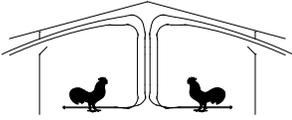




The University of Georgia

College of Agricultural and Environmental Sciences
Cooperative Extension



Poultry Housing Tips

How Much Should a Tunnel Door Be Opened During Hot Weather?

Volume 31 Number 6

2019



Figure 1. 5' Tunnel door

Originally, tunnel doors were only thought of as a method of reducing heating costs and litter caking in the tunnel inlet area of totally-enclosed houses. Producers often witnessed the heaters near the tunnel curtains running nearly constantly during cold weather, while the remaining heaters operated only occasionally. Producers installing tunnel doors, with their higher insulation value and tightness, often saw significant reductions in heating costs which is not surprising considering the tunnel inlet can extend over 1/3 of the length of the brooding area in many of today's broiler houses (Figure 1).

Something that many producers discovered which they didn't expect was that tunnel doors often proved nearly as beneficial during hot weather as they did during cold weather. Producers found that tunnel doors produced better air movement in the tunnel inlet area, eliminated the "dead spot" near the side wall just past the end of the tunnel opening, and most importantly improved side wall to side wall air speed uniformity throughout a house, all of which helped to lessen heat-stress-related production problems often experienced during hot weather.

In houses with traditional tunnel curtains the incoming air doesn't tend to stir much as it enters and moves down the house. It comes straight into the center of the house, collides with the air entering through the opposing tunnel curtain opening, and moves down the house toward the tunnel fans without a significant level of circulation.

In houses with the tunnel doors, the incoming air pattern is very different, resembling the air circulation pattern created by side wall inlets during cold weather. The angled opening of the tunnel door directs the incoming air up to and along the ceiling, where it remains until it reaches the center of the house where it collides with the incoming air from the opposite side of the house. It then rolls down toward the floor and then back to the side wall, creating a circular air flow pattern (Figure 2). This circular air flow pattern continues for a hundred feet or so as the air moves down the house towards the tunnel fans. It is this circular air flow pattern that increases the amount of air movement across the floor in the tunnel inlet area, eliminates the dead spot just past the end of the tunnel inlet opening, and promotes more uniform wall-to-wall air speeds throughout a house.



Figure 2. Circular air flow pattern created by tunnel doors

The benefits of a circular air flow pattern compared to that created by traditional tunnel curtain openings was demonstrated in two nearly identical 66' X 500' tunnel-ventilated broiler houses. One house was equipped with conventional tunnel doors that could only open to approximately a 50-degree angle. The other was equipped with a type of tunnel door system that could be opened to the point where the doors were parallel to the floor, which created an air flow pattern similar to that produced by a traditional tunnel curtain opening. An average house air speed was determined by taking 15 cross-sectional air velocity measurements 60' from the tunnel fan end wall, in both houses when all 16, 52" fans were operating. Though the average air speed of the two houses was found to be nearly identical, averaging 745 ft/min (+/- 15 ft/min), there was a large difference in wall-to-wall air speed uniformity between the two houses. In the house with the tunnel doors opened 50 degrees, the difference in air speed between the center of the house to within five feet of the side walls was less than 100 ft/min. In contrast, in the house where the tunnel doors were able to be opened parallel to the floor, the variation was approximately 250 ft/min (Figure 3), which would result in less of a cooling effect for the birds near the side walls compared to those toward the center of the house. But, when the same tunnel doors were closed to a 45 degree angle, the side wall variation was decreased to less than 100 ft/min (Figure 4). The conclusion from this study was very clear: simply getting the air to circulate as it enters greatly improves air speed uniformity along the entire length of a house.

