WINTER VENTILATION CHALLENGES BROILER GROWERS

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Adequate ventilation is critical for poultry house operation throughout the year. This is particularly true during colder times of the year (October through March) when growers must battle ammonia (NH_3), high in-house humidity levels and litter moisture buildup while trying to keep fuel use and costs at a manageable and affordable level. While wintertime minimum ventilation may sound simple (just cycle some fans now and then), it is often **quite difficult to achieve** the desired house conditions to maintain bird comfort while at the same time efficiently manage fuel use. Growers may sometimes sacrifice an in-house environment that is best for the birds to save a few dollars on the fuel bill. This is understandable because, for most growers, fuel is their greatest single expense during the year. In most cases, the gas bill is always higher than the electric bill at the end of the year. Therefore, growers often tend to reduce ventilation rates during the winter beyond what is prudent to conserve fuel and lower production costs. However, such actions **can prove detrimental in the long run** and have serious consequences on flock health, performance and profitability.

Moisture removal is the greatest challenge

Moisture removal is the **greatest cold weather challenge we face in poultry house ventilation**. Too much moisture and high in-house humidity levels for long periods of time often leads to wet litter and increased NH_3 levels, which are detrimental to bird health and welfare, performance and profitability. Poultry house **ventilation is perhaps the most difficult concept** of growing chickens for growers to understand in part because ventilation can't be "seen" in the same way that feeders and drinkers can be seen. A service technician can explain to a grower that the reason for the wasted feed near the feed line is because the feed line is too low or there is too much feed in the pans. The grower can visualize these things and make adjustments and see the results. The same is true for the water lines. Wet litter under the water lines could be the result of the lines being too low or the pressure on the regulators being too high. Growers can make needed adjustments and see the results. It's more challenging with ventilation, especially with minimum ventilation in cold weather because ventilation can't be seen in the same way that feeders and drinkers can be seen.

Air movement in a house and high humidity are difficult to see. However, NH_3 can be smelled, air inside the chicken house that is very moist and humid can be felt, and once litter starts to get slick, stick to your boots and cake over, those things can be seen. Although, **once the litter starts to slick over, we have lost control of our ventilation program,** and it's very difficult to fix the problem once it gets to this point.

The goal is to **stay ahead of the wet litter problem** with adequate minimum ventilation as the flock ages (Figure 1). Keeping the litter dry throughout the flock solves numerous problems. Footpad dermatitis is rarely an issue on dry litter. Ammonia production is much less on dry litter vs. wet litter. Bird health and welfare is better when the litter remains dry. However, dry litter requires adequate ventilation, especially during winter to remove all the water and moisture present in a chicken house. We just **can't leave the moisture in the house**, it must be removed or by the end of the flock, the birds would be wading around in water several inches deep on the poultry house floor. How can that be you might ask? To help answer that question, consider the following facts from Czarick and Fairchild (2012) related to bird moisture production and winter ventilation:

Figure 1. Proper minimum ventilation is key to keeping litter dry and improving flock health and welfare.

1) Roughly 20 percent of the water consumed by a broiler is retained by the bird. The remaining **80 percent is added back to the house** in the form of respiration and manure production and needs to be removed from the house daily to prevent an over buildup of moisture within the house and the litter.

2) For every pound of feed a bird eats, it will drink roughly one quart of water (or two pounds of water for every one pound of feed consumed). This holds true for the baby chick through the market age broiler; they consume roughly twice as much water as feed. In addition, broilers create water as they digest their feed. For every pound of feed eaten, roughly 0.45 pounds (7 ounces) of water will be created from breaking down the feed (Czarick, 2020). This increases the amount of water the bird is "consuming" by roughly 20 to 25 percent over what they are getting from the drinkers.

3) Water consumption increases seven-fold over the first 14 days of a flock. That means your **minimum ventilation rate should increase seven-fold** in the first 14 days as well. If it doesn't, the moisture level in the house will increase.

4) By seven weeks of age, a typical broiler has added roughly two gallons of moisture to the air and litter in the house. If you did not continuously remove this moisture, a typical broiler house would eventually have about **four inches of standing water** on the floor.

