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Poultry Housing Tips

Air Speed Distribution in Tunnel-Ventilated Houses - Part 1

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To produce the desired level of cooling during hot weather most broiler houses today are being designed to obtain a wind speed of between 500 and 600 ft/min. It is important to realize that a design air speed is an average air speed. Air speed will vary significantly across the cross-section of a house. Air speeds will tend to be higher in the center of the house than along the side walls and higher at the ceiling than near the floor. The reason for the variation is due to the fact that air will tend to take the path of least resistance. Look at a river. The water will flow faster toward the center of the river than along the banks.

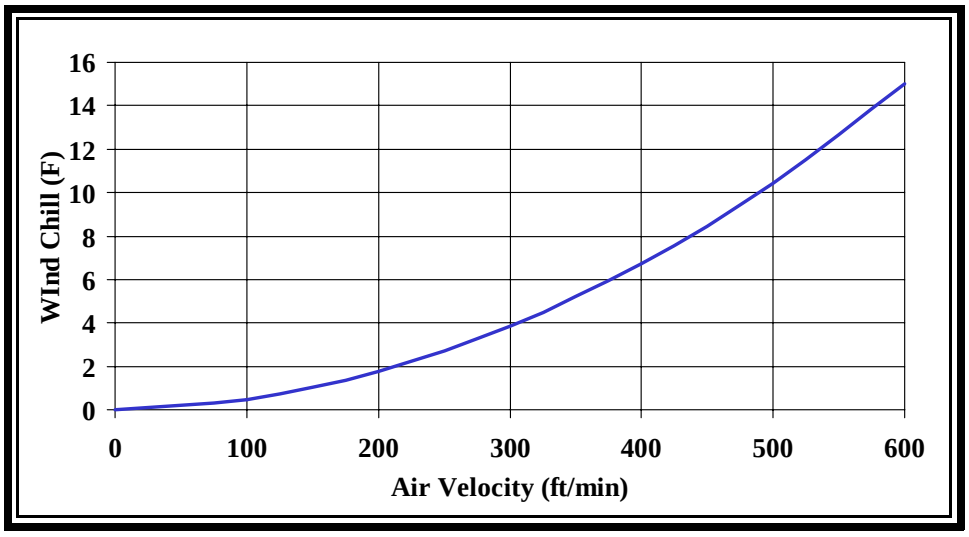

Figure 1. Air speed cooling effect at 85°F

With some houses showing a variation in air speed of 30% from near the side wall to the center of the house it is important to realize that uniformity of air movement can be just as important if not more to bird cooling as the average wind speed. For instance, let's say a producer wanted to add more fans to increase average air speed from 500 to 600 ft/min. At 85°F this would represent an increase in cooling of approximately 5°F (Figure 1) for a large broiler which on the surface sounds great. But if there was a 30% difference in air speed between the center of the house and that near the side wall, the birds near the side walls may only be getting about half the cooling effect of those near the center

of the house. The argument could be made that before someone adds fans to their houses to increase wind speed they should take a closer look at the uniformity of wind speed in their houses.

What affects air speed on the side wall? One of the major causes of low air speeds along the sides of a house is forced air furnaces. Figure 2 illustrates the air speeds in the tunnel fan end of a 500' dropped ceiling broiler house with seven slant wall 48" fans (18,000 cfm @ 0.10"). Air speed two and a half feet from the side wall (40" above the floor) with the three forced air furnaces was over 100 ft/min less than within two and a half feet of the side wall without furnaces. With market age birds this could result in a difference in cooling of approximately three degrees at an air temperature of 85°F.

An often overlooked factor that affects air speed distribution is the "smoothness" of the side walls. The "rougher" the side wall the slower the air speed will be along the side walls and the higher the air speed will be in the center of the house. A good example of a rough side wall would be one of 4" X 6" construction, while an example of a smooth side wall would be a stud wall with an interior plywood surface.

Recently a study was conducted to quantify the effect that sidewall smoothness had on air speed distribution. Air velocity profiles were conducted in two 40' X 500' dropped ceiling broiler houses. Both broiler houses were equipped with eight, 48" cone fans (21,000 cfm @ 0.10" static pressure) and had 7' 6" side walls and a peak ceiling height of 11' 6". One of the differences between the two houses was the construction of the side wall. In one of the houses the side wall was constructed of 4" X 4" posts with 2" X 8" lumber covered with metal attached to the outside surface of the posts. While the side wall of the second house consisted of 4" X 6" stud wall (plywood interior, fiberglass, metal exterior) on top of a 16" concrete curb wall. While the northern wall was totally enclosed, the southern side wall had a 30" curtain opening for use in emergencies. The second significant difference between the houses was the fact that the post house was equipped with forced air furnaces while the stud wall house used radiant brooders on both the brooding and nonbrooding ends of the house.

