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Poultry Housing Tips

Maximizing Bird Cooling Through Maintaining Uniform Bird Distribution

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One of the most important keys to optimizing broiler performance during hot weather is making sure the birds are uniformly distributed from one end of the house to the other. Having more birds at one end than another can lead to a variety of problems including insufficient water/feeder space for those birds on the crowded end of the house, increased incidence of scratches, and reduced litter quality. Though these are of course potentially costly problems, the most costly aspect of not having birds uniformly distributed throughout a house is the increased level of heat stress for the birds on the crowded end of the house during hot weather.

As birds digest feed, heat is produced...a lot of heat. In fact, a house full of market age birds produces over a million Btu's of heat each hour that must be gotten rid of. During colder weather this is not a problem because it is fairly easy for producers to keep their house temperatures in the sixties or seventies. But, during hot weather it becomes more difficult for the birds to get rid of the heat produced by the digestion of feed due to the fact that there is less of a difference between their body temperature and the temperature of the air in the house. If the birds cannot rid themselves of this excess heat their body temperatures will rise. Elevated body temperatures lead to reduced feed consumption to reduce the amount of heat produced. Reduced feed consumption leads to lower bird weights. Feed conversions increase as the birds pant harder and harder in an effort to cool themselves through evaporating water off their respiratory system.

Figure 1. Evenly distributed birds during hot weather

One of the best ways producers can help their birds get rid of excess heat during hot weather is through air movement. Numerous studies have documented that air movement dramatically increases heat removal from birds during hot weather. With increased heat removal, a bird will continue to eat during hot weather leading to higher weight gains. Feed conversions are lower because the birds are not panting as much to cool themselves. In general the higher the wind speed moving over birds during hot weather, the greater the heat removal, the better the birds perform. But, it is important to keep in mind that air movement is most effective at cooling when birds are spread out evenly throughout a house.

One of the most common reasons for poor bird distribution is bird migration. In tunnel-ventilated houses, birds tend to want to slowly migrate towards the inlet end of the house. Bird migration can be kept to a minimum if simple migration fences are installed every 100 feet or so down the length of a house. If the migration fences are not installed (or too few are installed) differences in bird density will increase over time as more and more birds move toward the inlet end of the house. Eventually, the density at the inlet end will be much higher than what the ventilation system was designed to handle, leading to an increased level of heat stress for those birds at the inlet end of a house even though the air is cooler than at the fan end of the house.

Figure 2. Tunnel fan end of house with migration.

Figure 3. Tunnel inlet end of house with migration.

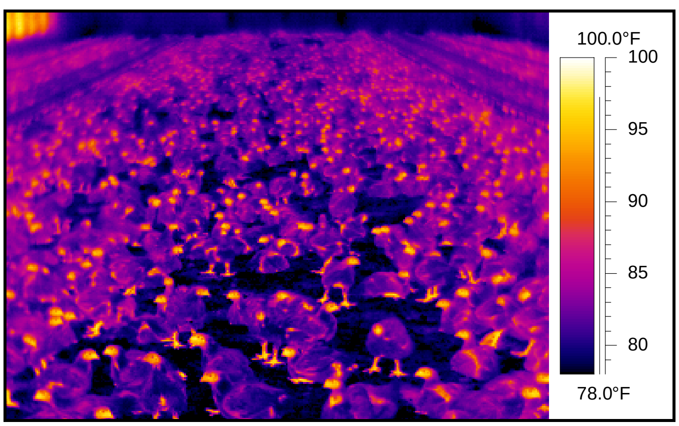


Figure 4. Tunnel fan end of house with migration.

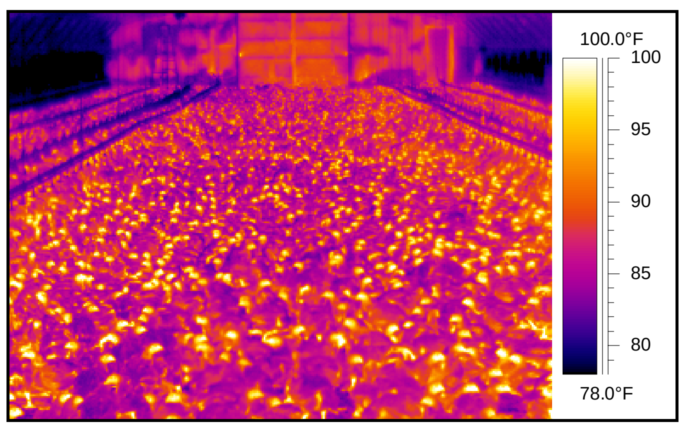


Figure 5. Tunnel inlet end of house with migration

The photographs in Figures 2 and 3 were taken in a house with a severe bird migration problem due to the fact that migration fences had not been installed. The outside temperature was in the high eighties but since the evaporative cooling pads were operating the incoming air temperature was 78ºF. Air temperature at the tunnel fan end of the house was warmer, approximately 82ºF, due to the heating of the air by the birds as it moved down the house. Since the air temperature was four degrees lower at the pad end of the house it would be easy to assume that the birds would be cooler at the pad end of the house than at the fan end, but thermal images taken of the birds at both ends of the house painted quite a different picture.

