

Effects of EcoCal™ on Ammonia Emission from a High-Rise Layer House

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

Description:

Ammonia (NH₃) is released in significant amounts from livestock and poultry facilities, especially from high-rise layer houses. Abatement technologies such as diet manipulation, manure amendment, improved manure drying, and frequent manure removal can be applied to high-rise layer houses to reduce NH₃ emission. However, very few studies have been conducted to quantify the effectiveness of these technologies, and report associated costs. The NH₃ emission rate of a modern manure belt house is less than one-third of the NH₃ emissions from high-rise houses (Sun et al., 2005). Emission studies conducted by Liang et al. (2005) concluded that manure belt houses emit significantly less NH₃ than high-rise houses (Liang et al., 2005). While most new construction are now manure belt, many of the existing high-rise layer houses would benefit from applicable abatement technologies, such as feed additives or manure amendments, to reduce NH₃ emission from the large quantity of manure stored in the first floors of these houses. A proprietary, patent-pending feed additive, EcoCal™, was tested for its effectiveness in reducing NH₃ emission from a high-rise layer house in Ohio.

Mitigation Mechanism:

Techniques that reduce manure pH are effective in reducing emission, since NH₃ volatilization from manure increases at higher pH. This mitigation approach can be either pre-excretion, or post-excretion. The dietary manipulation of manure pH is achieved by adding acidogenic phosphorus and/or calcium salts to the feed to decrease manure pH.

EcoCal is a combination of an acidogen (gypsum) and an indigestible cation exchanger (clinoptilolite zeolite). EcoCal's mitigation mechanism is a two-step process. With the proper amount of acidogenic materials included in the diet, manure pH is reduced so that more ammonium (NH₄⁺) is formed. This results in more nitrogen sequestered in the manure rather than released as NH₃.

Applicability:

Since both gypsum and zeolite are naturally occurring minerals, and are shown to improve feed conversion, EcoCal can be used for feeding laying hens housed in typical commercial egg production facilities. EcoCal is also suitable for use in organic egg production.

Limitations:

Diets with more than 60% of dietary calcium supplied by EcoCal should be avoided since overfeeding gypsum can result in thinning egg shells and lower production. However, diets containing 7% EcoCal are well below that threshold, and at that level, the gypsum in EcoCal supplies approximately 35% of the calcium needed in a typical layer diet.

The zeolite component in EcoCal is safe even when fed at levels well in excess of the amount needed for optimal ammonia emission reductions. No adverse effects on health or production have been noted.

Cost:

The gross cost of adding EcoCal was about 2.4 cents per hen per month or \$28,700/yr per 100,000 hens. The effects of EcoCal on egg production were not evaluated in this test, but any increases in egg production would offset the extra cost.

Implementation:

A field evaluation of EcoCal was conducted at two 169,000-hen, mechanically –ventilated, high-rise layer houses in Ohio. The test was conducted at the site of a six-month particulate impaction system test that started on August 1, 2004 (Lim et al., 2007). Data presented in this paper was collected from October 20 to January 26, which includes

about six weeks of data before EcoCal treatment was introduced in house 2 on December 3. The W-36 laying hens in house 2 were fed a diet consisting of 7% EcoCal to determine its effects on NH₃ emission rates. The untreated house 1 housed W-98 laying hens, which were fed an industry standard diet. Nutritional content was adjusted to the genetic, age, and production status of the hens in both of the houses.

Ammonia concentrations (ppm) were measured at the house exhaust fans and in incoming air using well-maintained and calibrated online analyzers. Other measured variables included house temperature, relative humidity, static pressure, and fan operation (Lim et al., 2007). After EcoCal was introduced in house 2, the mean daily exhaust concentrations became consistently less than house 1, Figure 1. After 10 days following the introduction of EcoCal, the daily mean exhaust concentration at the treated house was always less than the untreated house. Prior to introducing EcoCal, the mean exhaust concentrations of house 2 was very similar to house 1 from October 20 to November 16, but was much greater than house 1 during the two weeks prior to introducing EcoCal, Figure 1.

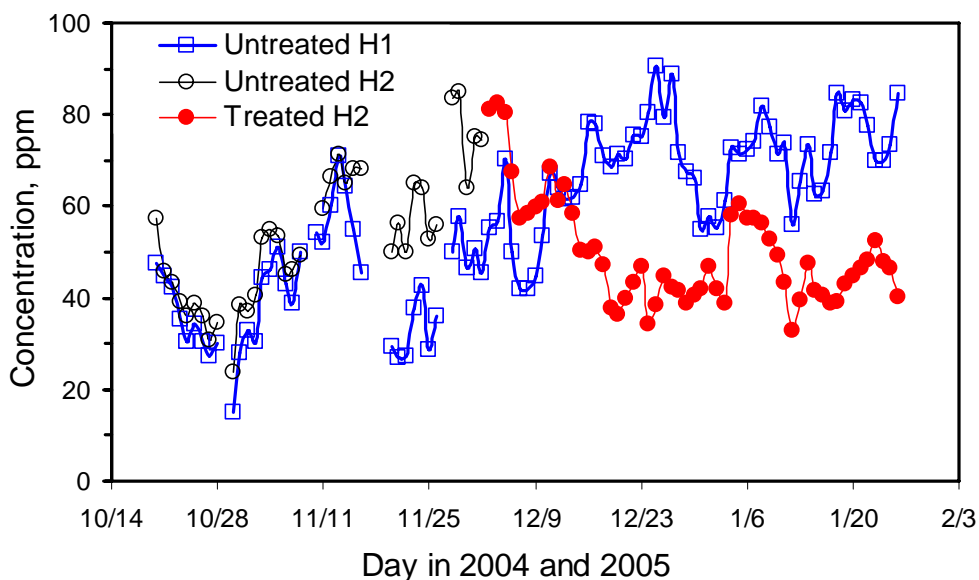


Figure 1. Daily mean NH₃ concentrations of untreated house 1, and treated house 2.

