

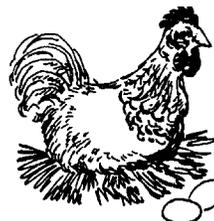


The University of Georgia

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COMMERCIAL EGG TIP...

IN-HOUSE AMMONIA CONTROL WILL BE CRITICAL FOR HIGH RISE LAYER HOUSES

Poultry operations are estimated to produce about 28 % of the ammonia (NH_3) emissions from farm animals in the United States. Animal agriculture, itself, is thought to contribute about half the total ammonia emissions produced by human activity in this country. Most of the rest comes from nitrogen fertilizer and combustion of fossil fuels.

Ammonia is considered an atmospheric pollutant because it has several detrimental effects when too prevalent in the air. It contributes to the formation of acid rain, which can damage sensitive ecosystems. In areas where nitrogen is a limiting nutrient, excessive deposition of nitrogen derived from atmospheric ammonia can support eutrophication of surface waters, and can lead to changes in species composition within land and water ecosystems. Ammonia also reacts with air-borne acids, such as nitric acid and sulfuric acid, to form particles having diameters of 2.5 microns or less ($\text{PM}_{2.5}$). $\text{PM}_{2.5}$ is considered to be respirable, meaning that it can be deposited in the lungs when inhaled. Excessive levels of $\text{PM}_{2.5}$ are thought to be associated with chronic bronchitis, asthma, and premature mortality of humans. In light of the potential adverse effects of atmospheric ammonia, current regulations in the U.S. establish reporting requirements for facilities that release 100 lbs or more of ammonia per day. Livestock and poultry operations have been thought to be exempt from these reporting requirements. Recently, environmental groups have sought through court action to have these standards applied to poultry houses. It is probably inevitable that ammonia release from poultry houses will be regulated within the next few years as indices for ammonia emission are developed for different types of animal housing.

Most of the nitrogen excreted in poultry manure is contained in uric acid. Uric acid can be broken down quickly into ammonia and carbon dioxide through the action of enzymes such as uricase and urease produced by microbes which colonize the manure. This process is affected by moisture, temperature, and pH. Colony growth of ammonia-producing microbes is optimal when manure moisture is 40-60%. Microbial growth is progressively inhibited at lower moisture levels, although established populations of microbes can continue to produce significant amounts of ammonia until manure moisture is in the range of 5-10%. Ammonia emission is significantly reduced when manure temperatures go below 70°F. Little ammonia is released when manure pH is below 7, for two reasons. In acidic conditions, uricase enzyme activity is reduced, thus curtailing the production of ammonia, and, secondly, ammonia (NH_3) is converted into the ammonium ion (NH_4^+), which is not volatile and remains in the manure. Although layer manure pH tends to be a little less than 7 when excreted, microbial action causes a rapid pH increase to between 8 and 9; levels which are ideal for uricase enzyme activity and subsequent ammonia volatilization from the manure. The highest rate of ammonia loss occurs in the first few days after excretion, when the manure moisture content is still high. When manure aeration,

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moisture and temperature are suitable for microbial activity, most of its nitrogen content can be lost as ammonia and other volatile nitrogenous compounds within a few months.

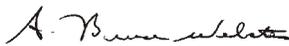
In a study of manure management practices (Kirchmann and Lundvall, 1998. Treatment of solid animal manures: identification of low NH_3 emission practices. Nutrient Cycling in Agroecosystems 51: 65-71), it was found that large amounts of ammonia were lost from stored layer manure when it was allowed to decompose aerobically, but additional ammonia losses were low when the decomposed manure was surface applied to land. Conversely, under anaerobic storage conditions (typical of very wet manure), ammonia losses from layer manure were relatively low, largely because ammonium (NH_4^+) was retained in the manure. However, when the manure was surface applied to land, much of this ammonium became volatilized as ammonia. Similarly, fresh, non-stored layer manure emitted large amounts of ammonia when surface applied to land. Incorporation of manure into the soil greatly reduced ammonia emission after land application. The study concluded that total nitrogen losses were minimized when fresh layer manure was immediately incorporated into the soil.

This study makes it clear that the total ammonia output from a layer flock is not necessarily represented just by emissions from the building where the hens are kept. It is possible that an operation in which manure is regularly removed from the layer house, for instance, a stacked cage system with manure belts, could emit little ammonia from the house itself, but produce more than the reportable limit of 100 lbs ammonia per day when ammonia release from the manure after removal from the house is taken into account. Whole manure-handling operations, not just houses, must be evaluated to determine if they are environmentally friendly.

Nonetheless, the high-rise house design has difficulties when it comes to control of ammonia emissions. Large amounts of manure are kept in the lower level of the house and given considerable opportunity to undergo aerobic decomposition at relatively high temperatures and favorable pH levels. Even though ventilation designs in modern high-rise houses can promote considerable drying of the manure, especially in warm, dry seasons, the moisture in the caps of the manure stacks remains high enough to facilitate microbial growth. Even the drier sections of the manure stack may support some ammonia production. The highest rate of ammonia emission from a high-rise layer house was observed to be during summer (Liang, et al. 2003. Ammonia emissions from layer houses in Iowa. Pages 1-9 in: Proceedings of the International Symposium on Gaseous and Odour Emissions from Animal Production Facilities. Horsens, Jutland, Denmark, June 1-4), a time when the manure would be driest, but temperatures also warmest. This house was estimated to have an annual emission factor of over 2 lb NH_3 /1000 hens/day (discussed in January, 2004, Commercial Egg Tip, "Ammonia in Commercial Layer Houses). By the time manure is removed from high-rise houses much of its original nitrogen content has already been lost to the atmosphere. Layer house designs that provide for removal of manure while it is still fresh at least give the opportunity to further handle it in a way that keeps its nitrogen content from being converted to ammonia.

There are a number of manure management options that have the potential to curtail ammonia volatilization or capture ammonia already in the air. None have yet been adapted to commercial layer operations and proven to limit total per house ammonia emission to less than 100 lb/day. Some might be adapted fairly easily to systems with frequent manure removal which allow an amendment or agent to be added before storage. Ammonia abatement is more problematic within a high-rise house because it would require development of methodology to deliver control agents to the manure over the entire expanse of house for the entire production cycle. Feed-related solutions may offer some hope in this regard. These and other possible methods of ammonia abatement for commercial layer operations will be discussed in a future Poultry Tip.

In conclusion, the high-rise house with long-term manure storage is prone to produce large amounts of ammonia within the house itself. The magnitude of manure nitrogen loss in the house probably leaves little opportunity for meaningful ammonia control after manure removal. For the high-rise house to remain viable, it is imperative that effective in-house ammonia abatement methods be developed for it.



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