



# Treating Swine Manure with Aluminum Chloride

Author: Doug Smith, USDA-ARS, West Lafayette, Indiana

## Definition:

Liquid aluminum chloride can be added to swine manure at most types of production facilities. This may occur in the pit inside the production facility or in a retention pond or lagoon. This may occur on a regular basis or prior to application of manure as a fertilizer. The aluminum chemically binds phosphorus tightly enough to reduce potential losses to surface water through runoff.

## Purposes:

- Reduce phosphorus losses from application of swine manure
- Reduce ammonia volatilization inside the production facility, thus reducing the susceptibility of animals to diseases and increasing production

## How Does This Practice Work?

Aluminum chloride works by precipitating phosphorus in forms that are not soluble in water. The aluminum phosphates that are formed are also not available to algae or other organisms that cause eutrophication in water. Addition

of aluminum chloride also controls struvite by removing soluble phosphorus.

Aluminum chloride can be added to manure in manure pits inside the production facility, settling ponds or lagoons. This treatment has even been successful when added to a liquid manure spreader as the manure is being loaded for fertilization.

When applied to manure pits inside the production facility, aluminum chloride can also reduce ammonia volatilization from the manure and reduce ambient ammonia levels in the production facility. This is beneficial, because reducing ambient ammonia levels in the rearing facility can increase weight gains and feed conversions, as well as reduce the incidence of respiratory diseases in animals and their caretakers.

## Where This Practice Applies and Its Limitations:

Treating swine manure with liquid aluminum chloride is suitable for almost any liquid manure-handling system. The site of treatment is important, as it may have additional benefits.

For example, adding aluminum chloride to manure pits inside the production facility can reduce ambient ammonia levels, while adding it to manure in a holding pond may enhance solid separation.

Caution should be used near concrete and metal surfaces, as aluminum chloride is acidic. If applied directly to these types of surfaces, corrosion may occur. However, if applied to manure within these types of materials, the manure can buffer the acidity, minimizing the risk of corrosion.

Addition of aluminum chloride to manure produces foam on the manure surface. This foam is not harmful, and may actually act as a physical barrier to gaseous losses. This should be one consideration to the site of treatment. For example, addition of aluminum chloride in the manure spreader will decrease its capacity. (NOTE: This should not be a concern if aluminum chloride is added to manure pits or lagoons.) If aluminum chloride is added to a lagoon or holding pond, foam may be blown from the surface during windy conditions.

Author's email  
drsmith@purdue.edu

Editing and Design:  
Forbes Walker  
Wanda Russell  
Gary Dagnan  
Anne Dalton  
University of  
Tennessee Extension

Developed by SERA-17,  
Minimizing Phosphorus  
Losses from Agriculture  
<http://sera17.ext.vt.edu/>



This project was funded in part under an agreement with the USDA-NRCS.

Other aluminum compounds can be used, such as aluminum sulfate. However, toxic gases (e.g., hydrogen sulfide) can be produced upon addition of aluminum sulfate to liquid manures. Iron and calcium compounds can also be used; however, they may not be as effective as aluminum chloride at binding phosphorus, since aluminum phosphates are more tightly bound than iron phosphates or calcium phosphates.

### **Effectiveness:**

Aluminum chloride can reduce soluble phosphorus in runoff to near background levels. For this to occur, the aluminum needs to be added to the manure at a 1:1 ratio of aluminum:phosphorus (molar ratio). For many manure sources, this is a rate of about 0.75 percent aluminum chloride added to manure on a volumetric basis. At this rate of aluminum chloride addition, phosphorus is greatly reduced in runoff; however, ample phosphorus remains for plant growth.

### **Cost of Establishing and Putting the Practice in Place:**

The cost of implementing aluminum chloride treatment of manure includes plumbing and a chemical pump, which is approximately \$1,500 to \$3,000. Standard PVC pipe is chemically resistant enough to be used. Aluminum

chloride costs \$0.10 to \$0.151 per pound without freight, which will vary with location, and can be shipped in disposable containers. Based on the rate of 0.75 percent aluminum chloride added to swine manure, approximately 133 gallons of manure can be treated with \$1.00 worth of aluminum chloride. A secondary containment system is recommended to reduce risks of spill from damage to the primary container, which can be done for \$1,000 to \$5,000.

A cost savings with aluminum chloride use may be noticed through increased weight gains, reduced respiratory diseases and reduced maintenance costs from corrosion resulting from ammonia and struvite control. Furthermore, since the available phosphorus is reduced in the manure, manure application may be applied at agronomic rates for nitrogen in phosphorus-sensitive watersheds.

### **Operation and Maintenance:**

Aluminum chloride can be added incrementally to flush water in hydraulic flush systems, or injected into flush water for pull/plug systems. If applied to holding ponds or lagoons, treatment can occur through injection into pipes carrying the manure from the production facility to the holding pond, or added directly to the holding pond.

### **References:**

Smith, D.R., P.A. Moore, Jr., C.V. Maxwell, B.E. Haggard and T.C. Daniel. 2003. *Reducing phosphorus runoff from swine manure with dietary phytase and aluminum chloride*. Journal of Environmental Quality. 33:1048-1054.

Smith, D.R., P.A. Moore, Jr., B.E. Haggard, C.V. Maxwell, T.C. Daniel, K. VanDevander and M.E. Davis. 2003. *Impact of aluminum chloride and dietary phytase on relative ammonia losses from swine manure*. Journal of Animal Science. 82:605-611.

Smith, D.R., P.A. Moore, Jr., C.L. Griffis, T.C. Daniel, D.R. Edwards and D.L. Boothe. 2001. *Effects of alum and aluminum chloride on phosphorus runoff from swine manure*. Journal of Environmental Quality. 30:992-998.

### **For Further Information:**

For further information on this practice, contact the waste management specialist for the state Cooperative Extension Service.

---

<sup>1</sup> Cost of aluminum chloride reflects 2003 pricing.