Starting two and a half feet from the side wall eight velocity measurements were taken at a height of 40" across the width of the two houses. The first row of air velocity measurements were taken 20' from the tunnel fan end wall. Air velocity measurements were then repeated every 20' until the half house curtain was reached. All eight 48" tunnel fans were operating when air velocity measurements were taken. There were no birds present during testing, but feeders and drinkers were lowered to provide more realistic house conditions. Radiant brooders on both the brooding and nonbrooding ends of the house with stud wall construction were raised to the ceiling prior to taking measurements as would be the case had there been older birds present. In the post wall house, forced air furnaces on both the brooding and nonbrooding ends of the house were hung by chains so no adjustments could be made.

In the house with post wall construction (Figure 3) air velocity in the center of the house was near 550 ft/min while that within five feet of the side wall was closer to 350 ft/min. This difference in air speed would amount to a difference in cooling effect on an 85°F day of approximately six degrees. As expected air speed near the northern wall was significantly lower than along the southern wall due to the fact that the forced air furnaces were installed along the northern wall.

In the house with stud wall construction (Figure 4) there was significantly less variation in air speed between the center and side walls of the house. While air velocities in the center of the house were similar to the post wall construction house the speed of the air near the side wall was significantly greater. In fact, while there was 30% variation in air speed in the post wall construction house there was less than a 15% variation in air speed in the house with stud wall construction. It is important to note that the 30" portion of southern wall with the exposed 4" X 6" posts did have a significant effect on air movement near the sidewall. While air velocity measurements taken two and a half feet from the northern solid wall were for the most part within 75 ft/min of those in the center of the house (approximately 10% variation), those taken two and a half feet from the curtain side wall were often 150 ft/min slower than in the center of the house (approximately 15%).

Though more studies need to be conducted it is clear from this study that totally enclosed houses of stud wall construction without forced air furnaces will produce significantly cooler conditions during hot weather than a house of 4" X 4" post construction with forced air furnaces. While the post wall construction appeared to adversely affect air speed as far away as eight feet from the side wall, the combination of furnaces and posts increased this distance to nearly 15 feet. As a result, nearly 50% of the birds in the house may be adversely affected during hot weather by the side wall construction method as well as the presence of forced air furnaces. Though at the present time there is little that can easily be done to reduce the effect the posts have on the movement of air along the side walls, installing the forced air furnaces externally, as done in some areas of the U.S., would likely prove beneficially during hot weather. The downside of installing forced air furnaces externally is that heating cost may increase slightly during cold weather.

It is important to realize that improved uniformity in the solid wall house without forced air furnaces may be in part due to the presence of radiant brooders over inside water lines. The radiant brooders may have helped increase air speed along the side walls by deflecting air from the center of the house toward the side walls thus improving air speed uniformity. It is important to keep in mind that air speed distribution can be improved not only by making it more attractive for air to move along the sides of the house but also by making it less attractive for the air to flow down the center of the house.

The study illustrated yet another advantage of building a totally enclosed, stud wall house. Not only will the heating costs be 30 to 50% lower, due to the higher level of side wall insulation and increased house tightness, but the birds will likely be significantly cooler during hot weather. The combination of increased air speed along the side walls, as well as the elimination of radiant heat emanating from the hot side wall curtains, could easily result in the effective temperature within ten feet of the side walls of a totally enclosed stud wall house being five degrees or more cooler than the birds in the same location in curtain-sided house of post wall construction. Since approximately 50% of the birds in a 40' wide house are within ten feet of a side wall the additional cooling would likely have a significant effect on a flock's overall performance.

There is still a lot of work that needs to be done in the area of air speed distribution in tunnel-ventilated houses. In future newsletters we will look at air speed distribution in wider houses as well as how different heating systems affect air speed distribution. We will also look at differences in air speed distribution between the brooding and nonbrooding ends of the house in addition to what things producers can do, at minimal expense, to improve air speed uniformity.

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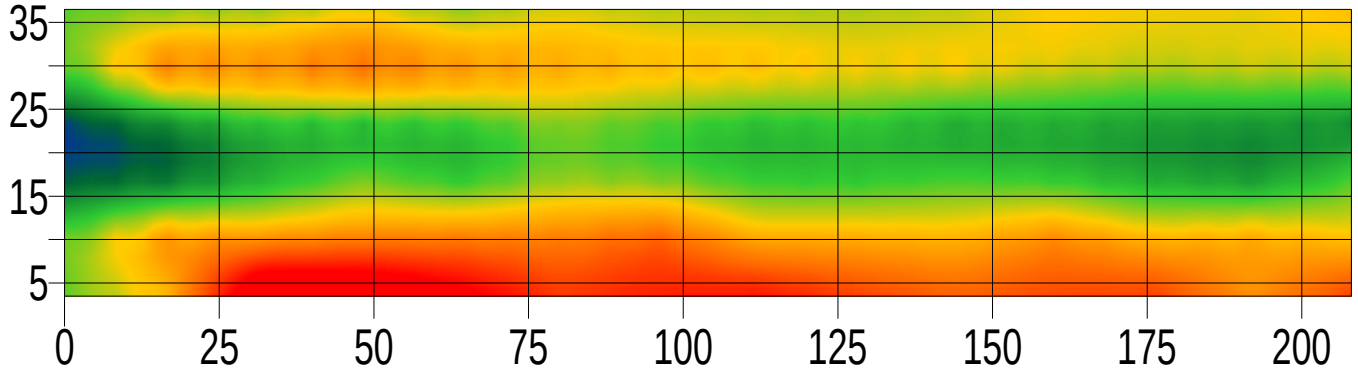