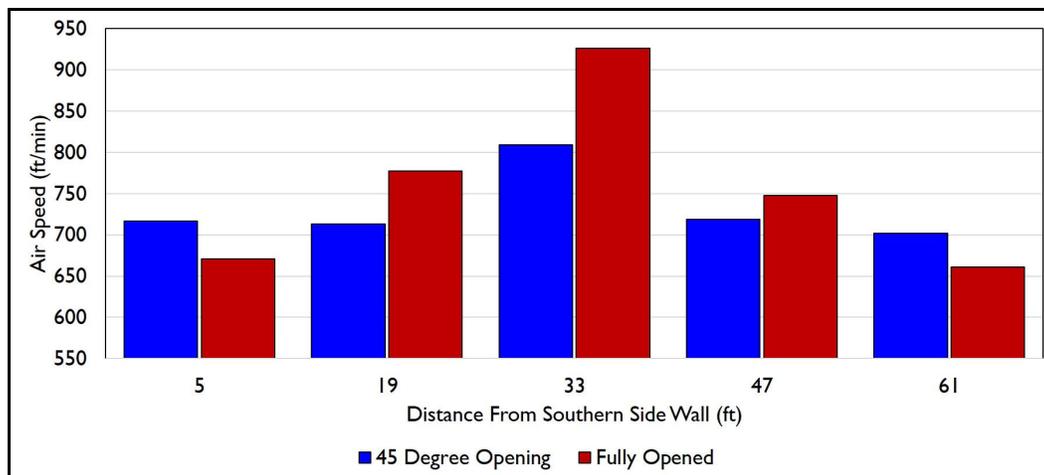


Figure 3. Wall-to-wall air speed measurements in a house with fully opened tunnel doors versus a house where the tunnel doors are only opened to a 50 degree angle

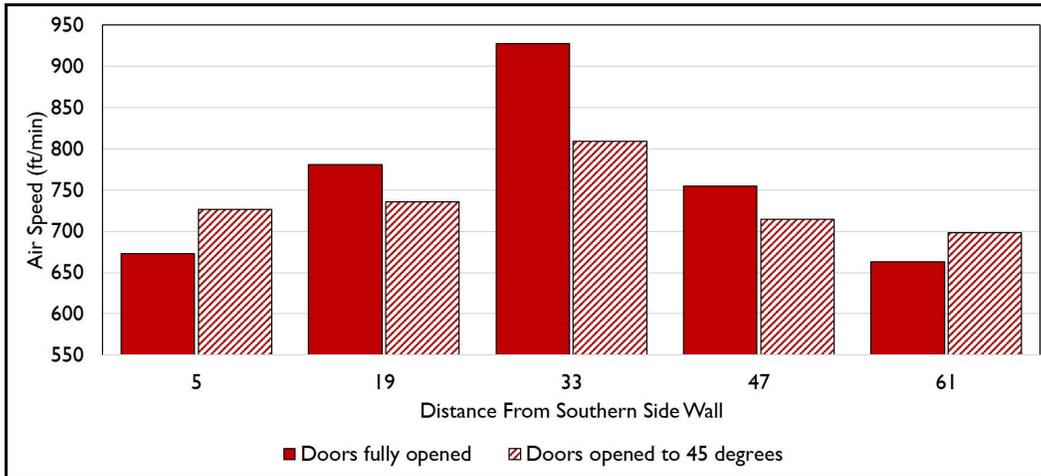


Figure 4. Wall to wall air speed measurements with tunnel doors fully opened versus opened to 45 degrees (same house)



Figure 5. Excessive tunnel door opening (>60°)

Figure 6. Excessive tunnel door opening (>60°)

From a tunnel door management standpoint, it is important to realize that not only does the degree at which tunnel doors are opened affect the birds hundreds of feet away from the tunnel door opening, it will also affect those birds directly under the tunnel door. The more tunnel doors are opened, the more likely a dead air spot will be created under the tunnel door (Figures 5,6, 7). This is because the more a tunnel door opens the harder it is for the circulating air to make it all the way back to the side wall under the tunnel doors.

