

MITIGATING AIR EMISSIONS FROM ANIMAL FEEDING OPERATIONS

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A New Geosynthetic Cover for Odor Control and BioGas Collection

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Species: Dairy, Beef, Swine
Use Area: Manure Storage, Manure Treatment
Technology Category: Cover
Air Mitigated Pollutants: Ammonia, Methane, Hydrogen Sulfide, Volatile Organic Carbon, Odor

Description:

Geosynthetic covers have been used for a number of years for the control of odors from liquid manure ponds. Current projects are concentrating on large biogas collection covers that require skilled installation and significant installation time. This paper introduces a new prefabricated impermeable manure containment cover that is designed to make smaller projects economical. The cover is adaptable for a number of manure storage applications including ponds with variable liquid levels (slurry storage) and ponds with constant liquid levels (biogas collection).

Mitigation Mechanism:

It has been reported that impermeable covers reduce odor from manure ponds by 95% (Nicolai et al., 2004 and Bicudo et al., 2004). The value is typically not 100% because pond covers can be removed periodically for agitation and pump out of manure. A geosynthetic impermeable cover will prevent the release of volatile compounds and gases to the environment. There are two main cover designs.

Slurry Storage. The first mechanism is the prevention of evaporation of volatiles from the surface of the manure pond. The impermeable cover prevents the surrounding air from contacting the pond surface suppressing evaporation. The space underneath the cover becomes saturated with water vapor and other gases restricting the movement of volatiles and keeping odor causing gases in solution. Any gas that accumulates is drawn off and destroyed with a flare or other device. Often a slight vacuum is applied to the underside of the cover to keep the cover flat on the liquid surface (controlling head space). This type of system is often used in swine operations and gas destruction is metered for carbon credits in some countries. In swine operations an annual agitation and pump-out are common practices. Odor control is often compromised during this pump-out activity and covers are frequently damaged. Key factors in the design of this cover type are that the cover needs to move up and down with the manure level and must accommodate agitation and pump-out.

Biogas Collection. The second mechanism is to use an impermeable cover to create an anaerobic digester for the treatment of manure contaminated water. Typical of the dairy and beef industry this mechanism uses a solids separation step to keep the dissolved solids low (often less than 5%) and to recover bedding material. The waste water goes to a covered pond where significant biogas can be produced. The biogas can be collected for alternative energy use or flared. In this type of system the cover can often lift off the surface of the pond storing gas underneath the cover. The most successful covers are operated at a constant liquid level and are never opened for agitation or pump-out. In these digester systems all gases are contained and either destroyed or used. Any emissions that do occur are from the biogas use system and can include products of combustion such as oxides of nitrogen or sulfur. Recent designs in California are cleaning the biogas and selling it as utility gas which transfers the burning of the gas off the farm entirely. Once covered these ponds do not produce any discernable odor. Key factors in the design of this cover type are the efficient movement of biogas and the tension in the cover to prevent wind damage when lifted.

Applicability:

Current practice in geosynthetic covers is to fabricate the cover on-site using a specialized crew. This type of construction is applicable to large scale installations but is not economical for smaller facilities. Layfield's new prefabricated cover design requires less on-site expertise and can be installed economically on smaller installations. This new patent-pending design incorporates pockets in the cover that can hold floats or weights. These floats and weights are factory fabricated further reducing field installation requirements. Fabricated covers are made up to 2400 m² (about half an acre) in one piece and larger covers are welded together in the field. This new cover design would be

applicable to ponds up to about 20,000 m² (5 acres). Larger covers would be fabricated on-site using a specialized crew.

