Using Liquid Aluminum Sulfate to Reduce Poultry Housing Ammonia Emissions

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Species: Poultry (Broiler Chicken and Turkey)
Use Area: Animal Housing
Technology Category: Chemical Amendment
Air Mitigated Pollutants: Ammonia

Description:

Gaseous ammonia is released from litter during poultry broiler and turkey production, and various chemical amendments have been used to minimize ammonia emissions from poultry litter (Arogo et al., 2001). Work by Carlile (1984) indicates that in-house ammonia levels exceeding 25 ppm can result in decreased bird performance. Reduction of in-house ammonia emissions can improve bird performance and reduce emissions from poultry housing. During the first 14 days of the grow-out, while the birds are young, ammonia has the greatest negative effect on a bird's performance. Therefore, ammonia control during the first half of a grow-out provides the greatest benefits to bird performance during growth, while also decreasing the overall ammonia emissions from the production house.

In a study assessing the mitigation potential of multiple chemical amendments performed by Moore et al. (1999), it was concluded that application of dry/granular alum to chicken litter resulted in the best combination of environmental and economic benefits of the tested amendments. Additional research now shows that liquid alum can also be used to mitigate ammonia emissions from poultry broiler facilities. Use of liquid alum requires application of chemical to litter prior to bird placement, and it can be applied from a truck fitted with a tank and spray nozzles as shown in Figure 1.

In addition to reducing ammonia emissions from poultry facilities, other benefits to using liquid have been reported as follows (Moore et al., 2003):

- Safer environment for farm workers and birds due to reduced ammonia levels in the house,
- Improved bird health and food safety through reduced pathogen levels in the litter, and
- Less ventilation required during cooler temperatures resulting in reduced propane use for heating.

Mitigation Mechanism:

The litter in poultry production houses consists of manure and the bedding material. The rate of ammonia volatilization from litter is dependent on pH, moisture content, air velocity, manure nitrogen concentration, and temperature. The pH of the litter is an important factor in controlling ammonia volatilization because it determines the ratio of volatile ammonia to ammonium, the ionic and non-volatile forms of ammonical nitrogen. Application of alum reduces the litter pH and therefore suppresses ammonia emissions. The extent of pH reduction and the length of time the pH reduction remains effective is related to the rate of liquid alum applied. With increasing liquid alum application rate, the litter pH decreases and as pH decreases, ammonia suppression increases.

Additionally, effective suppression of in-house ammonia levels may reduce ventilation requirements. During the winter months when exchanged air must be heated upon entry into a poultry house, a reduction in ventilation also results in lower heating costs for the production facility. Combined, reductions of ammonia levels emitted from the litter and reductions in ventilation rate, reduces overall ammonia emissions from the production house.

Applicability:

Liquid alum application is effective at mitigating ammonia emissions in poultry housing systems that produce animals on litter, such as in turkey and broiler chicken production systems. As shown in Figure 2, using liquid alum, ammonia levels can be held below 25 ppm in the house for the first 3 to 3.5 weeks of production for an improved animal environment and a reduction in gaseous emissions. Liquid alum should be applied between grow-outs; it can be applied to either new bedding or de-caked litter. Additional benefits of liquid alum application include a potential reduction in pathogen levels and reduced use of propane for heating during cooler temperatures. The high acidity of liquid alum helps reduce pathogens in the litter providing a better environment for the birds. And, lower ammonia levels in the house can reduce the overall air exchange in the house. During cooler months, reducing the volume of air exchanged results in lower supplemental heating requirements.

Figure 1. Liquid alum application.

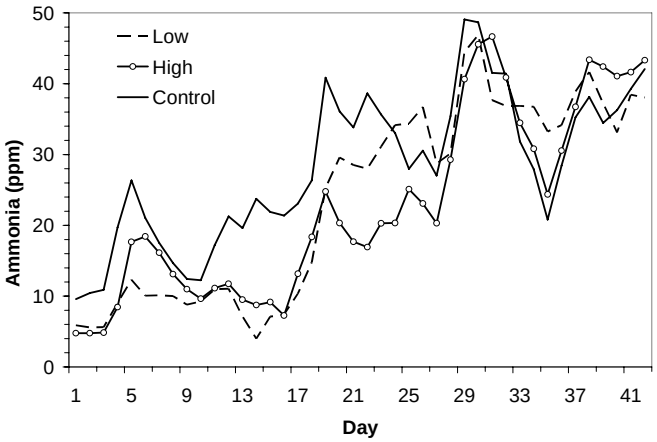

Figure 2. In-house ammonia concentrations based on liquid alum application rate.

Limitations:

Liquid alum is an acid; therefore, it is corrosive and can be hazardous to work with. Appropriate measures, as defined by the chemical supplier, should be used during handling of liquid alum. Like all acids, safe handling precautions should be used including gloves and eye protection. Generally, liquid alum will be applied by the supplier thus reducing any hazard to the producer during application.

Additionally, application of liquid alum only provides a temporary reduction in ammonia emissions from litter. Research results suggest that levels are equal to that of litter receiving no liquid alum three weeks into the bird grow-out. And, due to corrosiveness and bird disturbance it cannot be reapplied while animals are in the production area.

Cost:

The cost of using liquid alum is dependent upon the proximity of the production facility to a liquid alum distributor. Distributor cost is reflective of transport and chemical costs. For the costs discussed here, the production facility was 370 km (230 miles) from the distributer and the delivered liquid alum cost was 0.16 cents/L (0.60 cents/gal). The cost associated with liquid alum amendment is the cost of the material and transport and application fee. In this case, the application fee was $40/house. Cost savings from a reduction in propane use and reduction in the number of animal mortalities using liquid alum are expected to be similar to the savings achieved when using dry alum.

