Anaerobic Digester Covers

ENVE 737
Anaerobic Biotechnology for Bio-energy Production
Keep $O_2$ out of anaerobic environment in digesters.

- Prevent biogas and odors from escaping to atmosphere
- Reduce explosion hazard associated with CH4 in biogas
- Insulate the top of digesters.

There are four basic types of digester covers:

- Fixed covers
- Floating covers
- Gas-holder covers
- Membrane covers
## Digester cover features

<table>
<thead>
<tr>
<th></th>
<th>Fixed cover</th>
<th>Floating cover</th>
<th>Gas holder cover</th>
<th>Membrane cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drawdown capability</td>
<td>Not</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Gas storage</td>
<td>No</td>
<td>No</td>
<td>Yes (limited)</td>
<td>Yes</td>
</tr>
<tr>
<td>Odor potential</td>
<td>Low</td>
<td>Moderate</td>
<td>Low to moderate</td>
<td>Low</td>
</tr>
<tr>
<td>Recommended use</td>
<td>Primary digesters</td>
<td>Primary or secondary digesters</td>
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</tr>
</tbody>
</table>
Available in several types of construction.

Reinforced concrete covers may be flat-slab shaped or dome-shaped and may be self-spanning or column-supported with material of varying thicknesses.

Some are constructed of steel plates welded to the upper chord of a truss or to an arch-rib supporting framework.

Supporting framework is connected to the top of the wall by a sliding arrangement that allows the cover to expand or contract in response to changes in temperature.
Fixed Covers

- Flat Fixed Cover
- Domed Fixed Cover
- Walker Process Equipment Arched Beam Fixed Cover

- Manhole
- Pressure/Vacuum relief
- Cover
Fixed Covers

Steel Truss Structure
- Include steel plates welded to both the top and bottom of the trusses to form an attic space, which protects the structural members from corrosion and provides insulation for sludge.

Radial Beam Structure
- With no ceiling plates and 50% less field weld length than a truss cover, beam covers are a very economical choice for AD covers.
Fixed Covers
Fixed Covers

- Fixed-cover ADs require attention during feeding and withdrawal; incoming flow must equal the outgoing flow.
- Feeding without withdrawing an equal volume will cause overpressure, which can lift cover from its wall mountings.
- Withdrawal without a feeding will create a vacuum that can damage the cover or cause it to collapse.
- Both overpressurization and vacuum conditions can be alleviated by installing safety relief valves.
- Even with relief valves, fixed-cover systems often develop gas leaks at the interface of cover and wall.
Fixed cover AD with biogas holder

Fixed cover AD with a biogas holder  Biogas holder with lightning protection
Floating Covers

- Float directly on the liquid surface, supported by a system of roller bearings and guide rails along the digester wall that controls both vertical and lateral movement of the cover and prevents excessive tilting.

- The guide rail systems are available in vertical or spiral configurations; while vertical systems are less complex, the spiral systems provide more efficient control of the cover’s vertical movement.
Floating Covers

- Range of vertical motion of floating covers is typically 1.5-3 m with a corresponding capacity for solids drawdown.
- Floating covers can vary the liquid level in the digester without the danger of over- or under-pressurization.
- Because it rises and descends with the liquid level, a floating cover compensates for the suction created when removing solids, as well as minimizes the possibility of over-pressurization during solids addition.
Floating Covers

Walker Process Equipment
Radial Truss Floating Cover
Floating Covers

Floating Cover is to be positioned in an AD
Gas-Holder Covers

- Similar to floating covers; however, they are designed to accommodate gas storage as well as digester drawdown.
- The gasholder cover, which floats on digester gas rather than on the liquid surface, is equipped with a skirt that extends below the liquid surface to contain gas.
- A concrete ballast ring below the skirt stabilizes the cover and helps control gas pressure.
Gas-Holder Covers

- Cover has to be checked periodically to ensure that it is level and moves freely.
- A tilted cover may reflect uneven loading resulting from water accumulation in the attic space, snow buildup, or binding between the wall and the cover skirt.
- Excessive foaming may also be obvious during the cover inspection.
Gas-Holder Covers

Roller axis
Gas-Holder Covers

Walker Process Equipment Gas Holder Cover
Membrane covers

- Provide gas storage and separate AD from atmosphere.
- Consist of an inner and an outer membrane.
- Both membranes are attached to tank wall, preventing escape of gas to atmosphere.
- Fixed outer membrane is inflated by a blower system.
- Inner membrane is inflated and deflated in response to the volume of gas in the digester headspace.
- Inner membrane can travel up & down the entire depth of tank, enabling it to be almost completely emptied.
Membrane covers

- Pressure/Vacuum Relief Valve
- Center Gas Dome
- Air Supply/Bleed
- Reticular Dome Structure
- Air Membrane
- Gas Membrane
- Digester Gas Inlet/Outlet
Membrane 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
Membrane covers

Siemens Water Technologies - Dystor® gas holder system

Specifically designed for active primary digesters that have the potential for foaming, the high location of the gas take-off in this configuration keeps the foam from reaching the gas piping.

Mounted directly on a concrete foundation ring, a separate storage gas holder costs substantially less than a high-pressure gas storage sphere and does not require the use of gas compressors.
Membrane covers

EWT™ Ultrastore™ Membrane Gas Holders
Exposed surfaces of ADs are vulnerable to corrosion caused by high concentrations of \( \text{H}_2\text{S} \) in digester gas.

If the digester is operating at a low pH, \( \text{CO}_2 \) can form carbonic acid, which is also corrosive.

Areas affected by corrosion include surfaces that are not submerged, such as undersides of covers, tank walls above liquid surface, and exterior surface of covers, which are exposed to the atmosphere.
Corrosion Protection

- If there are leaks in cover that allow gas to collect in attic space, structural elements of cover may also corrode.
- Corrosion can be minimized by using corrosion-resistant construction materials, protective coatings, and cathodic protection.
- Typically, cover needs to be recoated every 5 to 10 years, depending on the location and weather conditions.
- Covers that show significant corrosion should be evaluated for structural integrity.