

A technical bulletin for The Americas

MINIMUM VENTILATION DURING COLD WEATHER

MICHAEL CZARICK – EXTENSION ENGINEER · POULTRY – UNIVERSITY OF GEORGIA

Knowing how much to ventilate during cold weather is crucial to a producer's bottom line. Ventilating too little can lead to poor air and litter quality, resulting in bird health and performance issues. Ventilating too much can lead to drafty conditions and high heating costs. The first step to knowing how much you need to ventilate during cold weather is to understand which air quality variables are most likely to cause problems.

The three primary air quality variables turkey producers need to manage, besides temperature, in a turkey house during cold weather are carbon dioxide, humidity, and ammonia.

Target levels to maximize bird performance:

- **Carbon dioxide concentrations below 5,000 ppm**
- **Relative humidity around 50%**
- **Ammonia concentrations below 30 ppm**

MANAGING CARBON DIOXIDE

Carbon dioxide is produced by the birds as well as by a house's heating system. High carbon dioxide concentrations can lead to lethargic poults and reduced performance. **Figure 1** illustrates the approximate minimum ventilation rate (cfm per 1,000 birds) required to maintain a carbon dioxide concentration below 5,000 ppm. The graph assumes the only source of carbon dioxide is the birds, which typically is not the case with younger birds. When propane/natural gas is burned it adds a significant amount of carbon dioxide to the environment.

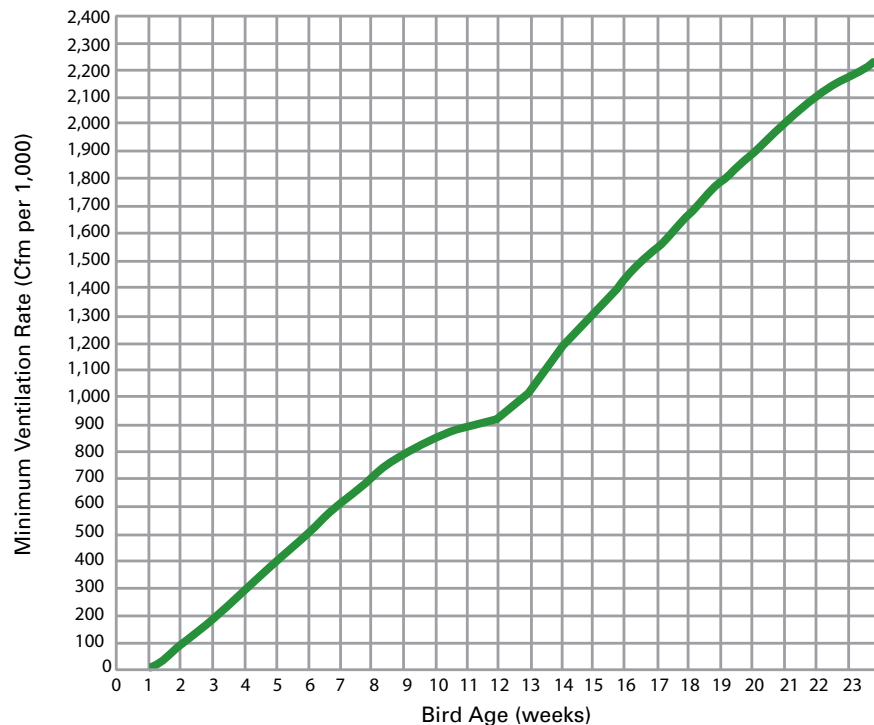


Figure 1. Minimum ventilation rates required to limit carbon dioxide

During cold weather the heating system can add two to four times more carbon dioxide to the house than the birds.

To be on the safe side, during cold weather in brooder houses it is typically best to double and possibly triple the rates depicted in **Figure 1**.

MANAGING RELATIVE HUMIDITY

Insufficient ventilation during cold weather can also lead to a buildup of moisture in a house, resulting in damp litter and all the associated problems. If, however, a producer ventilates too much not only will it result in high heating costs, but the resulting low relative humidity can lead to dusty house conditions.

The chart in **Figure 2** provides a way to determine minimum ventilation rates to control house humidity from daily water consumption and house temperature. For every pound of feed, a bird will drink approximately a quart of water. The older the birds get, the more feed they eat, the more water going into the house that we have to get rid of through ventilation.

If we know how much water is going into a house, the inside and outside temperatures, and have a target for inside relative humidity, then we can calculate how much we need to ventilate to rid the house of the moisture the birds are adding.

