Colorado State University Extension

Best Management Practices for Reducing Ammonia Emissions: Lagoon Covers

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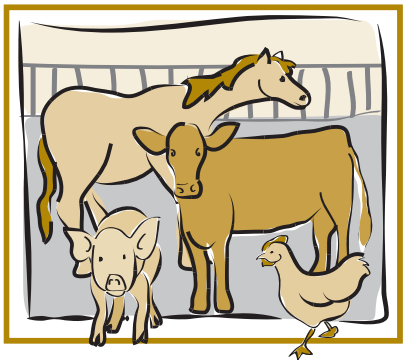

Lagoons are liquid manure storage and treatment facilities that can be significant sources of ammonia emissions from livestock operations. Where liquid manure is stored open to the atmosphere, nitrogen losses (as ammonia gas) can be significant. Emissions are generally greater during warm weather, because heat speeds up the chemical reaction that creates ammonia gas. Under windy conditions ammonia emissions are carried into the atmosphere, creating the potential for ammonia to be transferred and deposited far from the farm or operation. Ammonia that is lost to the atmosphere is no longer available as a nitrogen fertilizer, decreasing the value of the liquid manure inland application.

Covering lagoons slows the release of ammonia gas into the atmosphere and reduces the effect of wind on emission rates. Due to a decrease in ammonia volatilization, the liquid manure stored in a covered facility can have up to 3.5 times more nitrogen compared to manure slurry in an open lagoon, thus increasing its fertilizer value.

This document provides an overview of some of the most promising practices, highlighting their advantages and disadvantages, and allowing producers to evaluate alternatives and make informed choices about what works best for their unique situation.

Impermeable Covers

Impermeable covers made from flexible synthetic materials provide excellent ammonia and odor emissions control; however, their installation costs (which are often quite high) and maintenance costs must be taken into consideration.

Impermeable covers block the vast majority of odors, gases, and water from moving into or out of the manure storage structure, and they eliminate the effect of solar radiation and wind on emission rates. Manure stored in above-ground storage tanks can be covered with rigid, impermeable concrete and steel caps that may last for 10-15 years or flexible covers that serve the same purpose.

In Colorado, a more common practice is to store liquid manure in earthen structures and to cover the this area with a High Density Polyethylene (HDPE) flexible membrane. These covers are a commercially available option that is nearly 100% effective in reducing ammonia emissions. Plastic covers that are inflated over or float on the surface of the stored liquid manure are also available. Negative pressure lagoon covers that capture gases beneath the plastic tend to be more expensive to install but less expensive to maintain than positive pressure lagoon covers. Negative pressure lagoon covers require a system for removing freshwater precipitation from the top of the cover. Both types of cover are highly effective for reducing ammonia losses. Because they trap the vast majority of gases, impermeable covers can also help to reduce odors associated with manure storage.

Impermeable covers are more cost effective if left in place for longer periods of time and have been found to last between 10 and 12 years. In addition, it is important to consider how material left behind will be removed and cleaned up after the useful life of the cover.

Permeable Covers

Permeable covers typically reduce ammonia emissions 40-80%, depending on the material, its thickness, and long-term maintenance practices. They are not as effective as impermeable covers at reducing

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Quick Facts

- Covering stored liquid manure slows the release of ammonia gas into the atmosphere and reduces the effects of wind and heat on emission rates.
- Liquid manure stored in a covered facility can have up to 3.5 times the nitrogen content, compared to manure slurry in an open lagoon, thus increasing its fertilizer value.
- Permeable covers are commonly made from materials like straw, cornstalks, woodchips, foam, or LECA rock.
- Moving and agitating liquid manure increases nitrogen losses and should be avoided during the springtime when air movement towards the mountains is greatest.

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Further Reading

From the eXtension.org website:

Manure Storage Covers for Mitigating Air Emissions from Animal Agriculture

A Review of Permeable Cover Options for Manure Storage

From the Colorado State University Extension website:

1.631 *Best Management Practices for Reducing Ammonia Emissions*

ammonia emissions. Permeable covers have several advantages; they have lower capital costs than impermeable covers and, due to the permeability of the cover, do not require a companion gas or rainwater collection system.

Some permeable covers are thought to act as biofilters on the top of stored liquid manure. Biofilters reduce emissions by simultaneously trapping emissions, preventing exposure to sun and wind, and creating conditions that promote the growth of microorganisms that utilize and degrade trapped compounds, including ammonia. Commonly used materials include straw, cornstalks, woodchips, foam, or lightweight expanded clay aggregate (LECA) rock. Permeable covers are most effective as biofilters when the floating mat is 8-14 inches deep. A 12-inch deep cover will require about 100 bales of wheat or barley straw per acre of surface. Permeable covers made of organic materials such as straw or cornstalks typically begin to degrade and lose effectiveness after six-eight months and then must be replaced. For this reason, permeable covers are most effective when applied just before the springtime, in anticipation of higher ammonia volatilization rates and greater odor production during warm spring and summer months. Degraded and waterlogged cover materials need to be pumped out of the manure storage with the liquid manure, and pumping the cover materials may require different pumping equipment than that used for non-covered lagoons.

When selecting a biocover material, it is important to consider management and reapplication frequency, how the material will be removed, and, as with impermeable covers, the availability of additional land for subsequent application. Straw and cornstalk covers may sink in rainy conditions and generally perform better when used on slurry with more than two percent total solids. In addition, permeable covers are difficult to apply to storage facilities greater than two acres in size.

Liquid manure often develops a crust which can help to reduce emissions. Research suggests that crusting can be enhanced and promoted by (1) feeding cattle a high fiber diet (i.e., corn or grass silage); (2) managing slurries so they contain more than 1% dry matter; and (3) storing manure in deep tanks (with lower surface area to volume ratios, providing more crust forming materials under the exposed surface).

Challenges

In addition to high costs, covering lagoons poses another major challenge that must be considered prior to making this investment. Evaporation will be reduced, even with permeable covers, thus requiring either more frequent irrigation pumping or greater lagoon volume. Lagoons in Colorado are designed with high evaporation rates in mind and, therefore, covering those lagoons may result in having to increase lagoon capacity.

Covering a lagoon is labor intensive and requires calm weather conditions to be effective. In addition, the impact of storms—from blizzards to tornadoes—should be considered when selecting a lagoon cover.

Other Steps You Can Take

Aerating, moving, or agitating liquid manure increases nitrogen losses and should be avoided during the springtime when potential for impact on mountain ecosystems is highest.

Most importantly, manure treatment lagoons must be properly designed, built, and maintained in order to optimize their function and minimize their pollution potential. An agricultural or wastewater engineer will be able to advise the best options for improvement.

References

on next page

Figure 1. Relative costs, lifespan, and emissions reduction potential of impermeable and permeable liquid livestock manure storage covers. For permeable covers, emission reduction varies based on the thickness of the cover, with thicker covers achieving greater reduction potential.

Cover type	Emissions Reduction	Relative Cost	Lifespan
Concrete/Steel Cap	99%	$$$	10-15 years
High Density Polyethylene	70-99%	$$	Up to 10 years
Inflated Floating Plastic	80-95%	$$	Up to 10 years
LECA Rock	14-87%	$$	Up to 10 years
Wood Chips	17-91%	$$	< 1 year
Straw	37-90%	$	< 1 year
Cornstalks	37-60%	$	< 1 year
Natural Crust	20-50%	$	< 1 year

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