

Chapter 14 - LITTER AMENDMENTS

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A. Introduction

The most prevalent noxious gas in poultry housing is ammonia (NH_3). Exposure to high concentrations of ammonia for extended periods has serious consequences on human and poultry respiratory health. **Ammonia** (NH_4) is a colorless gas generated from the **volatilization** (vaporization) of decomposed uric acid in chicken manure. Microbial decomposition of uric acid to ammonia and carbon dioxide is a function of the litter moisture content, temperature, and pH, all of which influence the number and type of microorganisms (bacteria and fungi) present in the litter. The moisture content of air and floor litter impacts particle generation. If floor litter is excessively dry, air and broiler movement tend to increase the amount of particles in the air. Misting systems may be used to moisten dry, dusty litter.

To limit ammonia production, the litter pH should be below 7.0; litter moisture below 30%; and temperature at the level of the broiler's comfort demands. Chemicals may be added to the litter/manure pack to either reduce microbial growth and action, thereby slowing the decomposition of uric acid. The use of products that limit microbial growth is often discouraged, however, because the litter then loses its composting microbes. Other chemical treatments attempt to lower litter pH below 7, thus keeping nitrogen in the form of ammonium (NH_4) rather than ammonia (NH_3). Aluminum sulfate (alum), ferrous sulfate, ferric chloride, and phosphoric acid are chemicals that have been shown to reduce ammonia volatilization. Alum and phosphoric acid have been shown to reduce ammonia volatilization by over 90% in broiler houses. Alum would at first appear to be more desirable than phosphoric acid because it does not contribute to soil phosphorus loads when litter is spread to fields. However, there is insufficient evidence to predict the long-term effects on soil of accumulated alum.

The scarcity and expense of bedding material and the problem of litter disposal in some regions have dictated its reuse. When a mixture of manure and bedding material is reused, the flocks are often exposed to extremely high ammonia concentrations during brooding as warm air temperatures increase volatilization of ammonia from waste in the litter.

Methods for reducing ammonia or other noxious gas generation or concentration include lowering the broiler stocking density, litter pH, or litter moisture content; and increasing the ventilation rate will reduce gas concentrations. While these recommendations help by providing more fresh airflow per broiler, they may be economically impractical in many cases. Better litter and manure management is also recommended through more frequent cleanout and/or litter treatment.

As ventilation rates increase, ammonia concentrations are lowered and litter is dried. The interaction between ventilation rates, moisture content of manure or litter, and the resulting ammonia concentrations is difficult to predict, however. Limiting litter or manure moisture content to below 30% can control ammonia generation; however, ammonia release can be boosted by increased air movement over litter. Although increasing ventilation may sometimes encourage a short-term ammonia release, the air exchange provided by ventilation replaces contaminated air with fresh air and is therefore useful in lowering ammonia concentrations.

B. Measuring ammonia

The air should be sampled at broiler level, about one foot of the ground. A hand-held sampler pump and indicator tube, or a passive tube are common sampling tools. It is important that a producer not rely on his or her sense of smell to determine ammonia levels. A person's sense of smell will desensitize to ammonia over time. Always use a measuring device to determine levels.

Most of the instruments to measure ammonia directly can be cost prohibitive. A dragger tube to measure ammonia cost about \$300, whereas the accuracy of some of the inexpensive methods is questionable. An indirect method is to use a relative humidity meter. Relative humidity should be in the range of 50-70%, but as relative humidity increases above 70% ammonia can become a problem.

C. Litter treatments

Litter treatment amendments can be an effective management tool to reduce ammonia, but they are not a substitute for ventilation. Some growers have experienced variable results with litter amendments among flocks. The variation is partially attributable to not heating the house prior to applying the litter treatment. If the ammonia is not removed before applying the litter treatment, then the product will be tied up with the existing ammonia. Thus, a reduced amount of litter treatment will be available for the ammonia generate by the birds. Also, some litter treatments require a certain amount of moisture for activation.

MANAGING BUILT UP LITTER

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Summary

For the past 30 years there has been a general trend in the US to reuse litter for longer periods of time. Factors driving this trend have been improved health programs, better housing and equipment, increased use of litter amendments, shortages and higher cost of bedding, and nutrient/waste management issues. There are four interrelated components to managing built up litter. These include managing for proper litter moisture and temperature, and reducing the challenge from disease and ammonia stress.

Farm-related factors that contribute to poor litter conditions may include; wet or poor bedding quality, inadequate litter depth, poor site drainage, house condensation problems, improper management of the drinkers, cooling and ventilation systems, and not maintaining uniform bird density in houses. Controlling the depth of litter in a built up program can be an important tool in managing litter temperatures. Disease challenges associated with built up litter can be minimized by reducing litter moisture and ammonia, litter treatments to alter microflora populations, and timely plus effective removal of cake between flocks. The proper use of litter treatments and managing the factors influencing wet litter conditions are often key to reducing ammonia levels with built up litter. Failure to management litter quality in a built up litter program can be very costly and have negative environmental consequences.

