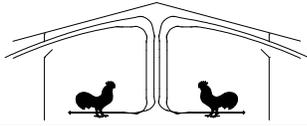




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Poultry Housing Tips

What Does it Take to Keep Large Broilers Cool During Hot Weather?

Volume 19 Number 11

October, 2007

There is a growing market in the U.S. for broilers in 7 ½ to 8 ½ pound range. Though there are many challenges producing such a large broiler minimizing heat stress related problems is often placed at the top of the list. Obviously to grow such a large bird the house will need to be tunnel-ventilated, but how much wind speed should the house be designed for? A number of studies conducted at the USDA Poultry Research Laboratory at Mississippi State have found significant improvements in weight and feed conversion efficiency for broilers grown during hot weather with an air speed 600 ft/min when compared to those grown 400 ft/min. Many poultry companies growing large broilers have confirmed the results of these studies finding relatively minimal heat stress related problems in their tunnel houses that had air speeds in the 600 ft/min range. So the question often becomes that if 600 ft/min is better than 400 ft/min, wouldn't 650 ft/min or even 750 ft/min produce even better results?

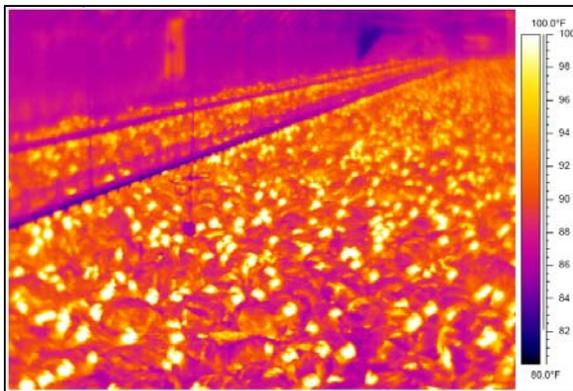


Figure 1. 400 ft/min, 86°F air temperature

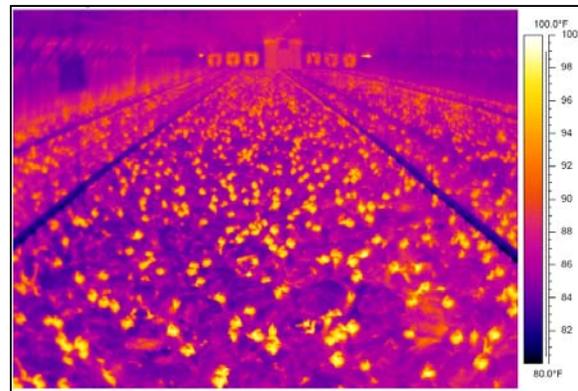


Figure 2. 650 ft/min, 86°F air temperature.

Before deciding to increase the target air speed in new or existing tunnel houses it is important to fully analyze all the costs and challenges associated with obtaining a tunnel air speed of even 600 ft/min:

- 1) Obtaining 600 ft/min takes a considerable amount of tunnel fan capacity. For instance, the typical 40' wide house with an average ceiling height of 9.5' would require approximately 230,000 cfm of tunnel fan capacity. This is roughly 30% more tunnel fan capacity than what was installed in most houses five to ten years ago.

For the typical 50' wide house with an average ceiling height of 9.75' it would require approximately 300,000 cfm of tunnel fan capacity. To obtain 700 ft/min would require an additional 50,000 cfm of tunnel fan capacity, which is approximately twice what the typical tunnel-ventilated house had 10 years ago.

- 2) To generate an air velocity of 600 ft/min the number tunnel fans required must be based on their air moving capacity at static pressure of 0.10". In a tunnel house designed for 600 ft/min tunnel fans will typically operate at

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a static pressure of 0.10" or better, so it is vital to determine the number of fans required at the static pressure they will be operating under when we are trying to cool our birds. Determining number of fans at a static pressure of 0.05" instead of 0.10" can reduce the resulting air speed in a house by 5 to 10%.

