Covered Lagoon Digesters: Technical Details

Information excerpted from: Biomethane from Dairy Waste: A Sourcebook for the Production and Use of Renewable Natural Gas in California

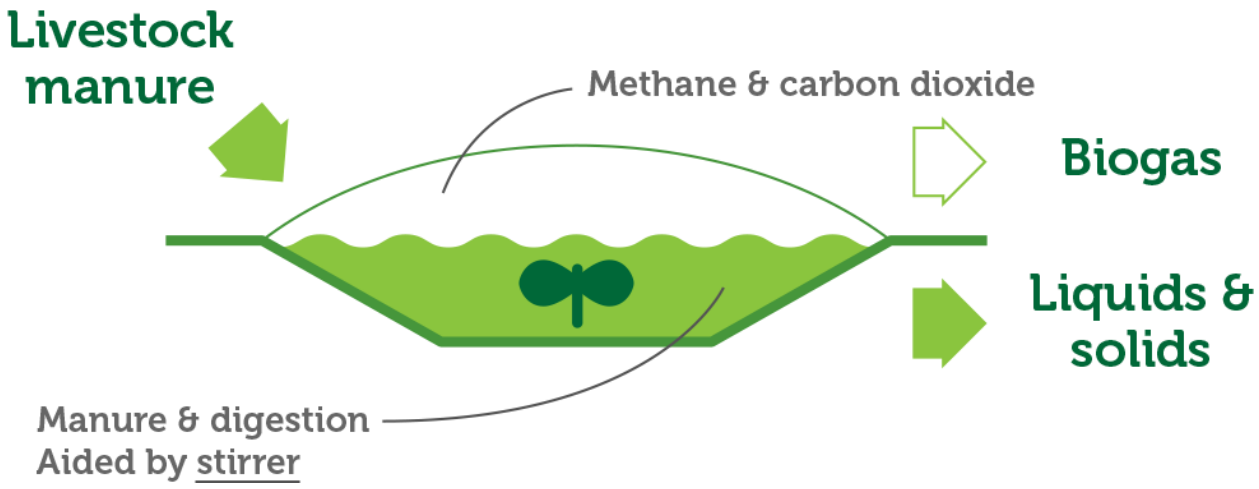
Description of a Covered Lagoon Digester

A cover can be floated on the surface of a properly sized anaerobic lagoon receiving flush manure to recover methane. The most successful arrangement includes two lagoons connected in series to separate biological treatment for biogas production and storage for land application. A variable volume one-cell lagoon designed for both treatment and storage may be covered for biogas recovery. However, a single-cell lagoon cover presents design challenges not found in constant-volume lagoons and will require assistance of professionals familiar with the design, construction and operation of these systems.

The primary lagoon is anaerobic and operated at a constant volume to maximize biological treatment, methane production, and odor control. The biogas recovery cover is floated on the primary lagoon. Ideally, manure contaminated runoff is bypassed to the secondary lagoon. The secondary lagoon is planned as variable volume storage to receive effluent from the primary lagoon and contaminated runoff to be stored and used for irrigation, recycle flushing, or other purposes.

Temperature is a key factor in planning a covered lagoon. Warm climates require smaller lagoons and have less variation in seasonal gas production. Colder temperatures in northern California will reduce winter methane production. To compensate for reduced temperatures, loading rates are decreased and hydraulic retention time (HRT) is increased. A larger lagoon requires a larger, more costly cover than a smaller lagoon in a warmer climate. Reduced methane yield may decrease the return on investment.

