

Ventilation and Brooding for Winter

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Introduction: Donald et al. (2001a) reported that propane accounted for as much as 40% of a producer's out of pocket expenses for producing broilers. Between 2001 and 2005, while propane prices increased by 41.5%, prices received by NC producers for their broilers increased by only 12.5% (2000-2004). Hence, the increase in energy prices has likely affected the profitability of broiler production. Since much of the energy consumption (from fossil fuels) in broiler production occurs during the brooding phase, optimizing brooding to reduce heat losses while increasing the thermal comfort level of the chicks is very important. The importance of an effective ventilation system cannot be overemphasized because while inadequate ventilation can reduce bird performance (through poor air quality in the house), excessive ventilation result in excessive heat losses. Hence, brooding and ventilation should both be viewed as profit centers (components that increase the profitability of the enterprise) and not as cost centers, i.e., as a drain on precious resources. This is particularly true in today's energy market that is characterized by both high and unstable energy prices.

Brooding: Newly-hatched chicks are incapable of regulating their body temperature and hence, have to be provided with supplemental heating. As they grow older and develop feathers, their need for supplemental heating diminishes as they produce their own heat and conserve it better. Maintenance of proper brooding temperature is critical to the success of the broiler operation because it impacts body weight, feed conversion, and mortality. There is difference of opinion regarding optimum brooding temperatures. Taking into account weight gain, feed conversion, mortality (including ascites), Deaton et al. (1996) recommended brooding at 85 F (floor temperature) during the first week with a 5 F decrease every week for two weeks. The lower temperature brooding reduced LP gas consumption by 18 and 10%, respectively, compared with brooding at 95 F and 90 F (Deaton et al., 1996). However, Donald et al. (2001b) and Fairchild and Czarick (2006) recommended brooding at a floor temperature of at least 90 F during the first week. Fairchild (2005) recommended temperature ranges for different types of brooding systems (Table 1) to achieve a floor temperature of 90 F.

Table 1. Recommended temperatures for broiler brooding based on heat source¹

Day	Temperature, F		
	Forced air furnace ²	Pancake brooder ³	Radiant brooder ⁴
0	93	90	88
3	90	88	86
7	87	86	84
14	83	85	82
21	78	80	77

¹Adapted from Fairchild (2005); ²at chick height; ³at chick height, 1 ft from edge of brooder canopy; ⁴at chick height, 4 ft from edge of brooder canopy

Since the forced air furnace transmits heat by moving warm air (convection) and warm air tends to rise to the ceiling, the ceiling will be warmer than the floor. Using air mixing fans or ceiling fans to bring down the warm air to the floor may increase the floor temperature by up to 5 F and reduce propane consumption by up to 30% during brooding (Donald et al., 2001b). However, even with ceiling fans, gas consumption will be higher in houses with forced air furnaces than with brooders. With forced air systems, the floor temperature will be more or less uniform in the brooding area and if the temperature is not optimum, the birds cannot migrate to a more comfortable location. Hence, there is less room for error with forced air systems versus brooders.

Brooders (Table 1) provide most of their heat in the form of infrared light, i.e., the light waves can travel through still air and heat objects. Compared with the forced air furnace, this is a distinct advantage since the heat is used for warming the litter and chicks instead of heating the air. The pancake brooder provides a relatively uniform temperature range directly beneath the brooder whereas the newer radiant brooder covers a larger area and creates circular bands of temperatures, with the highest temperature directly under the brooder (Donald et al., 2001b). With brooders, chicks have greater flexibility than with forced air furnaces in locating a comfortable location. Brooders are also likely to reduce the cold drafts than forced air furnaces; however, they generally need more maintenance. Radiant brooders can reduce fuel costs by 15 to 30% compared with pancake brooders or forced air furnaces (Lacy, 2002).