- 3) To insure adequate bird cooling is maintained over the life of a flock tunnel fans should have a MINIMUM air flow ratio of 0.73 (*Poultry Housing Tips*. The Best Performing Fans 2005. Volume 18, No5) . A fans air flow ratio is a good indicator of how well a fan will hold up to high static pressures caused by factors such as dirty pads or fan shutters. For instance selecting a fan with an air flow ratio of 0.70 as opposed to a fan with an air flow ratio of 0.80 could result in a decrease in air speed of 10% or more towards the end of a flock as pads and fans accumulate dirt.
- 4) If you are adding fans to existing houses to increase air speeds it is important to be realistic about the air moving capacity of existing tunnel fans when trying to calculate how much additional air moving capacity will be required. Many 48" fans installed in five to ten years ago moved at most 20,000 cfm at a 0.10" static pressure when they were new. Wear and tear on blades, shutters, motor pulleys, etc have reduced their air moving capacity to below 15,000 cfm in many cases.

A true "600 ft/min tunnel house" is one where the air speed from the center of the house to the side wall, from one end of the house to the other, would have little variation. Having an air velocity of 750 ft/min in the center of the house and 350 ft/min a couple of feet from the side wall means that 30% or more of your birds will not be receiving the necessary cooling. We want all the birds to be cool on those hot summer days, not just a lucky few in the center of the house or underneath a brooding curtain. Steps must be taken to insure as uniform of an air velocity as possible which in many cases is more important than adding fans to a house to increase the average air velocity.

- 1) Large birds should be grown in totally-enclosed housing with smooth side walls. Curtain-sided houses are problematic when it comes to growing large birds for a number of reasons. First due to their poor insulation value they can lead to the birds on the side wall being subjected to a fair amount of radiant heat. Secondly, leakage from side wall curtains not only causes increased air temperatures near the side walls of a house but can lead to increased temperature differentials between the pad and fan ends of a house. Last and most importantly, the exposed posts/studs in a curtain-sided houses tend to move air off the side wall leading to significantly reduced side wall air velocities. For instance, most totally enclosed houses have less than a 20% variation in air velocity between the side walls and the center of house whereas most curtain-sided houses have variations in the air velocities in the 30 to 50% range (*Poultry Housing Tips*. Air Speed Distribution in Tunnel-Ventilated Houses. Volume 16, No 4).
- 2) Beware of side wall furnaces. Furnaces along the side wall tend to move air off the side wall reducing air speeds on the side wall by 100 ft/min or more.



Figure 3. 100', 4' tall pad system

- 3) 6" evaporative cooling pads should be a minimum of five feet in height. As tunnel fan capacity increases so does the pad area. Full tunnel velocity is not achieved in a tunnel house until the end of the pad system. If you have a 100' pad system in a 500' long house this means that approximately 20% of your house will not have an air velocity of 600 ft/min. Taller pads reduce the length of the pad thereby reducing the size of this low air velocity area. Where possible considering installing a six foot tall pad system which further reduces the length of pad required. For instance, 300,000 cfm of tunnel fan capacity in a 50' X 500' house would require approximately 110 feet of four-foot tall pad, 85' of five-foot tall pad or just 70' of six-foot tall pad.

- 4) Air movement in the evaporative cooling pad end of the house can be improved by installing tunnel doors. Tunnel doors have been shown to improve the amount of air movement in the tunnel inlet area by directing the air entering the house up along the ceiling to the center of the house after which it rotates back to the side walls. In addition tunnel doors help to eliminate the problem of having a 100' curtain-sided house attached to a 400' totally enclosed house during cold weather, leading to more uniform house conditions and lower heating costs.



Figure 4. Air entering through tunnel doors.

As you might expect producing higher tunnel velocities though significantly improving bird cooling can be costly both in terms of initial as well as operating costs:

- 1) Make sure the tunnel fans have a MINIMUM energy efficiency rating of 20 cfm/watt @ 0.10" pressure. Unlike when growing smaller broilers where the tunnel fans may only be used heavily for a week or so when growing a large birds nearly all the tunnel fans could easily operating nearly 24 hours a day for nearly a month. Using fans with a high energy efficiency rating could easily save a producer thousands of dollars a year (see Poultry Housing Tip, Best Performing Tunnel Fans 2006. Volume 18, No 11).
- 2) Avoid “high flow” tunnel fans. In a effort to minimize number of tunnel fans required, thereby reducing initial cost, some producers have resorted to installing “high flow” versions of tunnel fans. A “high flow” fan is one in which the fan speed has been increased 10 to 15% typically resulting in a 10 to 15 percent increase in fan output, thereby reducing the number of tunnel fans required. The downside is that the power usage increases exponentially with fan speed. So a “high flow” fan often ends up being 25% less energy efficient (*Poultry Housing Tips*. Fan Performance Laws. Volume 15, No 4).