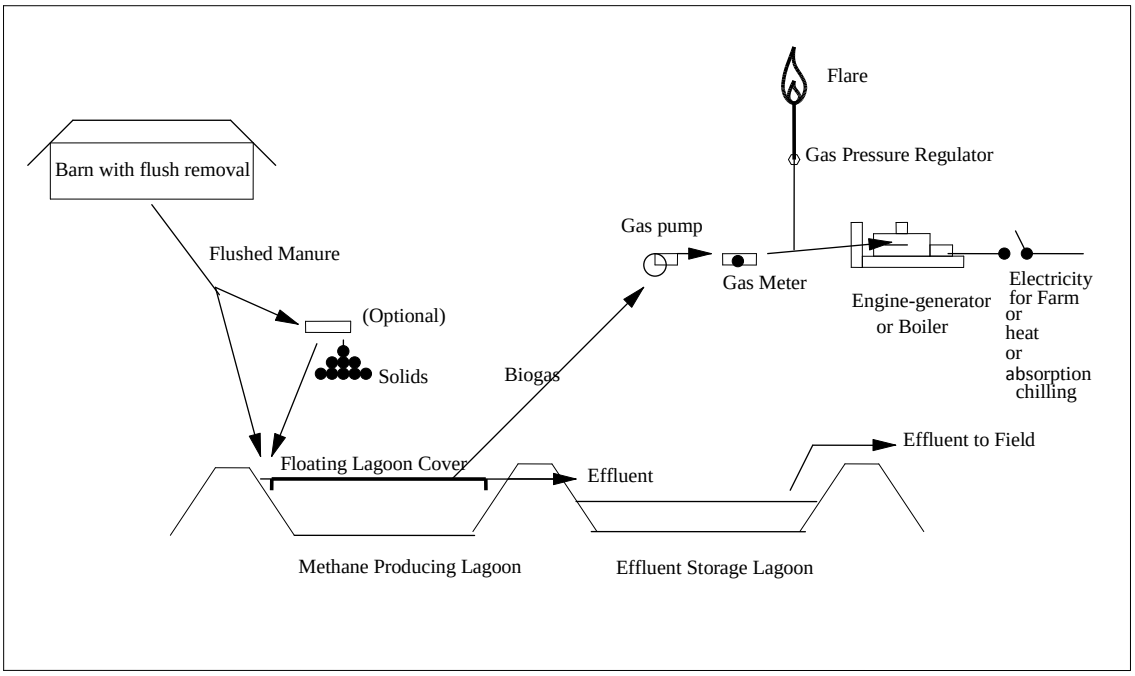
Covered Lagoon Digester: How it Works



Components of Covered-Lagoon Digester

- *Solids separator*. A gravity solids trap or mechanical separator should be provided between the manure sources and the lagoon.
- *Lagoons*. Two lagoons are preferred; a primary anaerobic waste treatment lagoon and a secondary waste storage lagoon.
- *Floating lagoon cover*. The most effective methane recovery system is a floating cover over all or part of the primary lagoon.
- *Biogas utilization system*. The recovered biogas can be used to produce space heat, hot water, cooling, or electricity.

Covered Lagoon with Methane Utilization



Covered-Lagoon Design Variables

- *Soil and foundation*. Locate the lagoons on soils of slow-to-moderate permeability or on soils that can seal through sedimentation and biological action. Avoid gravelly soils and shallow soils over fractured or cavernous rock.
- *Depth*. The primary lagoon should be dug where soil and geological conditions allow it to be as deep as possible. Depth is important in proper operation of the primary lagoon and of lesser importance in the secondary lagoon. Deep lagoons help maintain temperatures that promote bacterial growth. Increased depth allows a smaller surface area to minimize rainfall and to cover size, which reduces floating cover costs. The minimum depth of liquid in the primary lagoon should be 12 ft.
- *Loading rate, hydraulic retention time and sizing of primary lagoon*. The primary anaerobic lagoon is sized as the larger of volatile solids loading rate (VSLR) or a minimum HRT. The VSLR is a design number, based primarily on climate, used to size the lagoon to allow adequate time for bacteria in the lagoon to decompose manure.
- *Volatile solids loading rate*. Figure B-3 below shows isopleths for the appropriate loading rates for a constant volume primary lagoon in a two-cell lagoon system.
- *Primary lagoon inlet and outlet*. The primary lagoon inlet and outlet should be located to maximize the distance across the lagoon between them.

- *Rainfall*. Rainfall is not a major factor in determining the potential success of a covered lagoon. In areas of high rainfall, a lagoon cover can be used to collect clean rain falling on the cover and pump it off to a field. In areas of low rainfall, a lagoon cover will limit evaporation and loss of potentially valuable nutrient rich water.
- *Cover materials.* Many types of materials have been used to cover agricultural and industrial lagoons. Floating covers are generally not limited in dimension. A floating cover allows for some gas storage. Cover materials must be: ultraviolet resistant; hydrophobic; tear and puncture resistant; non-toxic to bacteria; and have a bulk density near that of water. Availability of material, serviceability and cost are factors to be considered when choosing a cover material. Thin materials are generally less expensive but may not have the demonstrated or guaranteed life of thicker materials. Fabric reinforced materials may be stronger than unreinforced materials, but material thickness, serviceability, cost and expected life may offset lack of reinforcement.
- Cover installation techniques. A lagoon cover can be installed in a variety of ways depending upon site conditions. This table describes several options.
- *Full perimeter attachment.* The entire lagoon surface is covered and the edges of the material are all attached to the embankment.
- *Completely floating or partially attached cover.* The cover may be secured on the embankment on one to three sides or the whole cover can float within the lagoon. All or some of the sides may stop on the lagoon surface rather than continuing up the embankment.

