Cooling Practices for Large Broilers

Jody C. Smith
Area Specialized Agent, Poultry
North Carolina Cooperative Extension Service
Union County Center
3230-D Presson Road, Monroe, NC 28112
Phone: 704-283-3743. E-mail : jody_smith@ncsu.edu

In today's poultry industry there seems to be a need for a bigger bird. Why is that? Is it due to the fact it puts more money in the company's pocket? Does the producer benefit for growing a larger bird versus a smaller bird? Is the larger broiler cheaper to grow? Is the public forcing the industry to a larger bird? Is it animal welfare? There are a lot of assumptions made at growing bigger birds either looking at the glass half empty or half full. Where do you stand? Depending on if you are a company representative or a grower for the most part depends on if growing a bigger bird is more efficient. And what we must do as an industry to prepare and educate on the requirements for growing this larger bird is crucial. In fact, there are several different practices that we must learn and focus on while still paying close attention to the small things. Typically we can separate the good grower from the not so good growers by them doing the little day to day operations and maintenance requirements that you normally do not see on a below average farm.

So, let's take a few moments and see just what it takes to be able to grow a big bird in the poultry industry in North Carolina:

Modern broiler houses typically are 40ft X 500ft in dimension. This equates to 20,000 ft^2. Bird placement is somewhere on the average of 21,000 birds/house. So, on a 90°F day where does most of the heat come from? Does it come from the roof? The sidewalls? The endwalls? The lights? The birds? From a few simple calculations we can determine how much heat is entering through the different areas:

Heat = (Area/R-value) X temperature difference

Well, luckily if you said the birds then you are on the right track. Many times people get caught up in the fact that heat loss and gain are coming in from the roof. However, due to insulation properties and today's modern designs most poultry houses will not be more than a 2°F change. Again this is due to the fact that 90% of heat flow is reduced by way of ceiling insulation. Going back to our calculation,

- To determine heat loss in the **ceiling**, with a R-value of 13 and a temperature difference of 50°F (135°F-85°F), we see there is approximately **77,000 btu's/hr** entering in through the ceiling.
- Ok, now the **sidewalls** using the same math, let say an area of 4' X 500' X 2(two sides) = 4,000 ft^2, a R-value of 4 and a temperature difference of 15°F (100°F-85°F) for a total of **15,000 btu's/hr** entering in through the side walls.
- Now the **end walls**, 9.5' X 40' X 2, a R-value of 4 and a temperature difference of 15°F (100°F-85°F). So, heat entering through the end walls equals approximately **2,900 btu's/hr**.
- Well, how much heat is generated from **lights**? We know that 80% of energy an incandescent light bulb uses is put off in the form of heat. One watt equals 3.4 btu's of heat. So, if we take

the wattage X 0.80 X 3.4 X # bulbs this will tell us the btu's/hr produced. If we have 50 lights in a poultry house then we would generate around **5,440 btu's/hr**.

- Lastly, **bird heat**, normally we do not contribute this to be a great amount until we actually do the calculations. In figuring bird heat we know that 1 pound of feed contains 1,500 Kcals of energy or 1 pound of feed contains 6,000 btu's of energy. Also, digesting feed produces heat at approximately 12 btu's/lb, where 5 btu's /lb is lost to the air and 7 btu's/lb is lost through panting. These two factors increases air temperature and relative humidity, respectively. So if we take an 8 lb bird at 0.95 ft^2/bird we produce approximately **842,000 btu's/hr**. Wow!!!!
- Now, if we add up **all the heat added** to the house we would have approximately **942,340 btu's/hr** produced. Now since we know where the heat is coming from we just need to know how much we need to get rid of.

Typically we work off of the idea that a maximum allowable temperature difference should be approximately 5°F from the inlet end to the exhaust end. Looking at the amount of heat generated (942,340 btu's/hr) divide that by 5°F and this will give up approximately 188,000 cfm. Now divide 188,000 cfm by 20,000 cfm/fan and this will tell us we need approximately 10 fans/house. ***From the calculations we know with 10 fans the temperature rise will not exceed 5 degrees.***

In tunnel ventilation there are essentially 3 goals we must achieve. First, we need to remove heat from the house, second to remove heat from the birds and third to reduce the temperature of the incoming air.

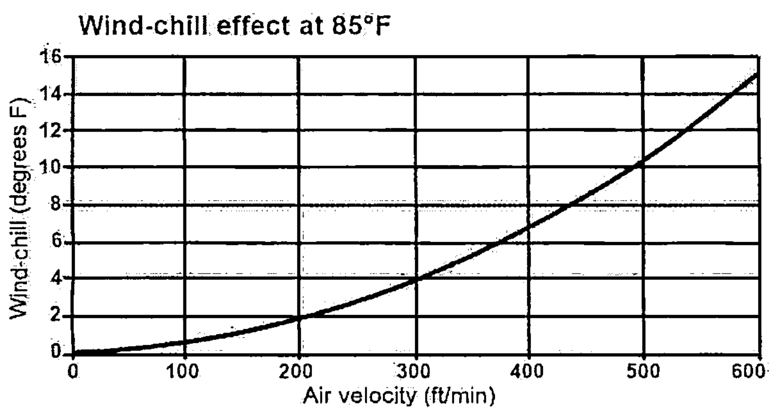
For the most part we do a pretty good job of this except in hot humid weather. Why is that? What has changed? **Relative humidity plays a major role, with an increase in humidity the cool cell pads are less efficient, the air is heavier, and there is a reduction in the amount of moisture removed from the house.** What do we do now to cool these large birds? Well, we have now figured out how much air it takes to remove the heat from the poultry houses, but is this enough. How many cfm's do we need to grow a big bird and are we getting any wind chill effect? In figuring air speed in tunnel houses we use the formula (speed = cfm / cross sectional area of the house).