Slurry Storage Covers are normally used in the swine industry for odor control but are applicable to any manure storage where the solids content is above 5%. These covers are used to control odors through the prevention of evaporation of volatiles and gases during the storage of the manure. The end use for the manure in these applications is land application which is typically done annually. The cover needs to accommodate pond level changes from empty at the beginning of the season to full just prior to agitation and pump out. Floats and weights in the cover are needed to control the slack that develops as the cover changes levels. The troughs formed by these floats and weights are used for rain removal on top of the cover (small pumps are used to remove the water). Layfield's new cover design used factory fabricated floats to create the rainwater and slack control systems. Although biogas handling is usually not the main purpose of a slurry storage cover some gas handling under the cover is required. Layfield's design includes a gas collection pipe around the perimeter. Previous slurry storage cover designs required that the covers be pulled back for agitation and pump-out. Layfield's design includes a large hatch that can be opened for agitation and pumping. The hatch allows the cover to be permanently installed reducing the chances for damage and leakage. Careful selection of agitation systems to protect these covers is recommended. Enclosed jet pumps are recommended over open propeller type pumps and air agitation systems are preferred over mechanical agitation. A modified design of the slurry storage cover is available for manure storage tanks; however, tank storage agitation and pumping issues have not been completely resolved yet.

Biogas Collection Covers are applicable to anaerobic digesters and water treatment systems with low solids contents (less than 5%). This type of system is typical of dairy or other facilities where there is effective solids separation prior to water treatment. This is also the system that would be applicable to industrial waste water treatment systems. The water level of these systems is constant and the covers are designed with no slack in the system. The cover is floated into place on a full pond and not removed for the design life of the cover. The small amount of slack in the cover is important to limit cover lifting under the pressure of biogas. The cover is weighted with a series of special weights to prevent wind damage of the lifted cover. Layfield's new cover design uses liquid filled weights that are prefabricated in the factory. These weights are filled after cover deployment and can be drained if the cover needs to be removed for maintenance in the future. In most locations these weights would be filled with water and would only exert tension once the cover starts to lift. Weight fluids with low freezing points can also be used to retain weight tube flexibility in cold temperatures. Additional sand-filled weight tubes are added after cover installation where factory fabricated pockets are not practical. Factory fabricated floats may also be included in these types of covers to enhance biogas movement to a perimeter collection pipe. Rainwater control is done by small pumps at the intersections of the cover weights. Adjustable safety valves that control the amount of cover lift are attached to the cover prior to deployment. These safety valves can be adjusted after installation to control the maximum amount of gas stored under the cover. The biogas produced by biogas collection covers is typically fed into a control system prior to use and uncontrolled odor and gas releases from these systems are rare.

Hybrid systems are being discussed where a biogas collection cover needs to accommodate significant changes in liquid levels over the year and/or periodic pump-out. If pond liquid level changes are required in a biogas collection cover then storage of biogas under the cover may not be practical. Alternative biogas storage systems such as gas bags may be needed in hybrid systems. Layfield's new cover design can incorporate both floats and weights into the same cover and that flexibility could be used to design a hybrid cover system.

Limitations:

The new Layfield prefabricated cover is designed for smaller ponds for odor control and biogas collection. The best pricing on these systems will be for ponds where the narrowest cover dimension is 300 ft or less. Long, narrow ponds are easiest to cover with this cover system; however all pond sizes are possible.

The current limitations in the use of impermeable cover technology are that pond liquid level changes (typical of agitation and pump-out) cannot easily be incorporated into a biogas collection cover. Biogas collection covers should have very little slack so that wind will not damage them if they lift off the pond. Slurry storage covers should be designed so that gases are drawn off to keep the cover from lifting.

In cold climates biogas production can be compromised when temperatures fall. Insulation panels are available that can be placed under a biogas cover to maintain liquid temperatures and to extend the season for the production of biogas. Insulation panels are available as an extra charge.

The liquid filled weight tubes in the biogas cover are designed so that they will not be damaged by freezing. In many locations in the US the surface of a manure pond will not freeze completely in the winter and water filled tubes are

satisfactory. If weight tube freezing causes problems in a particular area then a non-freezing liquid can be used to fill the weight tubes. There are a number of liquid food byproducts that can be used for weight that will not freeze.

