sulfide

**Gas phase** - Area of the tank wall and roof containing the biogas

**Liquid phase** - Area of the tank that contains the organic waste where bacteria are active with no oxygen present, therefore no corrosive activity

**Mesophyllic** - Anaerobic digestion process, normally between 10-40°C (50-104°F)

**Methane** - CH<sub>4</sub>, useful by-product from anaerobic digestion, colorless, flammable gas, the primary component of natural gas

**Mixer** - Mechanical device to agitate the tank contents, may be mounted on the roof or sidewall of the tank, to keep solids in solution and prevent "crust" layer from forming on top of sludge

**Sludge** - Semi-solid substance, in this context, a by-product of wastewater (industrial or municipal) treatment

**Thermophyllic Digestion** - Anaerobic digestion process at elevated temperature, normally between 60 - 80°C (140-176°F)

CST INDUSTRIES, INC.

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