Looking at a typical dropped ceiling 40 ft X 500 ft house with a peak ceiling height of 11 ft. and a side wall height of 8 feet and a fan capacity of around 190,000 cfm we can achieve around 500 ft/minute. Is this enough? Looking at some of the research out of United States Department of Agriculture-Agricultural Research Service (USDA-ARS) in Mississippi maintaining 550 ft/minute wind speeds 24 hours a day in the last two weeks of a big bird growout has been shown to pay off as much as a quarter a pound in additional weight gain. To get this additional wind speed most likely we need to add more fans. For instance, if we want a desired wind speed of approximately 600 ft/min then we would multiple 600 ft/min by 380 ft^2 (cross sectional area) to get total cfm. This equals 228,000 cfm, now divide by 20,000 cfm/fan to show up the total number of fans we need to achieve the wind speed we are targeting. Adding more fans is not as easy as it sounds. With the addition of more fans, the cool cell area will also need to be increased due to an increase in static pressure. So each time you increase fan capacity say by 20%, then you need 20% greater cross sectional area in the pad area and guess what, you will use around 20% more electricity.

This leads us into the next topic of interest – **house maintenance**. When discussing fans, cool cell pads, house tightness this all leads to management decisions that separate the good from the bad, and yes I mean the good growers from the bad growers. House maintenance is critical. Fans, for instance, do you go out and by the cheapest fan you can find. Do you check the cfm rating for a particular fan under a .05 or .10 static pressure? What about cfm/watt at a specific static pressure? If not, you should. Fans vary considerable especially among manufactures, in energy efficiency, and in air delivery. Before you purchase a fan you should check with Bess Labs (Bioenvironmental and

Structural Systems Laboratory) – Agricultural Ventilation Fans from the University of Illinois Agriculture Engineering Department and study the fans you are interested in. The purpose of this lab is to provide unbiased engineering data to aid in the selection of agricultural fans.

Over the years people has stressed the **importance of fan belts and pulleys**. Not only keeping the belts tight, but changing them when they get worn. Just because a belt is tight on the pulley does not mean the fan is operating efficiently. To better understand, when fan belts and pulleys get worn, they ride lower in the pulley therefore reducing fan performance. Fan performance such as air movement (cfm's) and rpm's (velocity) are directly related. When a fan is turning 15% slower then it is moving 15% less air. Well, do you think this is important? When you are trying to achieve 600 fpm in a tunnel house with ten fans in operation and there is a 15% reduction in air movement, then you are actually on moving around 510 fpm. Looking at the chart below with a wind-chill effect



of 85°F and an air speed of 600 fpm we obtain approximately 15°F of wind chill cooling. When we reduce this by 15% we lose approximately 4-5°F of wind chill cooling alone. Not only stressing the importance of belts, but often forgotten is maintaining clean shutters and fan blades. Research studies have shown caked shutters and fan blades can reduce performance up to 30%. Again, looking at the fans (belts, pulleys, shutters, and blades) can cause a significant reduction in fan performance.

Since we now have clean fans and new belts we are pulling air through the tunnel ventilated house just as if they were brand new. The only exception now is that we are pulling air through all of the crooks and crannies throughout the house. Air is entering through holes from the attic, the side walls, the attic, as well as the cool cells. One issue now is some of the air coming through the cool cell is not cooled. Portions of the cool cells are dry. Are we getting the same cooling effect even though the whole pads are not wet? Not hardly! We typically see this when pad care and maintenance procedures are not followed on a regular basis. It is very crucial in minimizing algae growth along with trash, grass clippings, bugs, etc. from collecting on the pad. **Be very careful in what products you use to clean the pads.** Chemicals containing chlorine or bromine do NOT need to be used; they can degrade the life of the pad. Also, time needs to be given to the pads so they have time to dry out. Filters need to be checked and cleaned weekly. Dirty filters restrict water flow, therefore restricting the amount of water on the pad ultimately reducing the cooling effectiveness.

Ok. Finally we have clean fans, clean shutters, new belts, cool cell pads free of debris, an algaecide to prevent algae build up in the cool cells, a good even water distribution throughout the cool cell, but we are still getting hot air entering the house. Have you checked static pressure lately??? Evidently if hot air is still entering the house then there are leaks. Most likely the static pressure is pretty low. Without using a static pressure gauge we really can not look at a house and determine how "loose" it is, but typically older house can pull as low as 0.05. This equates to around 14 square foot of leaks throughout the house. When testing poultry houses for tightness, running 1-48 inch fan or 2-36 inch fans should pull approximately a 0.15, newer solid sidewall houses can sometimes pull

0.25. The tighter the house the better because whether we are trying to grow birds in cold weather or hot weather minimizing leaks will put more money in the grower's pocket.

In summary, the poultry industry is heading in the direction of growing larger birds. Matter of fact we are already there. Managing these bigger birds are going to be a little bit different. We must still put a lot of focus on house maintenance including fans, belts, shutters, cool cells, and house tightness. The need for more air velocity is important too, especially during the hours we are not typically used to. As these birds grow, there is less surface area around the bird, so more heat is trapped. During hot humid days, we loose some of the effectiveness of cooling the birds so it is imperative in cooling them during the night time hours. We may need to look at setting fans where they will run longer during the night. As the birds begin to eat they will produce heat, so any cooling that we may be achieving still may not be enough. Research showing fan speeds around 600 fpm 24 hours/day appears to be effective in increasing body weights, improved feed conversion, and an increase in livability. Run the fans, while electricity may be on your mind, the increase that you would be obtaining with bird performance will pay for the increase in fan usage during the flock.