Features of a Floating Methane Recovery Lagoon Cover

Features	Description
Bank Attachment Options	See diagram below
Rainfall Management	Rainfall may be pumped off the cover or drained into the lagoon.
Securing Edges of a Floating Cover	The edges of the cover can be buried in a perimeter trench on the lagoon embankment or attached to a concrete wall. Floating edges not secured directly on the embankment need support in place. A corrosion resistant rope or cable is attached to the cover as a tie-down and tied to an anchor point.
Skirting	Portions of the cover floating in the lagoon require a perimeter skirt hanging into the lagoon from the cover.
Anchor Points	Anchor points for cable or rope may be driven metal stakes or treated wood posts.
Float Logs	A grid of flotation logs is attached to the underside of the cover. The float logs may be necessary as gas collection channels, to minimize gas pockets and bubbles under the cover.
Weight Pipes	A grid of weight pipes may be laid on the cover surface to help hold the cover down.
Gas Collection	Biogas bubbles to the surface of the lagoon and migrates across the underside of the cover. A gas pump maintains a vacuum under the cover. A gas collection manifold is attached to the cover. A gastight through-the-cover, through-the-attachment wall or under the buried cover gas pipe carries biogas to a biogas utilization system.

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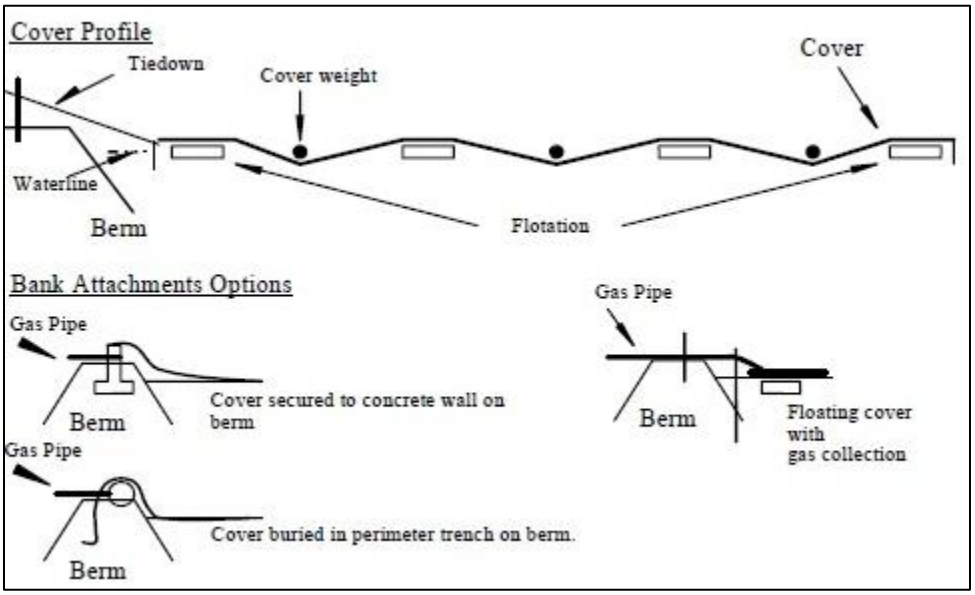
Bank Attachment Options



Operation and Maintenance of Covered-Lagoon Digester

The operation and maintenance of a covered lagoon should be relatively simple.

- *Primary lagoon — operation*. The proper design and construction of a primary lagoon leads to a biologically active lagoon that should perform year round for decades. Any change in operation will most likely be due to a change in farm operation resulting in an altered volatile solids loading or hydraulic load to the lagoon. The owner should make a visual inspection of lagoon level weekly.
- *Primary lagoon — maintenance*. Minimal maintenance of the primary lagoon is expected if the design volatile solids and hydraulic loading rates are not changed. Lagoon banks should be kept free of trees and rodents that may cause embankment failure. Weeds and cover crops should be cut to reduce habitat for insects and rodents. Occasional plugging of inlet and outlets can be expected. Sludge accumulation may require sludge removal every 8 to 15 years. Sludge can be removed by agitating and pumping the lagoon or by draining and scraping the lagoon bottom.
- *Cover operation.* Operating a lagoon cover requires removing the collected biogas from below the cover regularly or continuously. Large bubbles should not be allowed to collect. If the cover is designed to accumulate rainfall for pumpoff, accumulated rainwater should be pumped off.
- *Cover maintenance*. The cover should be visually inspected weekly for rainwater accumulation, tearing, wear, and proper tensioning of attachment ropes. The rainwater pumpoff system should be checked after rainfall and maintained as needed.