Radiant tube heaters may be another option for producers who are building new houses or are planning to replace brooders. Like the brooders, these heaters supply heat in the form of infrared radiation and hence, warm the litter and the floor, rather than the air. The heating system consists of a heating tube 30 to 50 ft in length, gas burner, blower, and reflector (van Wicklen, 2004). These heaters typically have outputs of 50,000 to 125,000 BTU/hour and are usually equipped with two heater settings. Since the heater is hung from the ceiling, it covers a much bigger area (practically the entire width) and does not have to be raised or lowered. Preliminary reports from Delmarva indicate that the higher cost of these tube heaters can be offset by improved production and energy savings (van Wicklen, 2004). However, these heaters require further evaluation.

Brooders are powered mainly by propane or natural gas. When burned, 1 cu. ft. of natural gas and propane will produce about 1,000 and 2,500 BTU of heat, respectively. Based on Dept. of Energy price projections and assuming residential rates, excluding taxes but including 5% additional charge for natural gas, \$1 will buy you 58,400 and 45,800 BTU of natural gas and propane, respectively, in the last quarter of 2006. However, before trying to switch to the 'cheaper' natural gas (even if it is available), there are other expenses. Propane, being denser, needs a smaller pipe and replacing the propane pipe with a larger pipe for natural gas (to maintain adequate gas flow to the burners) is likely to be the biggest cost component. Further, the pressure regulators and burner orifices will also have to be changed (Czarick and Lacy, 2001).

Hence, changing the fuel of the brooders should not be a priority except for new houses. The following recommendations should be helpful to producers in saving energy during brooding.

1. Introduce the day-old chicks into a house where the litter temperature is at least 90 F. Reducing the temperature by 2-3 F every 3-4 days will provide better conditions for the chicks and reduce energy use compared with 5 F reduction every week as practiced earlier.
2. Proper brooder maintenance will lower fuel use and carbon monoxide production inside the house. Blow off the dust from the brooder during each layout and clean the brooder orifices with the correct size of reaming needles (to avoid increasing size and wasting fuel).
3. Proper location of the temperature sensor will minimize fuel waste (Table 1 foot notes). Locating sensors improperly can chill the birds (e.g., too close to brooder or on the litter surface) or burn excess energy (e.g., too close to sidewall, brood curtain or air inlet).

4. Using paddle (updraft mode) or circulation fans can reduce thermal stratification and reduce energy use. Fans will provide greater benefits with forced air furnaces than brooders.
5. During the first 7-10 days, the brooding area should be brightly lit (at least 25 lux or 2.5 foot candles at chick height) to allow chicks to find food and water. Thereafter, the light intensity should be reduced to about 5 lux or 0.5 foot candles by 10 to 14 days (Fairchild, 2005).
6. Make the house as tight as possible to prevent leaks from unplanned openings. This is covered in greater detail below.

Ventilation: When a broiler house is too warm or too cold during brooding, the first impulse of many producers is to adjust the thermostat. It is equally, if not more important, to consider if the ventilation system is doing its job correctly. The main objective of summer ventilation is to ensure that the excess heat produced inside the house is removed. However, the main objective of winter or minimum ventilation is to remove excessive humidity; if the level of ventilation is adequate, ammonia and other poisonous gases will probably be at acceptable levels, except with old litter. However, with high fuel prices, some producers may reduce ventilation to save energy; this can result in build up of humidity and ammonia which may harm the health of the chicks.

The ventilation system is doing its job right when it brings in the right amount of fresh air through the planned openings at the right speed, and removes the right amount of stale air. For a ventilation system to function correctly (and thus save energy), the house should be as tight as possible so that fresh air only comes in through the planned inlets. One rule of thumb is that with one 48-in. fan running and all openings (including inlets) closed, a tight house will have a static pressure of 0.15 in. of water column; a not-so-tight house, will have a lower static pressure. To tighten up a house, install curtain flaps and boots, adjust curtains at the top and the sides, repair any and all damaged insulation, caulk all cracks and holes, close all inlets not in use, and ensure all doors and fan shutters shut and seal properly (Donald et al., 2001b). Simpson and Donald (2005) reported that tightening a 25-year old broiler house in AL reduced energy use by 30% and was cooler during summer. When building new houses, solid walls are preferable to curtain sided walls for energy conservation. A tighter house not just saves energy, but has a more uniform environment for the birds, and is easier to ventilate (Simpson and Donald, 2005).