Table 1. illustrates a comparison between a high flow and the standard version of a popular tunnel fan in a 50' X 500' house. Though the high flow version moves 12 percent more air and as a result would require approximately one less fan, the lower energy efficiency rating for the high flow version of the fan results in an increased yearly operating cost of approximately \$1,000.

Fan	cfm	Energy Efficiency	Fans	Air speed	Yearly electricity cost (4,000 hours per fan @ \$0.10 Kw*hr)
Standard	23,300 cfm	19.4 cfm/watt	12	590 ft/min	\$5,640
High Flow	26,300 cfm	17.1 cfm/watt	11	610 ft/min	\$6,650

Table 1. Standard vs High Flow Fan Comparison

- 3) Evaporative cooling pad water usage increases proportionally with fan capacity. 20% to 30% more fan capacity, 20% to 30% more water usage (Figure 1). When bird water and possibly fogging nozzles use is added, it is not uncommon to find a single house requiring a well capacity of nearly 20 gals/min! Supplying this amount of water often requires significantly larger well pumps, water pipes, pumps, bladder tanks, etc (*Poultry Housing Tips*. Broiler Farm Water Usage and Pipe Sizing Rules of Thumb. Volume 19, No 6).

Total Tunnel Fan Air Moving Capacity (ft ³ /min)	Potential 6" Pad System Water Usage (gals/min)
160,000	7.6
180,000	8.5
200,000	9.5
220,000	10.4
240,000	11.3
260,000	12.3
280,000	13.2
300,000	14.2
320,000	15.1
340,000	16
360,000	16.9
380,000	17.8

Table 2. 6" pad water usage on a 100 F day with 20% Rh (hotter drier weather will result in increased water usage)

- 4) Increased tunnel fan capacity obviously results in increased electrical demand. The increased electrical demand may require not only require larger electrical panels than what is traditionally installed, but larger transformers, wire size running between houses, and standby generators as well. Keep in mind many older tunnel houses only have a generator capacity of 15 - 20 Kw per house. To obtain air velocities of 600 ft/min or better in the same house may require a 25 Kw generator or larger.
- 5) The tunnel fan capacity required to obtain 600 ft/min in a 400 ft house is the basically same as a 500 ft house due to the fact that air velocity is determined by fan capacity and house cross-sectional area and not by house length. This means that initial and operating costs on a per bird basis will be significantly higher for a 400' house than a 500' house. As a result it is most cost effective to look for higher air velocities is in houses 500' or longer.

One method that has been used to increase air velocity in open ceiling houses is through the use of air deflectors or also known as "baffle curtains". Air deflectors are basically curtains hung periodically from the ceiling to temporarily decrease a houses' cross-sectional area resulting in a temporary increase in air velocity. Though the idea of increasing air velocity without increasing fan capacity is of course appealing, there are significant potential problems with air deflectors.

- 1) The increase in air velocity associated with air deflectors typically extends only about 25' past the deflector curtain. This means that in order for all the birds in a house to benefit from increased air speed produced by deflector curtains they need to be installed roughly 25' on center. This of course means that a house may required 15 or more deflector curtains to produce increase in air speed throughout a house.
- 2) Deflector curtains increase the static pressure the tunnel fans are working against thereby reducing the air moving capacity off the fans as well as increasing electricity usage. It is not uncommon to find in houses using deflector curtains that the tunnel fans are operating under a static pressure of 0.20" or greater! Depending on the type of fan installed this can result in an air moving capacity of 20% or more over the same fan at a static pressure of 0.10" and

30 to 40% less than what it moves at a static pressure of 0.05". When the deflector curtains are installed 40' or more apart, as is often the case, though the air velocity in the immediate vicinity of the baffle curtain may be well over 600 ft/min the air velocity 30' from the baffle curtain is often less than it would have been without the deflector curtains due to the reduced air moving capacity of the fans. Furthermore, the reduced air moving capacity results in a lowered air exchange rates which can lead to warm and humid conditions towards the tunnel fan end of the house.