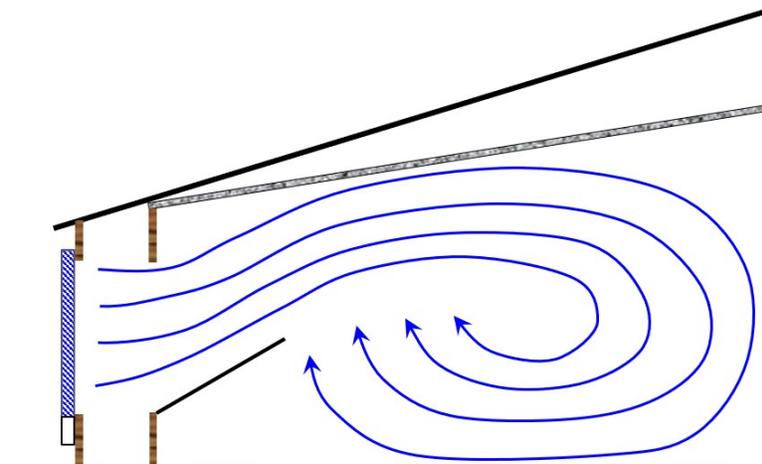


Figure 7. Air flow pattern created by an excessive tunnel door opening

It is often thought that a tunnel door opening must be equal to the side wall opening. For instance, for a five-foot tunnel door the opening between the top of tunnel opening and the side wall should be at least five feet, forming roughly a 60-degree angle with the side wall. By maximizing the tunnel door opening the static pressure is minimized which would improve fan performance and therefore house air speed and bird cooling. Though it is true that as tunnel door opening is reduced pressure will tend to increase, it is important to realize that there can be significant advantages to reducing the amount tunnel doors open. For instance, reducing a tunnel door opening from five feet to four feet would allow more space for the circulating air to make it all the way back to the side wall before rotating back up the side wall (Figure 8, 9). Furthermore, when a five foot tunnel door opening is reduced to four feet, the speed of the incoming air will be increased by roughly 25% generating a faster circulation pattern and improved air movement in the tunnel inlet area of a house. Last but not least, a partially closed tunnel door makes it easier to pick up any mortality which may occur beneath tunnel doors.

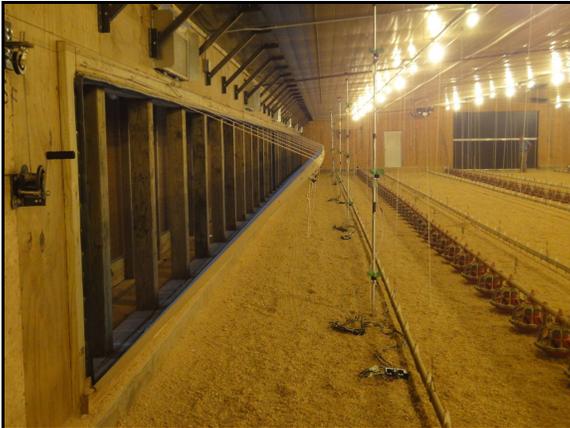


Figure 8. Tunnel door opened to a 45 degree angle

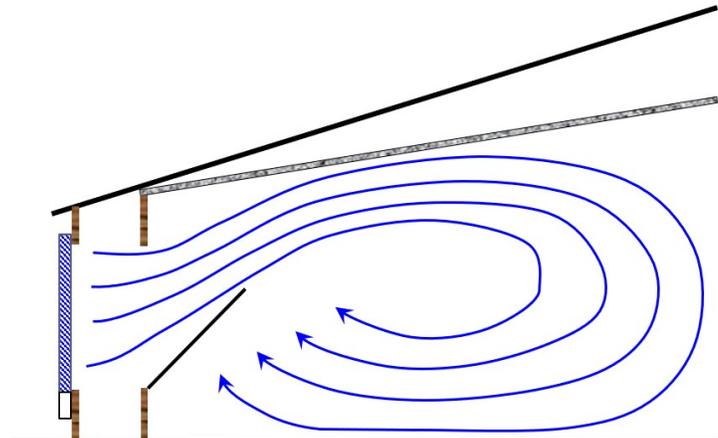


Figure 9. Air flow pattern created by 45 degree tunnel door opening

Studies were conducted on three broiler farms to examine how tunnel door opening affects static pressure and average house air speed. All the houses were equipped with pad rooms which positioned the pads approximately two feet from the house side wall. The average air velocity was determined from 15 cross-sectional measurements taken 60' from the tunnel fan end wall. Air velocity measurements were taken every minute for 15 minutes. Fifteen static pressure measurements were taken 20' from the tunnel fans over the same 15-minute period. Air velocity and static pressure measurements were taken with all tunnel fans operating with five-foot tunnel doors opened to 56", 48" and 36" (approximately 60°, 45°, and 20°).