5) Under typical brooding conditions (90°F, 50 percent relative humidity (RH)), there are roughly 13 gallons of water suspended in 100,000 cubic feet of air, or roughly the air volume in a 40' x 400' house. If outside temperature is 30° F and 50 percent RH, there are only two gallons in the same volume of air. Cold air cannot hold nearly as much moisture as warm air.

6) Heating 10,000 cubic feet of air, which contains approximately one gallon of water, from 30°F to 90°F requires the heat produced by burning approximately 0.1 gals of propane. If propane costs $2/gallon, it would cost roughly $0.14 to remove one gallon of water from a house during brooding.

7) During cold weather, daytime temperatures are typically 20±°F warmer than nighttime temperatures. As a result, whereas, at night it may cost around $0.14 to remove a gallon of water from a house (60°F temperature differential), during the day the cost would be reduced to $0.09 (40°F temperature differential). Basically, it costs 40 percent less during the day to remove a gallon of water from a house than at night, so ventilation rates should be maximized during the day to help keep heating costs to a minimum.

8) During brooding, if the RH is 50 percent, condensation will form on any surface (wall, ceiling, fan) that is 20°F cooler than the air temperature. But, if the RH is 70 percent, a house surface temperature needs to be only 10°F cooler than air temperature for condensation to form.

9) A practical implication of Fact #8 is to balance the minimum ventilation exhaust fan and corresponding inlets in respective brooding or nonbrooding sections to avoid condensation forming. If it is 90°F and 50 percent RH in the brooding section of a house and only 50°F in the nonbrooding section(s), for every 1,000 cubic feet of air pulled into the nonbrooding section(s) from the brooding section, 0.07 gallons of water will condense on the ceiling, walls, and equipment in the nonbrooding section(s) of the house. If a grower is operating a 48-inch fan one minute out of ten (2,000 cfm on average) over a 24-hour period, 200 gallons of water could potentially be deposited in the nonbrooding section(s) of a house. If it is 70°F, essentially no water would be deposited in the nonbrooding section(s) of the house.

10) During the first week of a flock, roughly 2.5 million cubic feet of air need to be exchanged each day to control house moisture levels. By the end of the flock, this increases to nearly 40 million cubic feet.

Typically, under wintertime conditions we need to exchange approximately **10,000 cubic feet of air to remove one gallon of water**. So, if your water meter indicates that 500 gallons flowed into the drinker system of a broiler house today, you would need to exchange 5,000,000 cubic feet of air over the course of the day to remove that water from the house (500 x 10,000 cfm/gallon), or on a cubic feet per minute basis, that would be 3,472 cfm (5,000,000/ (24 hours x 60 minutes)).

Keep in mind that outside conditions can make a big difference. Cold air cannot hold as much moisture as warm air so even on a cold rainy day there is still more moisture in the air inside the broiler house (because that air is warm) than outside. However, on a cold rainy day, minimum ventilation rates need to increase roughly 20 percent to account for the additional moisture in the outside air caused by the rain. This increase needs to be roughly 30 percent for moderate temperatures with no rainfall. Moderate temperatures with rainfall make it difficult to control in-house moisture levels because outside air may be roughly as saturated as inside air.

Figures 2 and 3. Fans must be in good condition to perform at their best. This requires inspection and routine maintenance, especially for minimum ventilation fans that work more than the rest.

Minimum ventilation fans

It is critical that growers always keep fans in good working condition (Figures 2 and 3), especially the minimum ventilation fans. Minimum ventilation fans **are the workhorses** of your poultry farming operation. To paraphrase from George Orwell's "Animal Farm," "All fans are equal, but some fans are more equal than others." When it comes to cold weather ventilation, **your minimum ventilation fans are more equal (important) than your other fans**. Consider these figures that you likely never think about. Minimum ventilation fans in a broiler house cycle on and off every five minutes (every 300 seconds). These fans cycle on and off 12 times every hour. In a 24-hour period, these fans start and stop 288 times. With baby chicks in winter weather, the house may stay in minimum ventilation mode for the entire brooding period (perhaps 10 days) and the minimum ventilation fans start and stop a total of 2,880 times. If we estimate the use only during brooding and consider five flocks per year, that's **14,400 cycles per year**. That's only for their time spent doing minimum ventilation duties. It doesn't include their duties related to summer cooling. The minimum ventilation fans will require additional inspection and extra routine maintenance to provide top performance because they are working overtime for you.