Similar to the NH₃ concentrations, the emission rates of house 2 were higher than house 1 prior to the introduction of EcoCal on December 3, Figure 2. The overall average NH₃ emission rate of the untreated house 2 was 25% higher than house 1 during the six weeks prior to December 3. Since the NH₃ emission rate of untreated house 2 was higher than the untreated house 1 in the six weeks prior to EcoCal implementation, the overall emission reduction of 51% due to EcoCal applications may be an underestimate. However, given the fact that there was only one treated house, and lack of test replication, the house difference before the treatment was not used to adjust the reductions in the subsequent test. The overall emission reductions after December 14, assuming the effects of EcoCal has stabilized in about 10 days, averaged 51%, and ranged from 18% to 69%.

Some important differences existed between the two houses. For example, the laying hens varied widely in age, genetics, and dietary crude protein requirements. The birds in houses 1 and 2 were 111 and 34 weeks old on December 1 and the mean weights were different. These factors had all contributed to the uncertainties of the emission reduction assessment. It is thus important to compare the emission rates based on per animal unit basis, where one animal unit equals 500 Kg of animal weight. The mean NH₃ emission rates were 327 g/d-AU for the untreated house 1 and 356 g/d-AU for the untreated house 2 during the six weeks prior to December 3, Table 2. The mean NH₃ emission differences between the houses were -25%, -12%, and 51% for the three test periods, Table 2.

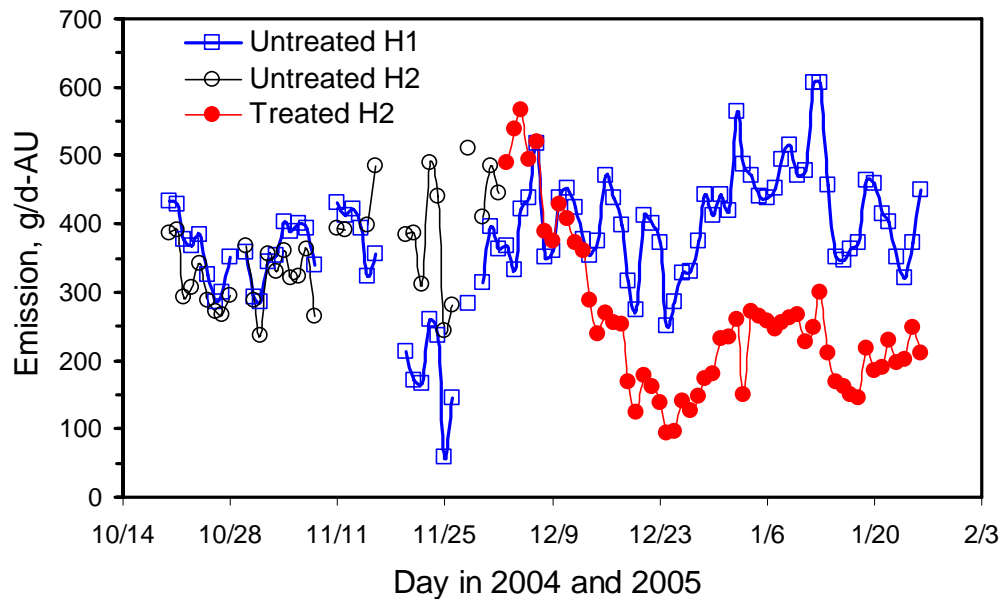


Figure 2. Daily mean NH₃ emission rates of untreated house 1 and treated house 2

Table 2. Emission rates and differences between treated and untreated houses.

Date	Treatment status	Emission rate, g/d-AU		Difference, %
		House 1	House 2	
10/20-12/2	None	326.6	356.0	-25.3
12/3-12/13	Treatment (transition)	407.2	449.0	-11.7
12/14-1/26	Treatment (equilibrium)	414.5	205.0	50.6

Besides the pre-existing higher emission rates in the treated house prior to treatment, another differences occurred later as a flood in the house 2 manure pit occurred on January 16. The flood in the house 2 pit was caused by a broken water supply pipe. The wetter manure in the treatment house had probably emitted more NH₃, thus working against the treated house in the comparison. Nevertheless, the NH₃ emission from the treated house remained consistently less than the emissions from the untreated house, and was 51% lower overall. Considering the emission differences between the two houses prior to the test, the overall reduction in NH₃ emission rates due to EcoCal was about 63%.

Technology Summary:

Continuous emission measurements at two mechanically-ventilated, high-rise layer houses were conducted to study the effects of EcoCal, a feed amendment, on reducing NH₃ emissions. Data presented in this paper was collected from October 20 to January 26. The hens in house 2 were fed a diet amended by EcoCal, while the standard diet was used in house 1, which served as the untreated house for comparison. EcoCal utilizes gypsum (acidogen) and zeolite (indigestible cation exchanger) to decrease manure pH and, in turn, reduce NH₃ emissions. Feeding a diet with 7% EcoCal significantly reduces ammonia emissions by effectively sequestering ammonium in the manure. An average reduction of 51% based on barn-to-barn differences was observed for one month after the emission rate stabilized following the introduction of EcoCal in house 2.

The application of the EcoCal was expected to reduce NH₃ emissions greater than 51%, but the test was compromised hindered by several unexpected incidents such as flood and disruption of feed delivery. The initial feed costs were increased by or \$28,700/yr per 100,000 hens when EcoCal was added to the diet, but improvements to the production environment caused by EcoCal may improve productivity, which could offset the additional feed cost.

Acknowledgments:

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