

Covers for Long-Term Dairy Manure Storages Part 1: Odor Control and More

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Introduction

Liquid manure, when stored long-term, has no oxygen (anaerobic conditions) resulting in the development and release of a number of manure-borne gases including various odorous compounds and methane (a greenhouse gas). With favorable economics, many farms with long-term manure storages could reduce odor and greenhouse gas emissions by installing a storage cover. Cover products are available for earthen, concrete and steel storages. When properly designed and managed, covered storages can greatly reduce farmstead gaseous emissions. However, when manure is recycled to cropland, odor emissions will occur, though injection or immediate incorporation can reduce field odor emissions.

There are two basic types of storage structure covers: **permeable** and **impermeable**. Each type has several options with varying degrees of complexity and costs.

Permeable Storage Covers

Permeable covers are generally the simplest systems and typically have the lowest capital cost. Cover types range from straw to commercial geotextile materials. By definition, permeable covers allow gases to escape and rainwater to enter the storage structure. Permeable covers rely on operative microbes residing within the cover material to consume odorous gases before they are emitted from the storage. The cover needs to have plenty of surface area for microbes to grow and treat the gases. Permeable covers also provide protection to the storage surface from rain, wind, and other agitation occurrences, further reducing emissions. Odor reductions for permeable covers have been reported to be: 40-65% for properly maintained geotextile covers, 77-99% for ground rubber, 90% for Lightweight Expanded Clay Aggregate (LECA), and 40-90% for mechanically blown on straw.

Geotextile covers are cloth-like materials made from woven synthetic components that are floated on top of the manure surface. They are anchored to prevent



Permeable cover installed on an earthen dairy manure storage

wind from uncovering a portion of the slurry and may require specific agitation and pumping procedures to minimize damage. The expected operational life of a geotextile cover can range from 3 to 10 years and cost from \$0.35 to \$1.75 per square foot installed.

Ground rubber and LECA can be used to cover manure storages and are comparable alternatives to permeable geotextile covers. They are granular in nature, and are typically applied as a 2- to 4-inch floating layer that stays on the storage surface. Windy conditions can shift the materials, exposing the manure surface, reducing odor control. LECA has been widely used in Europe and can be imported into the US (Claytek LTD is one supplier). Iowa swine production facilities have used LECA covers for more than 10 years. Agitation and pump out must ensure that floating cover material is not removed and can be conducted with minimal changes to standard practices. Prices of LECA and ground rubber are subject to availability and shipping, LECA may cost up to \$3 per square foot.

Straw can be mechanically blown on a storage surface with a recommended stem length of 12 inches. This is a temporary, but effective, odor mitigating method. Environmental conditions and biological activity degrades the straw, limiting its effective life to 2-6 months. A chopper pump should be integrated for storage pump-out in order to handle

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large straw particles. Twelve inches of fluffed straw provides the best odor control (90% reduction) while depths of 6" to 8" are commonly used. A six-foot round bale is expected to cover approximately 500 square feet to a 12-inch depth. The total cost of a straw cover will depend on the price and availability of straw; some sources indicate that the installation cost for mechanically blown straw is approximately \$0.03 per square foot.

Impermeable Storage Covers

As compared to permeable covers, impermeable covers are significantly more complex and costly in large part due to the need for biogas and rainwater handling systems.

The majority of impermeable covers are not designed to be removed for storage pump out or solids removal. Special considerations for slurry removal and handling are required, and manure solid-liquid separation with storage of liquid effluent is recommended. The best designs generally incorporate permanent access points for agitation and pumping. Producers may want to consider including permanent access points in any new manure storage designs if they think a cover may be installed in the future.

A properly designed and maintained impermeable cover is expected to have an operational life of 20 years. Impermeable cover cost is in part correlated with petroleum price, with recent estimates for installed cost ranging from \$1.50 to \$3 per square foot with an additional cost for the gas handling equipment; highly technical cover installations may increase the cost to \$5 per square foot.

At the end of the cover's useful life, it will need to be removed and properly disposed of, representing an additional cost for the system ranging at this time from \$0.50 to \$0.75 per square foot.

To achieve odor control, accumulated gas must be collected and combusted or potentially passed through a biological filter. During summer and fall, gas can usually be combusted with a flare, and has the unlikely potential to be used for supplementary heat and power by integrating a boiler or engine-generator set; in northeastern conditions, the cover system will not likely produce sufficient quality or quantity of gas for combustion in the winter or spring. The cost of gas handling will depend on the system chosen, applicable regulations, and carbon credit market requirements. A basic gas flare can be implemented for \$15,000 to \$25,000; for a more complex, high efficiency flare, capital cost may exceed \$150,000.

Annual Benefits of Storage Covers

Permeable and impermeable covers reduce odor and may reduce nitrogen volatilization losses to the atmosphere. The perceived and actual benefit from odor control and potential for increased nitrogen content of manure will be farm dependent.

An impermeable cover can provide further operational benefits that can help offset higher installation costs. Operational benefits include the avoidance of handling rainwater that would otherwise enter the storage, as much as 300,000-700,000 gallons of water per acre of surface area can be excluded annually in NY. Additionally, a gas collection and combustion system installed in conjunction with an impermeable cover can potentially allow for the sale of carbon credits by capturing and burning methane generated beneath the cover in warmer months.

Fact Sheet SC2: Estimate Your Annual Cost and Benefit, has been developed to assist in determining the potential economic impact of installing a storage cover based on farm specific information.

Fact Sheet Series

Covers for Long-Term Dairy Manure Storages

- SC1: Odor Control and More
- SC2: Estimating Annual Cost and Benefit
- SC3: Flares and Gas Handling (pending)
- SC4: Design Considerations for Impermeable Covers (pending)
- SC5: Design Considerations for Permeable Covers (pending)
- SC6: Design Considerations for Pump-out of Covered Storages (pending)

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References: General information within this document was gathered from the 2008 Conference Proceedings of Liners and Covers for Agricultural Waste Storage, Robert Burns, Iowa State University. Cover cost information reflects personal correspondence with Andrew Mills of Layfield Group, Richmond BC, Canada, November 2008. Odor reduction estimates were obtained from the 2008 Conference Proceedings of Mitigating Air Emissions from Animal Feeding Operations, Robert Burns, Iowa State University.

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