In the study discussed here, the cost per 1,824 m^2 (20,000 ft^2) production house was $262 for an application rate of 0.82 L/m^2 (0.02 gal/ft^2) and $504 for an application rate of 1.64 L/m^2 (0.04 gal/ft^2). In this case, the proximity of the production facility to the distributor was favorable, and the cost of applying liquid alum was less than the cost of applying the equivalent amount of dry alum. Table 1 shows a liquid and dry alum product cost comparison using dry alum rates equivalent to the liquid alum rates represented here. The liquid alum used in this study was a 48.5% alum Al Clear product produced by the General Chemical company.

Table 1. Liquid and dry alum product cost comparison.

Product	Application Amount	Cost per Unit Kg or L (cents)	Total Cost per house ($)
Liquid Alum (low)*	1514 L	0.16	242***
Liquid Alum (high)*	3028 L	0.16	484***
Dry Alum (low)**	907 Kg	0.33	299
Dry Alum (high)**	1814 Kg	0.33	599

* Liquid alum rates are 0.82 and 1.64 L/m^2 (0.02 and 0.04 gal/ft^2), considered low and high rates, respectively.
** Dry alum rates are 0.5 and 1 kg/m^2 (0.1 and 0.2 lb/ft^2), on an aluminum basis, considered low and high rates, respectively.
***For direct product cost comparison with dry alum, this cost does not include the $40 house application fee.

The broiler chicken production facility representative of these economics was stocked at 30,000 birds per house. For the low application rate, the cost of liquid alum amendment is $0.009/bird produced. And, for the high application rate, the cost of liquid alum amendment is $0.017/bird produced.

Implementation:

Information reported here concerning the use of liquid alum to reduce ammonia emissions is based on data from a study performed using four tunnel ventilated broiler production units measuring 152 m by 12 m (500 ft by 40 ft). The recommended application rates were tested during multiple 42-day flocks where birds were placed as day old hatchlings and caught at 2.25 kg (5 lb) slaughter weight.

Liquid alum can be applied to fresh bedding or aged litter. Liquid alum should be applied for each new flock after the litter has been prepared for bird placement into the production house (following either placement of new bedding, litter de-caking and a drying period, or placement of additional bedding on existing litter). The application rates discussed here were tested against a non-amended control house.

Selection of liquid alum rate is dependent upon the amount of ammonia control required for the facility. Suggested liquid alum application rates are 0.82 and 1.64 L/m^2 (0.02 and 0.04 gal/ft^2), considered low and high rates, respectively. On an aluminum basis, these rates are equivalent to 0.5 and 1 kg/m^2 (0.1 and 0.2 lb/ft^2) of dry aluminum sulfate, considered low and high rates, respectively. Generally, liquid alum will be applied by a commercial truck equipped with nozzles. This means that all instrumentation within the house (feeders, waterers, scales, etc) will need to be raised above the height of the truck during application.

A liquid alum application rate of 0.82 L/m^2 (0.02 gal/ft^2) will suppress ammonia concentrations below 25 ppm for the first 2.5 weeks of a flock grow out. Ammonia concentrations above 25 ppm decrease bird performance, especially in young birds. A liquid alum application rate of 1.64 L/m^2 (0.04 gal/ft^2) will suppress ammonia concentrations below 25 ppm for the first 3.5 weeks of a flock grow out. However, after 3.5 weeks ammonia concentrations will appear similar to those in non-amended production houses.

During the liquid alum study discussed here, mortalities were tracked during the study. An example of the mortalities numbers from one grow-out are as follows; the production house not amended with liquid alum (the control) had 1,100 mortalities while the production houses with low and high liquid alum application rates had 1,082 and 989 mortalities, respectively. An even higher liquid alum application rate of 2.46 L/m^2 was also tested and had even fewer mortalities (939); however, the ammonia concentrations in the house were not different then those achieved with an application rate of 1.64 L/m^2 (0.04 gal/ft^2). While the houses treated with liquid alum had lower mortalities than the control house in this study, there was no statistical difference in mortality numbers between the houses.

Technology Summary:

Liquid alum is a method to mitigate ammonia emissions from poultry broiler facilities. Use of liquid alum requires application of chemical to litter prior to bird placement, and it can be applied from a truck fitted with a tank and spray nozzles. Application of alum reduces the litter pH and therefore suppresses ammonia emissions. The extent of pH reduction and the length of time the pH reduction remains effective is related to the rate of liquid alum applied. Application of liquid alum only provides a temporary reduction in ammonia emissions from litter. Research results suggest that levels are equal to that of litter receiving no liquid alum 3.5 weeks into the bird grow-out. In the study discussed here, the cost per 1,824 m^2 (20,000 ft^2) production house was $262 for an application rate of 0.82 L/m^2 (0.02 gal/ft^2) and $504 for an application rate of 1.64 L/m^2 (0.04 gal/ft^2); this is equivalent to $0.009 and $0.017 per bird produced. In addition to reducing in house ammonia levels, there is some evidence that using liquid alum will also reduce mortalities through improved bird health and reduce propane use during cooler months because of reduced ventilation requirements.

Additional Resources:

Treating Poultry Litter with Alum http://www.uaex.edu/Other_Areas/publications/PDF/FSA-8003.pdf

Treating Poultry Litter with Aluminum Sulfate http://www.sera17.ext.vt.edu/Documents/BMP_poultry_litter.pdf

Treating Broiler Litter with Alum http://www.utextension.utk.edu/publications/infosheets/Pss318/PSS318.htm

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