A floating cover will be locked in the ice when the surface of a pond freezes. For locations where an ice cover in excess of 6" forms adjustments to a slurry storage cover design may be required. Anything other than small changes in liquid levels when the cover is frozen in the ice could cause damage.

Layfield's prefabricated gas collection covers are made to order to fit a specific pond size. Orders must be placed with sufficient time to consult on the design, obtain materials, schedule fabrication, and arrange installation. Seasonal workloads will affect the time needed to fill these orders. Contacting Layfield early in the development of the project will prevent delays later.

Cost:

Cover costs have typically been estimated as construction projects with specialized installation staff. The new Layfield cover is prefabricated in the factory and delivered to site mostly assembled. Installation requires one or two skilled people to perform welding and direct the work. Freight costs may vary depending on the distance from a fabrication location; however, freight for these covers does not significantly increase the costs.

Typical cost for these covers is independent of whether it is a slurry storage cover or a biogas collection cover. The details of both covers are slightly different but the resulting end price is about the same. Cost of the cover would include the supply of the cover, the on-site welding, placement of floats or weights, installation, and filling of weight tubes. A gas collection pipe underneath the perimeter of the cover would be included. Anchor trench excavation and backfill are not included but an estimate of \$2.50 to \$3.00 per lineal foot is appropriate in most locations. The supply of equipment on site would be extra – typically a front-end loader would be available at most facilities and would be borrowed for the installation. Local labor would also be needed – typically 8 to 10 people for up to two days. Most projects will take two days to install but will require good weather for those two days (no precipitation and wind under 12 mph). Weather delays can incur standby charges. Other materials required to be supplied on site are a quantity of sand for making sandbags (wind safety) and a source of clean water to fill weight tubes (contaminated water is not suitable).

Cost for the supply and installation of Layfield's new slurry storage or biogas cover would be between \$15.60 and \$20.98 per square meter (\$1.45 and \$1.95 per square foot) of surface area depending on project specifics. The development of a standard size of pond requiring 5 or more identical covers would reduce the price. Alternative weight fluids (other than water) would be quoted extra. Hybrid cover systems would require a special quote and would be above this price range. Insulated panels are also extra if needed.

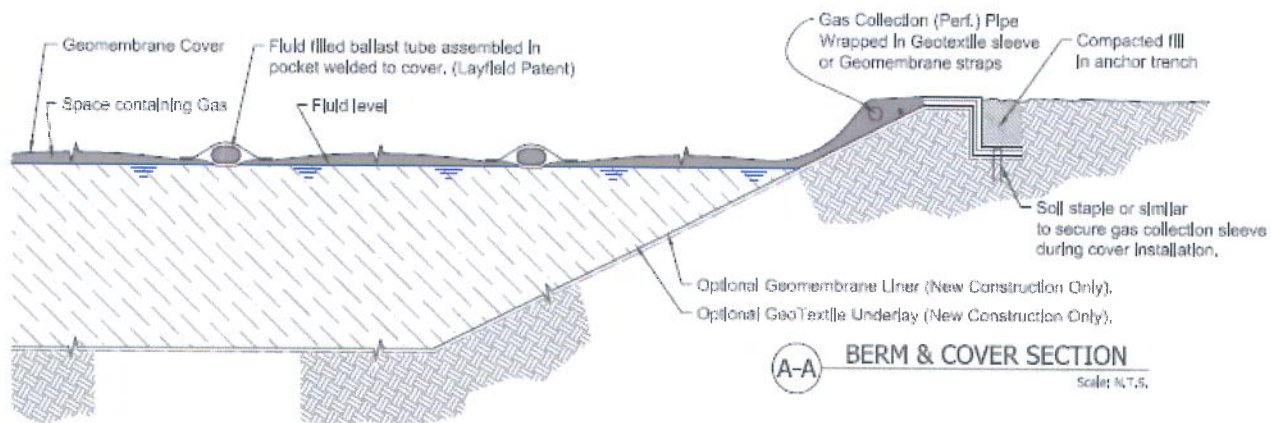
We recommend that you contact Layfield early in your project design phase to provide an accurate estimate of cover costs based on facility requirements.