From thermal images taken of the birds it is clear that even though the air temperature at the inlet end of the house was lower than at the fan end, bird body surface temperature was actually higher than that of birds at the fan end of the house, indicating that air movement was doing a better job of removing heat from the birds in the rear of the house where the birds were more spread out than at the inlet end where they were more crowded (Figures 4 and 5). In fact, though the air temperature at the tunnel inlet end was 78ºF the bird body surface temperature was actually 87ºF, nine degrees higher. At the fan end the bird surface temperature was 84ºF, only two degrees warmer than air temperature.

It is important to realize that for the most part during hot weather the closer a bird's surface temperature is to that of air temperature the better job you are doing cooling the bird. In a perfect world if the air temperature in a house was 80ºF, the surface temperature of a bird would be 80ºF, indicating there is very good interaction between the air and a bird's body. The lower the interaction of the air with the bird's body, the warmer the bird's surface temperature, the warmer the bird. As a result, though the air temperature was lower at the inlet end of the house the increased bird density resulted in significantly higher effective air temperature for the birds at the inlet end of the house. Though it is difficult to determine the exact effective temperature of a bird based on it's surface temperature, it would not be a stretch to say that the effective temperature for the birds at the inlet end of the house was much closer to 87ºF than it was to 78ºF.

The cooling effect produced through the interaction between the air and a bird's body is most evident with changes in air speed. The lower the air speed the less interaction there is with the air and the bird, the lower the amount of heat removed from the bird, the hotter it will be. This phenomena can be seen in thermal images recently taken in a turkey house (Figures 6 and 7). The tunnel-ventilated house had a high ceiling, not enough tunnel fans, and the tunnel fans present were suffering from maintenance related issues. The house's evaporative cooling pads were clogged and the house deflector curtains were too low resulting in a very high static pressure and a dramatically reduced air moving capacity of the fans. As a result, though air speed under the deflectors was approximately 450 ft/min, in between the deflectors it was only150 ft/min. Air temperature in the house was approximately 80ºF.

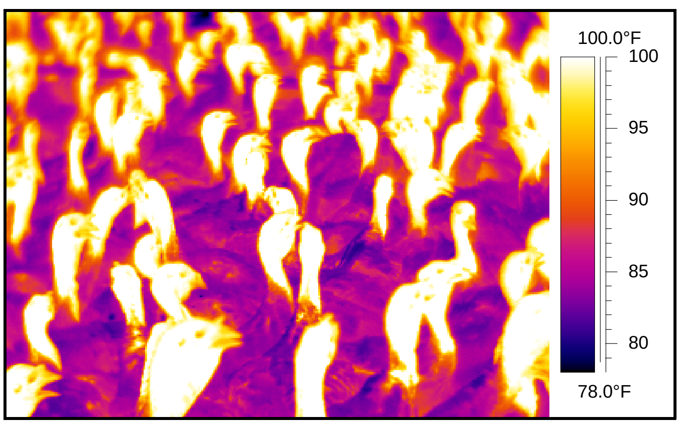


Figure 6. Turkey's with 150 ft/min air speed (air temperature =78ºF).

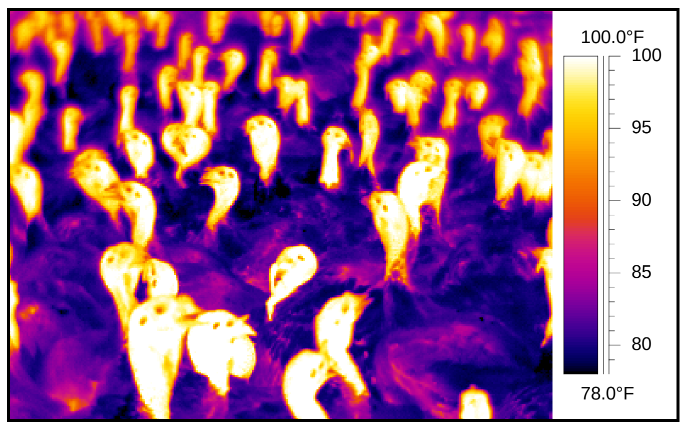


Figure 7. Turkeys with 450 ft/min air speed (air temperature = 78ºF).

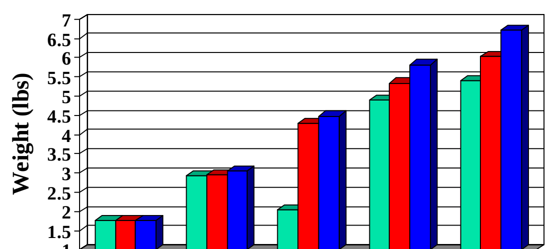
As can be seen in Figure 6, even though the air temperature was approximately 78ºF the body surface temperature was in the mid to high eighties for the turkeys in the house where the air speed was only 150 ft/min. In Figure 7 where the air velocity was 450 ft/min, just 20 feet away from the birds in Figure 6, the turkeys' surface temperature was in the low eighties. The higher air velocity increased the interaction between the air and the turkey's body resulting in lower surface temperatures and therefore improved cooling. The difference in cooling was evident by the fact that a majority of the birds in Figure 6 were panting while only a few of those under the air deflector where the air speed was higher were panting (Figure 7).