The air should move in through the inlets (sidewall or ceiling) at the right speed (800 to 1,000 ft/min irrespective of the number of fans) and direction, so that the airstreams coming in from both sides can travel about mid-house along the ceiling and mix with warm air and allow some of the heat to move down to bird level. Sidewall inlets open 1 ½ to 2 in. and ceiling inlets open 1 to 1 ½ in. wide will ensure proper 'throw' of the fresh air into the house, resulting in better mixing. Wider openings of the inlets will cause air to dribble down mostly along the sides of the inlets causing cold regions (and wet litter) on the floor; narrower than desired inlet openings will increase static pressure and cause the airflow to be choked. During brooding, all inlets in the non-brooding area should be latched and only the required number of inlets in the brooding area should be unlatched to let in fresh air. However, inlets within 8 ft of the minimum ventilation fans should be latched shut. The number of inlets to unlatch will depend on the size and opening width of the inlet (also its design), the tightness of the house, and the ventilation rate. For new houses or to retrofit existing houses, producers should consider installing the recessed, European style inlets. These inlets not only allow for better air mixing inside the houses but are also better insulated (Czarick and Fairchild, 2004). While the European inlets are more expensive than the galvanized steel straight inlets, only half as many inlets and light hoods are required (Czarick and Fairchild, 2004). Ensure that all inlets open the same width to create even temperature throughout the house; in this regard, use of steel rods instead of cables will be helpful.

Finally, the ventilation system should exhaust the right amount of air from the brooder house to maintain proper air quality and not waste energy. The minimum ventilation rate should be increased from 0.1 cfm/bird (first week) to 0.9 cfm/bird over an 8-week period (Donald, 2003). A minimum of two 36-in fans should be used since one fan alone will not create the static pressure to open the inlets; this will also improve temperature uniformity in the brooding area. While a single 48-in. fan will open the inlets, it will concentrate heat at the end of the house. Use 5-min instead of 10-min timers to reduce temperature swings inside the house. Maintain minimum ventilation settings irrespective of inside or outside conditions (Donald, 2003). If there is a cold rain outside, the fresh air brought inside will be warmed up and dried and the exhaust air will thus have the capacity to remove humidity from the house. It is also important to maintain all components of the ventilation system in good condition. Make sure cold air does not come in through broken or dirty shutters that do not close completely. Ensure proper V-belt tension and make sure that the belts are riding the pulleys at the proper height. When belts run loose or deep in the pulleys, inadequate ventilation in the house will result in poor air quality and impact the birds adversely. Self tensioning belt systems are very effective and have short payback times. Finally, acidifying amendments such as PLT®, Al+Clear® or Poultry Guard® are effective in reduce ammonia concentrations inside broiler houses. High ammonia levels can weaken the respiratory and immune systems of birds and thus, reduce body weight, increase feed conversion, and increase mortality. Amendments are particularly useful during brooding.

Based on the discussion above, the following recommendations will help the producer optimize his/her ventilation system to increase productivity.

1. Make sure that your houses are as tight as they can be. Given the high energy prices, payback on caulk, insulation material, and your labor will be quick.
2. Unlatch the right number of inlets for the number of fans that will be operating in the minimum ventilation mode. Ensure that all your inlets open the same, correct width.
3. Maintain your minimum ventilation rate irrespective of conditions inside and outside the house, except when the litter is very wet (also high ammonia) or very dry (dusty). Use at least two 36 in. fans rather than a single fan run for a longer duration. Use 5-min fan timers versus 10 min to minimize temperature swings and enhance bird comfort.
4. Poor ventilation will cause you to lose money. Proper maintenance of your ventilation system will have quick payback.
5. Consider using amendments, particularly during brooding to improve inside air quality.

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