Implementation:

The development of this new prefabricated cover was part of Layfield's ongoing development of covers for manure storage. Initial prefabricated covers were used for swine slurry storage. These covers were simple in design and were pulled back for agitation and pump-out. Damage to these covers led to significant design changes including the addition of floats and weights and the use of a stronger new material.

These changes were incorporated into a full scale design trial that was installed in the summer of 2006. The 4,000 m² pond cover (about an acre) was installed in a single day in a farm pond north of Edmonton Alberta Canada. This cover is used for ongoing trials with weights, floats, and rainwater removal systems.

The innovation prototyped in this new cover was a special sleeve that can hold either floats or weights. The arrangement of these sleeves and their preparation is the subject of a current US patent application.



Working from approved pond drawings a layout and estimate are prepared for a prefabricated cover. Details of the operation of the pond are discussed with the client and a slurry storage or biogas collection design is developed. Materials are ordered and the fabrication of the cover is scheduled. Fabrication can be completed well in advance of planned installation.

Prefabricated panels are shipped to arrive at site in time for planned installation. These panels can be shipped in advance and stored if required. Prior to installation the site is prepared. A laydown area is cleared next to the pond (typically on one end). Sand is delivered for sandbags and the anchor trench is excavated. Other site preparation may be completed such as the installation of specific gas piping but this is usually part of the installation planning and is unique to the project.

Skilled installers arrive at site and inspect the area. Local equipment and laborers stage materials, fill sand bags for wind safety, place gas collection piping, and rig pulling ropes for deployment of the cover. Once weather permits the cover materials are unrolled in the laydown area and welded together into a panel large enough to cover the pond.

A leading edge float is inserted into a pocket on the leading edge and pull ropes are attached. If floats are to be inserted into the prefabricated pockets then they are inserted during deployment. Weight tubes will usually be installed at the factory and will not need to be inserted during deployment. It takes about 15 minutes to insert a float into a cover pocket during deployment. The floats are wrapped in a sleeve that makes insertion easier and also controls where the floats end up in the final cover.

Slurry storage covers may be installed on full or partially full ponds. The required slack in the cover is measured and adjusted after it is pulled into place. The anchor trench is backfilled after the slack has been placed. In new construction the cover can be assembled in the bottom of the new pond. A special hatch is designed into the end of the pond normally with a permeable cover.

Biogas collection covers are only deployed over full ponds. The pond must be brought to operating level prior to floating in the cover. The cover is floated into place, the anchor trench backfilled, and then the weight tubes are filled with liquid.

Once installed and the anchor trench backfilled additional sand tubes are placed to complete the design of the cover. Biogas safety valves are adjusted as needed and the gas collection tube is connected to the gas collection system

Technology Summary:

Impermeable covers have been shown to reduce odors by 95%. This paper introduces a new, patent-pending, prefabricated cover that is economical for small and medium size manure containments. The cover is adaptable for both slurry storage (variable liquid level) and biogas collection (constant liquid level) applications. The cover costs between \$15.60 and \$20.98 per square meter (\$1.45 and \$1.95 per square foot) and installation is quick and requires minimal resources. The cover mitigates air emissions by either holding volatile gases in solution or by drawing off gases for use or destruction.

Additional Resources:

Layfield Web Site <http://www.layfieldgroup.com> (select Floating Covers)

Layfield's REVOC® BioGas Collection Covers

http://www.floatingcovers.net/index_product2.cfm?ID=geo&divID=3&applicationID=79&pass=product&productID=194&type=2&return=yes#194

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