Air Emissions Mitigation from Aviary Cage-free Hen Litter

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Summary and Implications

Spraying water or electrolyzed water (EW) has been tested to reduce animal house dust level. In this study, lab-scale experiment was conducted to mitigate particulate matter (PM) emissions of litter from aviary cage-free hen houses by spraying EW. The results showed that higher spray dosage led to greater PM reduction (PM reduction of 71%, 81% and 89% immediately after EW spray at 25, 50, 75 mL per kg dry-basis litter or 3, 6, and 9 gal per 1000 ft^2 at 0.4 inch (1 cm) litter depth, respectively) but higher ammonia (NH_3) emissions. To address this issue, solid litter additive (PLT®) at three application rates (i.e., 60.8, 121.6, and 182.4 lb per 1000 ft^2) along with spray of EW was tested for NH_3 mitigation. The lab-scale study results showed that the three litter additive application rates reduced NH_3 generation by 28–79%. This study provides the foundation for conducting subsequent field test to verify the efficacy of this promising mitigation technique (EW spray and PLT use) to improve the indoor air quality of CF hen houses.

Introduction

Concerns over animal welfare have led to pledges of sourcing cage-free only eggs by many U.S. food retailers and restaurants. Compared to conventional cage, cage-free (CF) hen housing offers hens more space and opportunities to exercise their natural behaviors. However, CF housing poses many environmental challenges, including high particulate matter (PM) and ammonia (NH_3) levels.

Spraying liquid agents, such as tap water, acidic water, electrolyzed water (EW), and mixture of water and soybean or canola oil, etc., has been tested to reduce dust level or disinfect livestock and poultry houses. Although spray of EW has the positive effect on PM and airborne bacteria reduction in laying-hen houses, high spray could lead to increase of NH_3 emissions. While application of lower pH liquid can reduce NH_3, there are concerns about potential corrosive effect of the application on layer housing equipment. The objective of this lab study was to assess the reduction effect of liquid spray and solid litter additive application on PM and NH_3 from litter of aviary CF house so as to provide basis for field verification.

Materials and Methods

Four dynamic emission chambers (DEC's, 34×18×26 inch each, **fig. 1**) in an environment-controlled room were used for the evaluation. Litter samples from a commercial aviary hen house was obtained and used to assess effect of liquid spray (EW) and litter additive (PLT) on PM and NH_3 reductions (**fig. 2**). A metal rake and a step motor were used to till litter to mimic bird-scratching activities on the litter. Air temperature (T), RH, and VR of the four DECs were controlled to similar conditions (i.e., T=70°F, RH=60%, and VR=6 L min^{-1}) before the AEW spray.

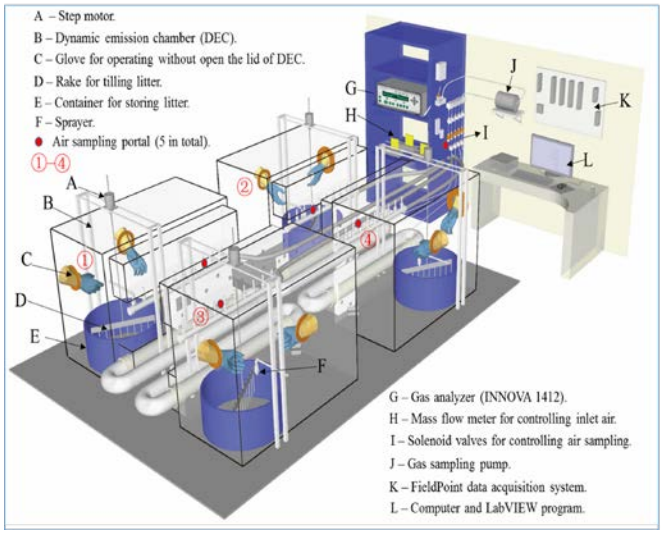

Figure 1. Dynamic emission chambers and experimental setup

Figure 2. Solid litter additive and liquid spray (electrolyzed water-EW)

Results and Discussion

Higher spray dosages led to significantly lower emissions of PM (**fig. 3**), with PM reduction efficiency of 71%, 81%, and 89% for D25, D50, and D75, respectively. The D25 was selected for further study of litter additive use because D50 and D75 sprays showed high NH_3 emissions due to increased litter moisture content. Daily PM concentration under D25 spray is shown in **Fig. 4**.