Minimum ventilation fans operate at a high static pressure (0.10 to 0.15) in addition to their high workload, increasing the potential for problems to develop. Dirty shutters, condensation and dirt buildup on fan blades all make the fan work harder to do its job. Things to check include fan belts (minimum ventilation fans should have new or near new belts), pulleys (if a fan is squealing, check the belt and the pulley), belt tensioners (most tensioners lock up in the relaxed position so make sure the tensioner is forcing the belt to stretch to prevent it from slipping on the pulley), and shutters (should be cleaned and repaired (if needed) after each flock). Pullet growers with light traps on their fans should clean the traps after each flock. Each fan is rated to provide a certain amount of cubic feet per minute (CFM) of airflow. If lack of maintenance means the fan can't provide its rated CFM, you are under ventilating with that fan which will lead to moisture buildup over time unless the difference is made up with additional run time.

House tightness

House tightness is critical to any minimum ventilation program. Without a tight house you cannot successfully manage your ventilation program. A house that cannot achieve a minimum of 0.13 to 0.15 inches (curtain sided) or 0.20 to 0.22 inches (solid sidewall) of water column when a static pressure test is performed will use excessive amounts of fuel to maintain the target house temperature and you will not have a uniform environment throughout the house because of excessive air leaks in places you don't want, such as loose-fitting curtains, gaps along footings where the seal is not tight, leaks around entrance and loadout doors, and so forth. Sealing the house and **maintaining a tight building envelope should be your first priority** to properly manage winter ventilation programs and minimize fuel use.

Consider installing stir fans if your houses do not have them. In older houses, they can reduce fuel costs by 25 percent. Even newer houses can see fuel savings approaching 10 percent with stir fans (Campbell et al., 2008). Stir fans break up the temperature gradient that forms in houses without stir fans. Hot air rises so unless you have a way to mix the air in the house, the hottest air in the house is at ceiling level while the birds are on the floor. Stir fans mix that hot air in the ceiling with the rest of the air in the house and break up that temperature gradient. They gently move this hot air back down across the litter to help promote drying while reducing brooder run time. Direct the airflow horizontally toward the end wall of slightly uphill toward the ceiling but not down toward the floor. Birds (especially young chicks) do not like a draft. Different growers may use stir fans in different ways. Some run them continuously during the brood period while others tie them to the controller and alternate their operation in combination with the vent doors and minimum ventilation fans. Stir fans should remain in use from the pre-heating period before chick arrival through the brooding period (14-18 days of age). **After tightening up the house, stir fans may be your best energy savings investment**.

Understanding ventilation

The American Society of Agricultural Engineers indicates that a ventilation system for poultry and livestock facilities accomplishes one or more of the following goals (ASAE, 1993):

- Provides the desired amount of fresh air, without creating drafts, to all parts of the shelter.
- Maintains temperatures within the desired limits.
- Maintains relative humidity within desired limits.
- Maintains ammonia levels below specified levels.

Ventilation rates are designed to **balance sensible heat (dry heat) gains and losses with latent heat (moisture) gains and losses** (Porter, 1998). Sensible heat gains in a broiler house include bird sensible heat (body heat), mechanical heat from equipment such as lights; feeder motors, fan motors, etc.; supplemental heat from brooders and furnaces; and solar heat gain. Sensible heat losses include building heat losses through curtains, doors, walls, etc.; heat removed by ventilation; and sensible heat used to evaporate water. Latent heat gains include water vapor from animals (manure and respiration); water vapor in the incoming air; and water vapor from evaporation from wet litter. Ventilation removes latent heat from the house.