Figure 2. 40' X 500' broiler bouse, stud wall construction, curtain sided, with forced air furnaces (bottom wall)

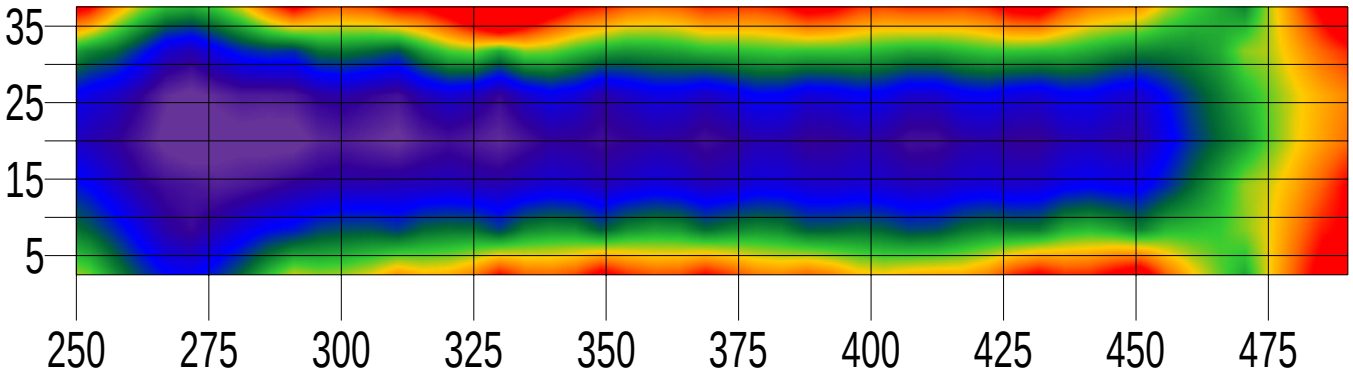


Figure 3. 40' X 500' broiler house, 4" X 4" post wall construction, forced air furnaces along northern wall (top)

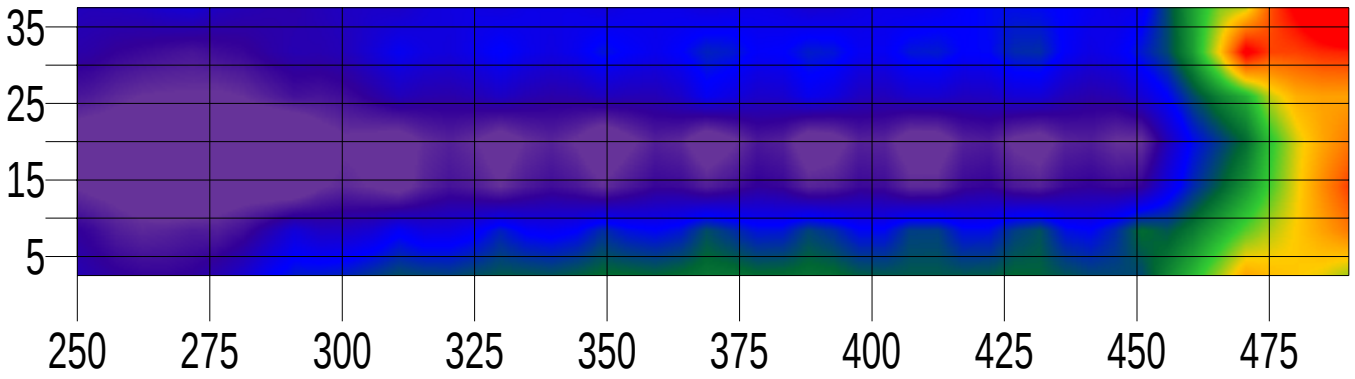
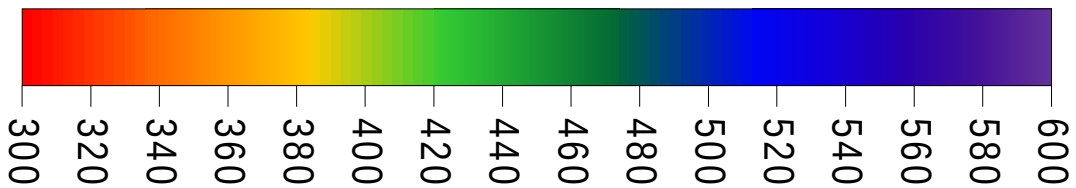


Figure 4. 40' X 500' broiler bouse, stud wall construction, solid north wall, with radiant brooders



note: Figures 2,3, and 4 best viewed in color