Decreasing the tunnel door opening on the three farms from approximately 56" to 48" resulted in a minimal increase in static pressure of 0.006" and decrease in air speed of less than 5 ft/min (0.7%), thus indicating that there wouldn't likely be any negative ramifications associated with changing the tunnel door angle from a 60 degree to 45 degrees in the typical tunnel-ventilated broiler house (Table 1). Interestingly, reducing the tunnel door opening from 56" (60°) to just 36" (20°) increased the average static pressure by approximately 0.02" and reduced the average air speed by approximately 15 ft/min, not what most would consider a significant change.

The tunnel door pressure is typically only a small, relatively insignificant portion of the total static pressure the fans are working against (*Poultry Housing Tips*. Measuring Static Pressure in Tunnel-Ventilated Houses. Vol 22. No. 9). The pressures required to pull the air through the pad, into the relatively small cross sectional area of the house, and down the roughly 400' "pipe" from the pads to the fans are all greater than that needed to pull the air through a tunnel door whether it is fully opened or closed 20%. The pressure is primarily the result of the house's relatively high air speed. The greater the air speed, the higher the static pressure will be. The air speed in the study houses ranged from a little under 600 ft/min to 700 ft/min, which generally means the pressure will range between approximately 0.14" (600 ft/min) to 0.17" (700 ft/min) as was the case with these particular houses (*Poultry Housing Tips*. High Tunnel Velocities = High Static Pressures. Vol. 22. No. 8). No matter how much the tunnel doors are opened, the static pressure will typically remain essentially the same.

House Size	Pad Height (inches)	Side Wall Opening (inches)	Tunnel Door Opening (size / angle)	Air Speed (ft/min)	Fan Static Pressure (")
50' X 500'	60	56	56" / 60°	583	0.125
			48" / 45°	579	0.132
			36" / 20°	566	0.145
66' X 600'	72	56	57" / 60°	599	0.134
			48" / 45°	594	0.142
			36" / 20°	582	0.151
46' X 565'	60	56	57" / 60°	706	0.167
			48" / 45°	703	0.171
			36" / 20°	695	0.184

Table 1. The effect of the amount of tunnel door opening on average house air speed and static pressure

Another important advantage of reducing tunnel door opening is that the size of the “dead spot” which occurs near the tunnel inlet end wall in houses with very long evaporative cooling pad systems, can be reduced. As the length of pad system increases so does the difference in the amount of air pulled through the pads along the length of the system. In systems 100' in length it is not uncommon to find twice the amount of air coming through the pad at the “tunnel fan” end of a system compared to pads near the end wall of a house. Though the air speed will always be lower near the end wall of a tunnel-ventilated house due to the limited volume of air traveling down the house near the end wall, it has been found that partially closing tunnel door can help to bring in more air through the pads near the end wall, thereby reducing the size of the “dead spot.”



Figure 10. 124' X 5' Evaporative cooling pad system

A study was conducted in a 66' X 500' house with two 124' X 5' evaporative cooling pads systems, installed in pad rooms approximately three feet from the house side wall (Figure 10). The house was equipped with four-foot tunnel doors which resulted in a minor increase in static pressure (0.01") when all the fans were operating and the tunnel doors were fully opened. Air velocity measurements were made 16' from the side wall, at six locations along the length of one of the systems (20', 32',

44', 56', 68', 80') using anemometers positioned two feet above the floor connected to a data logging system with all 16, 54" fans operating.