Introduction

“As the litter goes, so goes the flock!” This saying has a lot of truth as it relates to managing litter and the subsequent effect it has on air quality. For the most part, litter management often has more to do with managing the systems that influence litter quality rather than managing the litter *per se*. Litter conditions are often a reflection of how well one has done in managing these systems.

The key areas where growers can have an influence on managing built up litter include; managing for proper litter moisture and litter temperature; and reducing disease challenge and stress from ammonia. In managing our systems, we often have a good understanding of *what* needs to be done and each company has general recommendations on *how* it is to be accomplished. However, we sometimes fail to explain to growers *why* our recommendations are so important. A grower may be more likely to change their practices if they have a solid understanding of why it is important and the potential impact it may have on their profitability. Hopefully, the following

information will aid in a better understanding of some key management concepts with built up litter.

The average total cleanout of broiler houses in the U.S. is steadily increased over the years. Due to high bedding cost, limited bedding supplies, short layouts, nutrient management issues, greater use of litter amendments, and/or low industry profitability, total cleanouts in many areas of the U.S. have gone from once per year to every two or more years. To remain competitive on a built-up litter program one must fine-tune the management of their litter. This is further compounded by the fact modern broilers are less tolerant to stress and adverse environmental conditions. With a narrowing of production cost between “good” and “poor” growers, one must seek every opportunity in managing litter and air quality to remain competitive. During the past few years we have seen the following regional events that have had a detrimental influence on litter quality; wet and very cold winters, high fuel cost, limited bedding supplies, depressed poultry markets and extended reuse of litter.

Litter Moisture

Dry, dusty litter may contribute to increase chick dehydration, respiratory disease, and condemnations. However, wet litter is generally recognized as having a much greater negative impact on performance, health, and overall profitability. Ideally, litter should be managed to have ~25 percent moisture. Litter moisture control starts with building houses on an elevated pad and maintaining good drainage throughout the life of the facility. Over time drainage around houses deteriorates, causing ponding and water seepage into the house. During wet weather or intense rain events, this can represent a major source of wet litter in houses having poor drainage.

Managing litter depth is critical in a built-up litter program. This starts with placing an adequate initial depth of 3 inches or more. It has been my experience at depths less than this amount, caking is often excessive and leads to greater bedding replacement costs over time. Another source of wet litter is high moisture bedding materials. Mill-run sawdust that has been stored outside often exceeds 45 percent moisture. This can represent up to 6 to 7 tons of water that must be removed from the house when used as the bedding source. If one starts with a wet bedding material or has wet built-up from the surface to the pad, only the top two inches of the litter surface will be reduced by the ventilation system during a flock. Undisturbed, it may require several flocks to dry the lower profile in built-up and with very deep litter, drying on top of a wet pad may never occur.

Another major opportunity in improving litter quality is the timely replacement of worn nipples. After 5 years nipples should be checked for wear. Reductions in cake volumes of 50 to 90 percent are often reported following replacement of worn nipples. Other management opportunities include regular pressure adjustment, proper line height, and routine flushing and line sanitation. When excessive caking develops under drinkers, it may be necessary to stir the litter or top with fresh, dry bedding.

Maintaining uniform bird density throughout the house is essential in tunnel as well as conventional housing. Performance, carcass quality, and litter quality are negatively influenced when birds are subjected to the stresses associated with high density in a portion of the house. In a study to determine the amount of cake produced

in conventional houses several years ago, I found that 25 of the 30 tons of cake removed during a summer flock on one farm was confined to one end of the house where the birds had migrated toward the direction of air flow. Timely installation of migration fences will prevent the detrimental effects of high bird density due to migration in response to differences in temperature, light intensity, and wind direction within houses. Even with timely installation of migration fences, uneven density will occur if the ventilation system is not properly designed and/or operated. Finally, cull birds utilize precious floor, feeder and drinker space, and increase the potential for disease transmission. Culls should be removed promptly.

Of all house systems and management practices, proper ventilation is the primary means available to growers to maintain good litter and air quality. With the advent of tunnel ventilation and evaporative cooling pads, litter conditions during hot weather have greatly improved. However, setting evaporative cooling pads to operate at too low a temperature may lead to wet litter at the tunnel curtains (Czarick and Fairchild, 2003). House sweating and condensation in cold weather can also create wet litter. Donald et. al. (2004) suggest maintaining <70% relative humidity, operate 0.10 static pressure with 1 to 1 ½ inch inlet opening, seal cracks and air leaks, consider using mixing fans, check for areas of inadequate ceiling insulation, use caution when using only off chamber fans during brooding, and use heat with large birds if needed to maintain air and litter quality.