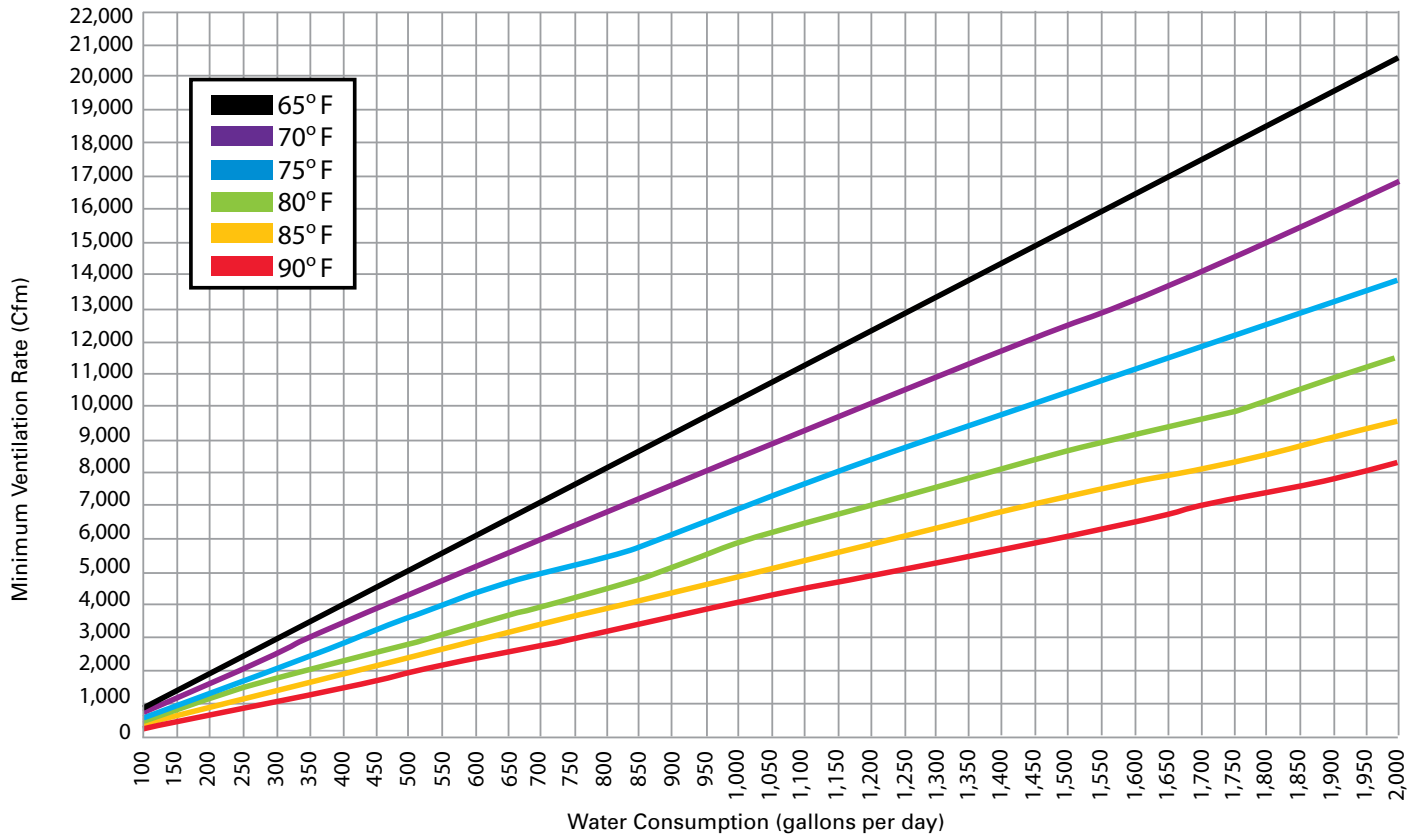


Figure 2. Minimum ventilation rates required to manage house moisture based on bird water usage and inside temperature

What about outside relative humidity?

The fact is that when it is cold, outside relative humidity really doesn't have a large effect on how much we need to ventilate to control moisture in the house because cold air, whether at 40% or 100% relative humidity, actually contains very little moisture.

For instance, if during brooding it is 90°F (32°C) and 60% Rh, there would be approximately 20 ounces of water in every 1,000 cubic feet of air in the house. If outside it were 40°F (4°C) and 50% Rh, there would be 3 ounces of water in every 1,000 cubic feet of air. When the minimum ventilation fans come on, for every 1,000 cubic feet of air we bring in, we are bringing in 3 ounces of water.

The good news is that although we are bringing in 3 ounces of water, we are at the same time exhausting 20 ounces of water. Even though when we are

ventilating, we are bringing in some moisture, the fact is we are exhausting air with significantly more moisture, which results in an overall reduction in house moisture levels.

Now, let's say that it is 40°F (4°C) and 80% Rh outside. Under these conditions there would be 5 ounces of water in every 1,000 cubic feet of air we brought into a house. But again, since the inside air has 20 ounces of moisture for every 1,000 cubic feet we would be removing 15 ounces (20 ounces - 5 ounces) of moisture for every 1,000 cubic feet of air we moved into and out of the house.