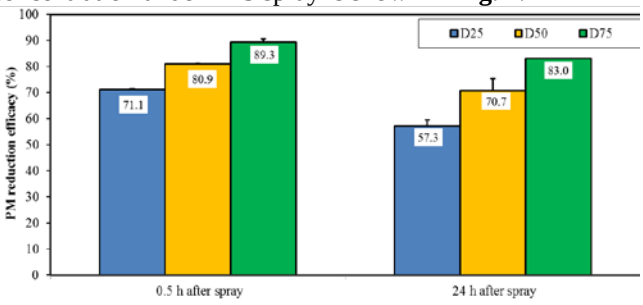

Figure 3. Reduction in PM concentration 0.5 and 24 h after spray. D25, D50, and D75 represents EW spray dosage of 3, 6, and 9 gal/1000 ft^2 at 0.4 in. litter depth, respectively.

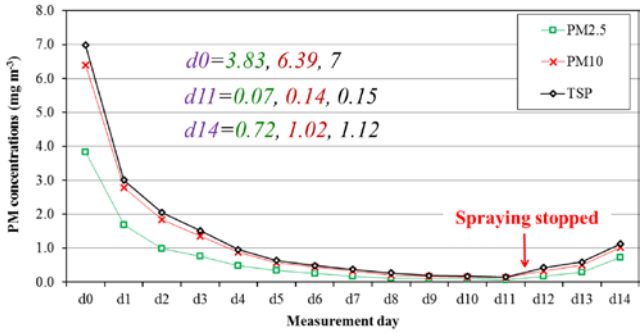

Figure 4. PM concentrations after 11 once-a-day D25 sprays (d0-before spray).

Reduction efficiency of the low, medium, and high application rate of litter additive (PLT) were 28%, 52%, and 79%, respectively, relative to the control-no litter use, as shown in **Fig. 5**.

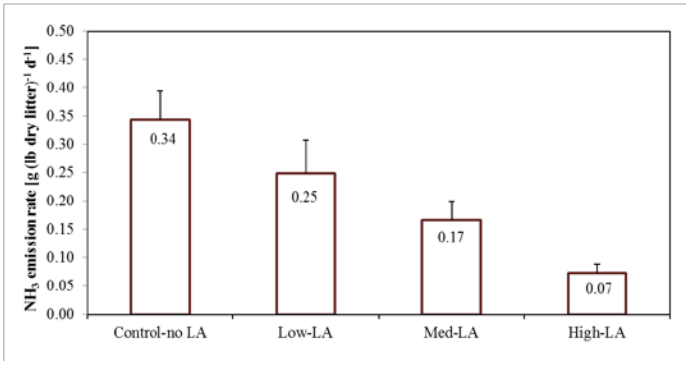

Figure 5. Ammonia emission rate and reduction efficiency (mean±SE) during 14 d, once-a-day sprays of EW and control (no PLT); Low-, Med-, and High-PLT = 60.8, 121.6, and 182.4 lb per 1000 ft^2, respectively).

Field verification on the efficacy of the mitigation method is ongoing with a commercial CF house (50,000 hens, 505 L × 70 W × 10 H ft) in central Iowa. A sprinkling system is installed in half of the CF hen house in the length direction (the treatment section), and the other half of the house is used as the control (**fig. 6**). Results of the field verification will be available next fall.

Figure 6. Field verification in commercial CF house

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