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Effects of Aluminum Sulfate and Aluminum Chloride Applications to Manure on Ammonia Emission from a High-Rise Layer Barn

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Species: Poultry (Layer)
Use Area: Animal Housing
Technology Category: Chemical Amendment
Air Mitigated Pollutants: Ammonia

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System Summary:

The effectiveness of aluminum sulfate (alum, $\text{Al}_2(\text{SO}_4)_3$) as a litter amendment in poultry houses has been recognized in several studies. Emission rates of ammonia (NH_3) were measured at two 169,000-hen high-rise layer barns in Ohio, for six months. The tests were conducted to evaluate baseline and mitigated emission rates. An alum and aluminum chloride (AlCl_3) spraying system was installed in the treated Barn 2. Concentrations of NH_3 were measured at the barn exhaust fans and in incoming air, using real-time NH_3 analyzers. Temperatures, relative humidity, barn static pressure, and fan operation were also measured.

The average daily mean untreated net NH_3 emission rate was 480 g/d-AU (1.35 g/d-hen), where AU is an animal unit or 500 kg (1100 lb) of bird weight. The alum and AlCl_3 applications reduced NH_3 emission by 23% based on the overall cross-barn comparison of paired emission differences between barns. The NH_3 mitigation efficiency of the $\text{Al}_2(\text{SO}_4)_3$ application was compromised by clogged nozzles, manure turning, and introduction of a new flock of hens. Higher reductions of 33, 23 and 40% were achieved during later test periods. The application of AlCl_3 in the last test was expected to further reduce NH_3 emission, but the reduction was only 27%. The lower NH_3 emission reduction efficiency of AlCl_3 was probably due to higher moisture content of manure in Barn 2.

Applicability and Mitigating Mechanism:

- Aluminum sulfate and aluminum chloride can lower manure pH and reduce ammonia emission
- A 3000-gal tank stored the chemicals, and spray tubes and sprinkling nozzles were installed along the barn length
- Solutions were automatically sprayed every hour, for a total of 24 times per day

Limitations:

- The nozzles were easily clogged when spraying aluminum sulfate
- The additional chemical solution increased manure moisture content, especially in cold weather, thus reducing its effectiveness
- The spraying system requires training to operate and maintain
- The chemicals were acidic and corrosive
- Manure on second floor was untreated.

Cost:

The costs of the alum and AlCl_3 were \$0.13/L and \$0.14/L, respectively, without delivery charges. At each delivery, 5678 L (1500 gal) of alum or AlCl_3 was first added into the holding tank, and an equal volume of water was added to produce a 50% solution. The field records showed that five deliveries worth \$3700 of alum were used in 85 days, or \$44 per barn per day. The automatic spray controller cost about \$3000, and the doubled-wall holding tank was \$6500. A single wall tank would be less expensive. The labor to maintain the controller, air and water pumps is estimated at 3 hours per week per barn. The air pump provided the pressure for spraying, and the water pump filled the spray pipe with the solution.