From an environmental standpoint maintaining quality litter will be more important in the future. As phosphorus-base nutrient management plans are implemented, transport of nutrient-dense litter (*ie.* built up litter) to alternative uses will become more critical. Excessively wet litter has less nutrient density and more costly to transport. Many pellet or granulation facilities are not able to use litter in excessive of 28% moisture. Wet litter has more offensive odors and may create nuisance complaints from the production facility or following land application. And, with potential regulation of ammonia release from poultry houses in the future, maintaining drier litter will aid in reducing volatilization losses.

Litter Temperature

Rearing birds on wet, cold bedding can have major negative consequences on performance and carcass quality. With wet, cold, ammonia-laden built-up litter it is essential, particularly during cold-weather flocks, to preheat houses at least 24 to 48 hours prior to chick placement. Managed properly, deep litter can benefit production by providing a greater insulating layer on the pad, allowing for greater moisture absorbency, and can generate heat in winter via its composting action. To reduce added heat load in houses from this built up litter program in warm weather, it is a practice by some growers to reduce litter depth to approximately four inches going to summer. For a multiyear built up litter program, this involves “cutting-the-centers” of houses. Litter is removed from the center of the house, often feed line to feed line, and the remaining litter from the sidewalls leveled out across the house. From a nutrient management standpoint, this practice may aid some growers in that it provides an even distribution of litter from year to year.

Disease Challenge

Litter management and its indirect affect on air quality have a major influence on poultry health. The following are a few examples of recent research that supports this

statement. A study of commercial farms by Stayer, *et al.* (1995) found 12 times more cocci oocysts/gram of feces on “poor” farms and the oocysts increased during the flock on these farms compared to “good” farms. The “poor” farms were identified as having wet litter due to poor drinker management and drainage. In a survey of Delmarva farms having an early respiratory disease challenge, Tablante (1998) found drinker age and layout time as factors influencing the challenge on farms. Compared to control farms, the challenged farms had older, worn nipple drinkers (5.2 vs. 4.9 years) and short layout times (15 vs. 17 days). One could speculate that the older nipples produced wetter litter resulting in a greater challenge.

The importance of adequate layout time in reducing disease challenge can not be over emphasized! Layout time should not be measured from the day of movement, but from the day of crusting. Since cake is the most concentrated source of pathogens and ammonia producing material in the house, effective and timely removal of this product is an essential component of a litter management program. For Delmarva, the order of preference for machinery to “remove” cake between flocks has been crusters (de-cakers) and skid-steer machines with forks. Weather permitting, following crust-out, the house should be aired-out to dry the litter. This can be a greater challenge in solid sidewall houses. Although tillers have not been recommended, we are interested in using aeration equipment to windrow litter as a means to revitalize built up litter.

Recent work by Mallinson and co-workers at the University of Maryland has demonstrated the role of water activity in litter on the incidence of Salmonella. Litter with a water activity $<.83$ is usually negative while that $>.90$ is almost always positive for Salmonella. Since water activity is a key factor in bacterial reproduction, management programs to reduce litter moisture (water activity) will reduce bacterial challenges. In addition to the wet areas of the house (*ie.* cake under nipple lines), Mallinson *et al.* (1999) found Salmonella (and general bacterial populations) “hot spots” are also associated with the dead air spots on the litter surface (*ie.* in corners having poor air circulation).

From a disease standpoint, many factors determine how many flocks can be reared on built up litter prior to requiring a complete clean out and disinfection. Unless a house has a major disease challenge, some poultry complexes essentially never require a complete clean out, only manage the litter depth. In a 57 house study by Thaxton, *et al.* (2003) having 4 to 28 flocks litter base, they found once a stable microflora population is established it does not tend to change with increasing flocks on built up litter. If numbers of pathogenic organisms are reflective of their total aerobic and anaerobic bacteria, staphylococci, mold & yeast, and coliform counts, they suggest only cake removal may be adequate cleaning built up litter.

Ammonia

The negative effects of ammonia on broiler performance, health and carcass quality have been well documented. Maintaining desirable litter moisture and reducing litter pH are two means frequently used to reduce ammonia volatilization (and bacterial populations) in used litter. Chemical, microbial and enzymatic litter treatments are being used to reduce ammonia and/or bacterial populations. Selecting the best litter treatment is dependent on matching the characteristics of the product with your treatment goals. The acidifying litter treatments currently dominate the market. The following are some of the reasons why these acidifying products have not met ammonia control expectations; uneven or timely applications, inadequate moisture for chemical activation, improper or inadequate ventilation following treatment, and insufficient amounts of chemical to meet the ammonia challenge in houses.

In summary, the way in which we manage built up litter will continue to change as we are challenged with evolving production, food safety, welfare and environmental issues.

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