When the tunnel doors were fully opened the air speed 20' from the end wall was 45% lower than it was 20' from the fan end (324 ft/min vs 529 ft/min) (Figure 11). The average air speed and static pressure measured 50' from the tunnel fans was 671 ft/min and 0.16", respectively. When the tunnel doors were closed one foot, the air velocity 20' from the end wall increased nearly 100 ft/min, while the air speed at the opposite end of the pad increased a little over 10 ft/min. Though the greatest change in air velocity was near the end wall, air speed increased approximately 50 ft/min even 68' from the tunnel inlet end wall. The reduced tunnel door opening increased the static pressure by 0.01", which caused the average house air speed to decrease by a negligible 1% (661 ft/min). Measurements indicated that closing the tunnel doors to roughly 45 degrees can help to reduce the size of the dead spot near the end wall without adversely affecting overall house air speed and bird cooling.

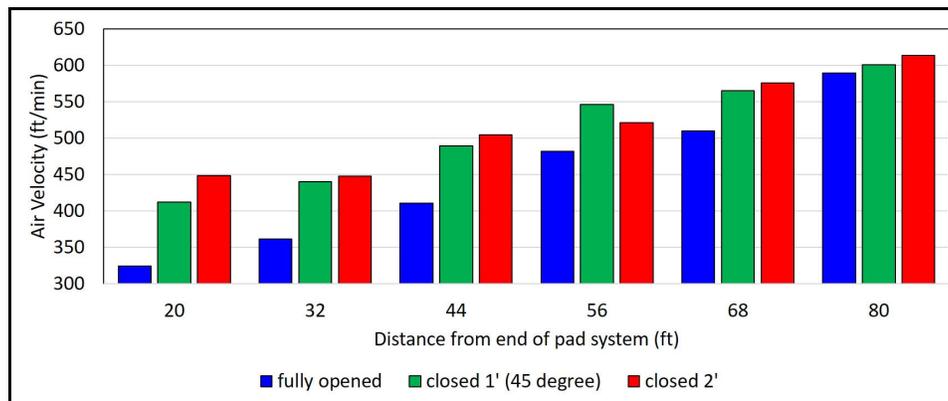
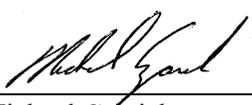


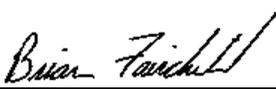
Figure 11. Air speed along the length of a 124' evaporative cooling pad system

When the tunnel doors were closed two feet, the improvement in air speed near the end was less dramatic. Air velocity measurements taken within 56' of the end wall increased on average less than 25 ft/min. The problem was that the marginal increase in air speed near the end wall came at the cost of significantly reduced air speed in the rest of the house. The reduced tunnel opening increased pressure by 0.04", which reduced the house air speed by 6% air speed (621 ft/min). This illustrates that though reducing tunnel door open can prove beneficial, if it is reduced too much the pressure can increase to the point where overall house air speed will be adversely affected.

The thing to keep in mind is that there is not a single "correct" tunnel door opening. There is a range of openings that will work. Some people may find that a 45-degree opening works best for them, others a 60-degree opening. If you operate your tunnel door based on pressure just set the maximum opening to between 45 and 60 degrees and your tunnel static pressure between 0.05" and 0.08". Generally speaking, the tunnel door will go to its maximum opening after about 75% of a houses tunnel fan capacity is operating, depending on the tunnel static pressure settings and house air speed.

A quick and safe way to determine how much you can close your doors without significantly affecting overall fan performance is to measure the static pressure with all the tunnel fans operating and the tunnel doors opened to their maximum (tunnel door opening is equal to the side wall opening). Then, start the closing the doors while monitoring the static pressure. When the static pressure increases approximately 0.01", stop closing the door. Typically the doors will closed to approximately 45 degrees. As discussed previously, a increase in pressure of only 0.01" will not noticeably affect average house air speed, but could result in improved cooling for some of the birds in the house. Use smoke emitters/insect foggers to examine air flow patterns with the larger and smaller openings. Measure air speeds throughout the house as well. Finding the optimal tunnel door opening takes some experimentation, but if you keep an eye on your static pressure as you adjust your tunnel door opening you will be assured that you are not harming the majority of the birds in a house to cool a few birds near the end wall.


Michael Czarick
Extension Engineer
(706) 542-9041
mczarick@uga.edu
www.poultryventilation.com


Brian Fairchild
Extension Poultry Scientist
(706) 542-9133
brianf@uga.edu