The head temperature of the turkey's in Figures 6 and 7 is another indicator of the increased cooling produced through increased air movement. The 450 ft/min wind speed resulted in head temperatures approximately three to four degrees lower than those measured where the air speed was only 150 ft/min. There was a similar difference in reduction in broiler head temperature between the two ends of the house noted in Figures 4 and 5. Though a bird's head temperature is not a direct measure of it's deep body temperature, it would not be hard to say that a three degree lower head temperature is a good indicator that the bird is receiving significantly greater cooling.

When comparing the thermal images of the turkeys at low and high air speeds to those of the broilers at low and high densities it becomes apparent that when birds become crowded the effect is much like that of a house with low air speed. The broiler at the inlet end had surface temperatures similar to the turkeys at an air speed of 150 ft/min even though the air speed in the broiler house was in fact approximately 500 ft/min. So allowing the birds to migrate may increase heat stress as much as turning off over half the fans in a house. To adequately cool birds that have crowded would have required significantly higher air speed than the 500 ft/min measured in this particular house.

The fact that crowded birds need higher than normal air speeds to keep them cool can be seen when comparing two different studies on air speed and weight gain. In the first study, conducted by Dr. Bill Dozier at the USDA Lab at Mississippi State University, three groups of broilers were kept in test chambers where the air temperature was cycled between 77ºF at night and 95ºF during the day. The study found that weight gains were highest for those birds where the air velocity was 600 ft/min (Figure 8).

In a study conducted by Dr. Shlomo Yahav of the Department of Poultry Science, ARO the Volcani Center in Israel the results were noticeably different. In Dr. Yahav's studies, birds were kept at an air temperature of 95ºF, 24 hours a day and kept in air velocities of 160, 300, 400, and 600 ft/min from five to seven weeks of age (Figure 9). The most significant difference between the two studies was that while Dr. Dozier's study showed an increased weight by increasing the air speed from 400 to 600 ft/min, Dr. Yahav's study showed a decrease weight gain at 600 ft/min when compared to 400 ft/min.



	3 weeks	4 weeks	5 weeks	6 weeks	7 weeks
still air	1.77	2.93	2.05	4.89	5.4
400 fpm	1.77	2.96	4.29	5.34	6.04
600 fpm	1.77	3.06	4.48	5.82	6.72

Figure 8. Weekly broiler weights (77ºF night/95ºF day)

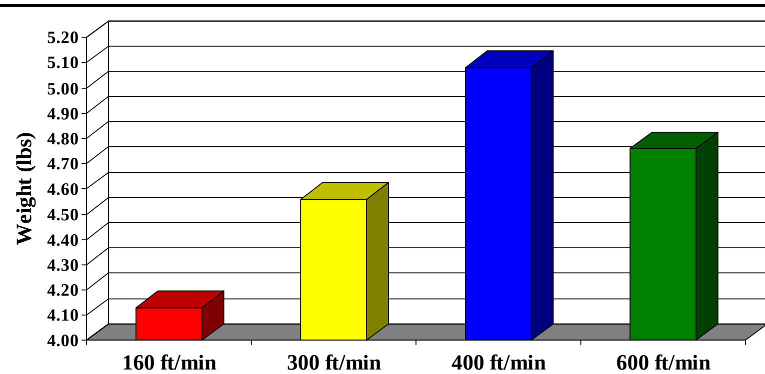


Figure 9. Seven-week-broiler weights (95ºF, 24 hours a day)

One of the most significant factors that undoubtedly lead to the difference in results between the two studies was Dr. Dozier's study was done for a group of birds in a tunnel-like chamber while Dr. Yahav's study was done with individual birds in a cage where a bird's entire body was subjected to air movement. For a single bird in a cage the argument could be made that it takes less air velocity to produce the desired level of cooling because there is no trapped heat and the bird's entire body is being exposed to air movement maximizing the interaction between the air and the entire bird's body. The fact is the more spread out the birds are the easier they are to cool. The more crowded they are the greater the amount of air speed that is required.

Why in the Dr. Yahav's study did the higher air velocity actually reduce weight gain? It was suggested that birds exposed to 600 ft/min had a high loss of passive water loss through the skin and may have been dehydrated. This was supported by increased arginine vasotocin levels, an important hormone in water balance regulation, and increased blood plasma osomolarity, a measurement that increases as birds become dehydrated. So theoretically it is possible for high air speeds to harm performance, but to achieve a similar air movement in a broiler house as produced in Dr. Yahav's study would probably take air speeds of well over 600 ft/min or very dry air both of which are not likely to occur in a typical broiler house.

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