As you can see, even though the humidity is much higher outside than in the first example it only reduced the amount of moisture we removed from the house by a little over 10%. So, even though technically a minimum ventilation chart should take into

account outside relative humidity, for the most part you can obtain fairly accurate results with a chart that assumes an outside relative humidity of 50%.

Outside temperature has more of an effect on minimum ventilation settings than does outside relative humidity.

The minimum ventilation rates provided in **Figure 2** are based on an outside temperature of 30°F. (-1°C). The minimum ventilation rates indicated can be adjusted for very cold or moderate conditions. For instance, if the minimum outside temperature is 50°F, 20°F warmer, (10°C, 11°C warmer) minimum ventilation settings should be increased by approximately 25%. If the minimum outside temperature is 9°F, 10°F colder, (-11°C, -10°C colder) the minimum ventilation rates can be decreased 25%.

CONTROLLING AMMONIA

Last but not least, we need to ventilate enough during cold weather to control ammonia. High ammonia concentrations can lead to reduced bird weights, increased feed conversions, and increased incidence of respiratory problems. The problem is that there isn't a minimum ventilation chart to provide a minimum ventilation rate to control ammonia. This is because though the moisture and carbon dioxide produced by the birds doesn't change much from farm to farm, ammonia production is very hard to accurately predict.

The amount of ammonia produced is a function of factors such as age of litter, litter moisture, amount of caked litter, and length of downtime between flocks. At this time the best way to determine how much you need to ventilate to control ammonia is to simply set a couple of 36" fans to run a minute or so out of five and measure the ammonia concentration right after the fans shut off.

If you want to cut the ammonia concentration in half, double your timer setting.

If it is very low, and you think it would be okay to double the concentration, then cut your timer fan settings in half.

DETERMINING FAN SETTINGS

Which variable – carbon dioxide, relative humidity or ammonia – should be used to determine timer fan settings?

Ideally, you should determine minimum ventilation rates based on the variable that requires the highest minimum ventilation rate.

For instance, if you have a house with built-up litter and you are not using a litter treatment, you will probably find

that the minimum ventilation rate to control ammonia concentration will be the highest. With a freshly cleaned out house, you may find that relative humidity will be the controlling air quality variable. In a house with very dry fresh litter, managing carbon dioxide might be the determining factor.

In an ideal situation we wouldn't use any charts. Producers would have meters to measure ammonia, relative humidity, and carbon dioxide and then make adjustments to minimum ventilation fan settings accordingly. In most cases this is not possible.

To date, there hasn't been an ammonia meter that has been proven to accurately measure ammonia in a poultry house on a continuous basis. Yes, there are some meters that can be taken into a house for a short period to measure ammonia, but they tend to be expensive (\$1,000+), require frequent calibration, and the meter's sensor typically has to be replaced once a year at significant expense (over \$400), putting them out of the reach of most producer.

Carbon dioxide meters cost around \$500, though typically less problematic than ammonia meters, they are not particularly useful because for the most part carbon dioxide is not very likely to be a significant problem on most farms except for the first couple of weeks in the brooder house.

This brings us to relative humidity meters/sensors. For the most part, they are very reliable and relatively inexpensive. Furthermore, relative humidity is what we typically are most interested in controlling during cold weather.

The fact is that if we properly manage humidity in our houses we will keep ammonia and dust from becoming problems in the first place. If a house has fresh shavings and it is ventilated

to control relative humidity from day one, then litter caking will be kept to a minimum, and therefore, keep ammonia from being a major problem.

A relative humidity meter/sensor is a ventilation tool that no poultry house should be without.

Trying to determine how much to ventilate a house is always going to be a challenge. Balancing the well-being of the birds and heating costs is difficult at best. But, the better you understand the goals of minimum ventilation rates during cold weather, the more likely you will have optimal bird health and performance and the less likely you will be to over ventilate your houses, which of course will lead to higher heating costs.

ABOUT THE AUTHOR

Michael Czarick III is an extension biological and agricultural engineer at The University of Georgia. He is considered by the poultry industry and the academic community as a leading authority on the design and operation of poultry house environmental control systems. Mr. Czarick has given presentations on poultry house environmental control and energy conservation in 35 countries and has authored numerous publications, including scholarly journals and industry-related pieces. His unique ability to explain relatively complex ventilation concepts in an easy-to-understand way has made him a highly sought-after speaker around the world.

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Aviagen Turkeys Inc.

31186 Midland Trail, East • Lewisburg, West Virginia 24901 • USA

Tel: +1 304 793 2680 Fax: +1 304 793 2684

turkeysinc@aviagen.com

Aviagen Turkeys Ltd.

Chowley Five, Chowley Oak Business Park • Tattenhall, Cheshire CH3 9GA

Tel: +44 (0)1829 772020 Fax: +44 (0)1829 772059

turkeysLtd@aviagen.com

Web: www.aviagen.com

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