An often-asked question from growers is "How long should I minimum ventilate to control moisture in the house?" The answer to that question is part science and part art. Integrator guidelines are a good starting point. These guidelines increase the minimum ventilation rates as the birds age. However, several days of damp, rainy weather may mean the guidelines are under ventilating the house for the conditions that you have. This is where the "art" comes in. As a grower, you must learn to "feel" when the air is too heavy in the house and when the humidity is too high and increase the minimum ventilation rate to account for that. You can also watch the litter for signs of slicking over and cake formation, especially near the walls and under the drinker lines, and for the litter to become tacky and start sticking to your shoes or boots. However, by the time you recognize that there is a problem with the litter, it is almost too far out of hand to correct. Staying ahead of litter problems and striving to maintain the proper relative humidity (RH) at all times may be a better strategy.

In most cases, the **proper in-house humidity level is somewhere between 40 and 60 percent**. If in-house RH goes over 60 percent, consider increasing the minimum ventilation rate to prevent the litter from caking. If RH drops to 40 or 45 percent, consider backing off the minimum ventilation rate just a bit to prevent the house from becoming dusty. Take advantage of the occasional warm winter day and increase the ventilation rate to aid in drying out the house without burning any extra fuel. Let Mother Nature help with the fuel bill whenever you can. Just remember to set the minimum ventilation back to its normal setting at night. This is another opportunity to use your artistic talent to maintain proper house conditions. Raising chickens is only part science. Art has a much larger role in it than most people realize. Most growers can walk into a chicken house and know if everything is all right or not simply by how things feel, how they smell, what the sound level of the birds is, etc. There is **science to raising chickens, but there's also a lot of art**…and some growers are better artists than others.

Keep in mind that **high NH_3 concentrations can throw a wrench in the works** when it comes to your winter ventilation program. Controlling NH_3 is more difficult than controlling other air quality parameters. Ammonia concentrations will often overwhelm minimum ventilation programs and force growers to increase ventilation rates well above minimum ventilation moisture removal rates to maintain NH_3 at acceptable levels (<20 ppm). Every house generates ammonia differently depending on conditions, and if you have high NH_3 levels when chicks are placed, it is difficult (and expensive) to ventilate your way out of that problem. However, you **cannot afford to blind chickens because of high NH_3 levels**. You must over ventilate to control ammonia. Therefore, litter amendments that lower litter pH and reduce NH_3 levels for the first week to 10 days of the flock should be considered as a cost-effective alternative to overventilation as a means to decrease NH_3 levels during the brooding period. Remember that the primary goal of wintertime minimum ventilation is moisture removal; minimum ventilation is not designed for NH_3 removal. Ammonia removal will require additional ventilation.

We have known for more than 60 years that prolonged exposure to NH_3 concentrations as low as 20 ppm can be detrimental to bird health and performance, when birds remain in such an environment throughout the growout period (Anderson et al., 1964). In addition, eye damage may occur with as little as 12 hours of exposure to 45 to 100 ppm NH_3 (Black, 2012). These are basics that every grower should know. New growers likely will not know all the basics, but this is where the service technician can play a valuable role in helping new growers understand what to look for and how to respond to various situations. Growing chickens does not get easier once you know the basics, but at least you **better understand what you need to do and why you need to do it**.

Summary

Wintertime minimum ventilation programming can often challenge the best poultry growers. However, the proper minimum ventilation program is critical to successful broiler production during cold weather. While the temptation may be great to reduce ventilation to save fuel, consider what it will cost you later in poor performance, increased mortality, and reduced market weights. **Moisture and NH_3 are likely the two greatest challenges** that growers face during the winter season. The proper minimum ventilation program can likely handle the moisture issue if growers will follow recommended guidelines and not cut corners to save fuel. However, minimum ventilation will not handle a serious NH_3 challenge. That will require additional ventilation above what is needed strictly for moisture removal. Recognize that providing the proper minimum ventilation rates during winter months will result in the necessary environment that will allow the flock to optimize its earning potential for you.

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