- 3) Though generally not recommended if installed in a dropped ceiling deflector curtains should only be 12" to 18" in height and placed 25' on center to minimize high static pressure problems and to promote a more uniform increase in air velocity.
- 4) If you are planning to install deflectors it is advisable to install fans with a high air flow ratio (0.77 or better). This will minimize the negative effects of the high static pressures that tend to be generated by the presence of deflector curtains.
- 5) It is important to realize that deflector curtains can create significant problems during cold weather. Even if rolled up tightly they can make it difficult for circulation fans to properly mix the air within a house resulting in increased fuel usage. They can disturb side wall inlet air flow pattern leading to drafty conditions. The presence of deflector curtains can make it difficult to properly position in houses with radiant heaters due to fact that you don't want a deflector curtain positioned right over a radiant heater. Last but not least they can cause significant variations in floor light intensities.

In order for higher air velocities to be effective in producing increased bird cooling, air must be able to get between the birds. When birds migrate and densities increase, the cooling effect produce by high wind speeds decreases dramatically because the only part of the bird that is exposed to air movement are their heads and their backs. To maintain uniform bird densities properly managed migration fences are a must. The fact is there is little point to increasing air velocities in a tunnel house if the majority of the birds end up packed together on the evaporative cooling pad end of the house.

- 1) 500' houses should have a minimum of three migration fences. Longer houses may require more.
- 2) Fences should allow the air to freely pass through them so that air is not deflected away from the birds.
- 3) Migration fences should be installed no later than two weeks of age.
- 4) Migration fences must be installed year round.
- 5) Houses should be equipped with two water meters so that water usage on each end of the house can be monitored. Monitoring water usage on each end of a house will provide an indicator of whether or not there are the same number of birds on each end of the house.

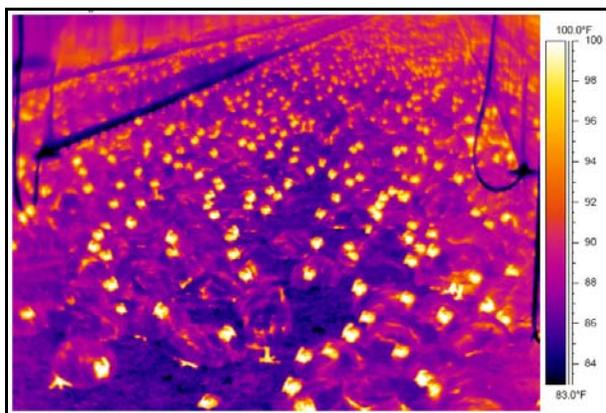


Figure 5. Spread out birds (400 ft/min).

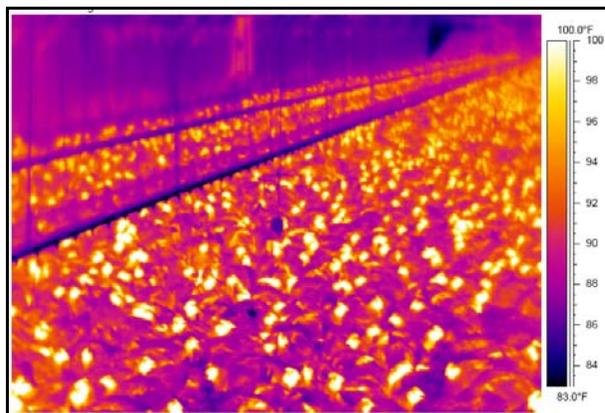
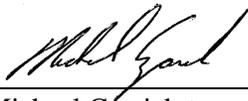


Figure 6. Crowded birds (400 ft/min)

One final point, related to challenges of cooling birds that have been allowed to migrate. Sometimes the best way to increase bird cooling is not to increase air velocity but is to simply put fewer birds in a house. Fewer birds will not only decrease the heat load in a house and increased feeder as well as drinker space but more importantly allow for more space between the birds thus making easier to cool the birds. Figures 5 and 6 are thermal images of large broilers taken on a hot day in the same house. Though the air temperature and wind speed is the same, the birds that spread out are significantly cooler than those that are crowded.

There is little doubt that air velocities of 600 ft/min or greater will produce greater cooling of large broilers during hot weather. But it takes much more than simply adding a fan or two to a house to get an uniform air velocity of 600 ft/min in a tunnel houses. It takes the right kind of fans, smooth insulated walls, large evaporative cooling pad, increased water supply, larger pipes, wires, generators, etc all of which increase costs. As with most things these costs have be carefully balanced with the benefits to determine what is right course of action.



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