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Poultry Housing Tips

Measuring Static Pressure in Tunnel-Ventilated Houses

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In a tunnel-ventilated house static pressure is primarily an indicator of how hard the fans are having to work to pull air into and down the house. The higher the pressure the harder the fans have to work. As the level of work/static pressure increases, the amount of air moved by a fan decreases and power usage increases. For instance, increasing static pressure from 0.05" to 0.20" will tend to decrease the amount of air moved by a tunnel fan between 20 and 30%, while at the same time increasing power usage of the fan by between 8 and 16%.

When determining how hard your tunnel fans are working, is important to measure the static pressure in the proper location, namely within 20' of the tunnel fans. The further you move from the tunnel fans the less accurate your measurement will tend to be. This is because the amount of static pressure measured decreases as you move away from the tunnel fans. Or, another way to look at it is the static pressure/work increases as you move from the tunnel inlet to the tunnel fan end of a house.

When you measure static pressure in a tunnel-ventilated house, you are essentially measuring the amount of work it takes to get the air from outside the house to where you are standing inside the house. For instance, if you are measuring the static pressure half way between the tunnel inlet and the tunnel fans you are essentially measuring the amount of pressure/work required of the tunnel fans to pull air through the pads, through the tunnel curtain opening, into the cross-sectional area of the house, and then half way down the house. This is not the total static pressure because the fans still have to draw the air under the half house curtain and down the remaining length of the house. The total static pressure or work required of the tunnel fans can only be measured right before the air exits a house.

Though measuring static pressure in locations other than near the tunnel fans does not indicate the total pressure the fans are working against, it does allow a producer to examine how the static pressure increases as the air moves from the inlet end to exhaust end of the house and as a result how each area of a house contributes to the total. One example

of how static pressure changes down the length of a tunnel-ventilated house is illustrated in Figure 1. The chart is derived from a recent study conducted by University Extension engineers and poultry scientists in a new 50' X 560' broiler house with 13 high-capacity tunnel fans and a total of 240 linear feet of five-foot-tall evaporative cooling pads. With all the tunnel fans operating, static pressure measurements were taken at the evaporative cooling pads, just inside the tunnel doors, at 1/4 house, ½ house, 20' past the ½ house curtain, 20' from the tunnel fans, and at the tunnel inlet end wall. Average house air velocity was determined by measuring air velocity in 15 locations across the cross section of the house approximately 50' from the tunnel fans.

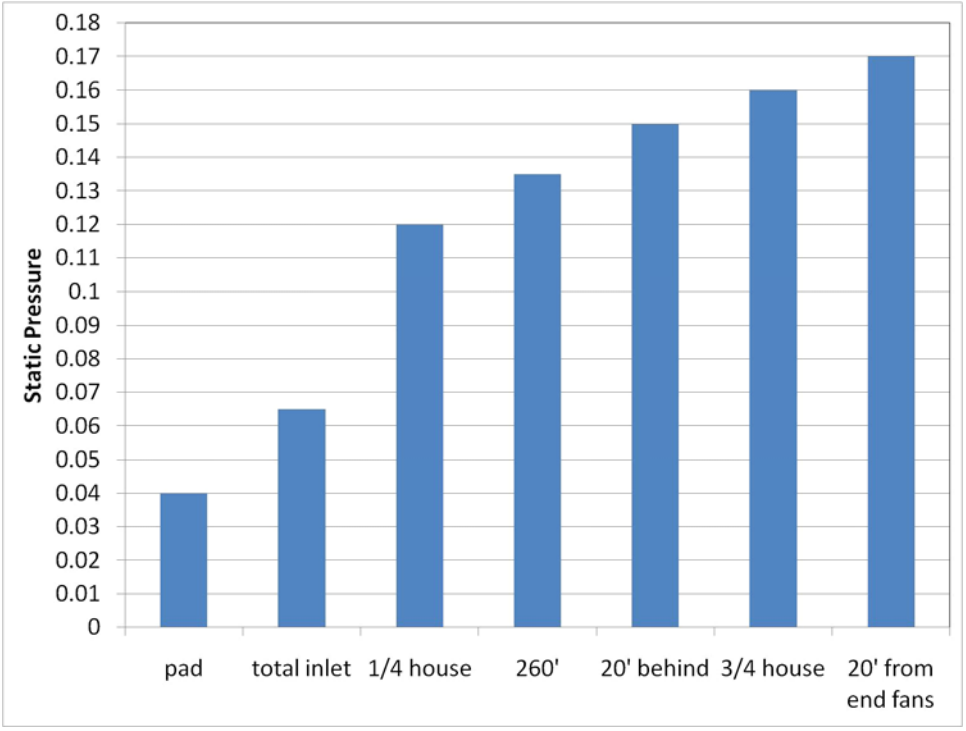

Figure 1. Static pressure measurements down the length of a 50' X 560' broiler house.

With all the tunnel fans operating, the average air speed was determined to be 705 ft/min. The static pressure at the pads was measured by standing in the "dog house" (half way along the length of the pads) and placing the "high" static pressure tube outside the house. A magnehelic pressure gauge as well as the "high pressure" tube running outside the house was placed at ground level to minimize the amount of air movement over the tubes which can affect the accuracy of a static pressure measurement. The pressure difference between outside and inside the dog house (pad pressure) was found to be 0.045".

Next the magnehelic unit was moved just inside the tunnel doors and again placed at floor level while the tube leading outside the house remained at ground level just outside the pads and a pressure difference o f 0.065" was measured. This location provided a measure of the total static pressure or work required to pull the air through the pads and the tunnel doors. Since static pressure is additive, by subtracting the pad pressure (0.045") from the total inlet pressure (0.065"), the tunnel door portion of the total inlet pressure was determined to be 0.02" (0.065" - 0.045" = 0.02"). The two-point pressure increase was the result of air from the five-foot-tall pads speeding up to move through the relatively small 40" tunnel door opening.

Static pressure was then measured approximately 140' from the tunnel inlet end wall (1/4 house) where the static pressure increased to 0.12". This relatively large increase in pressure (0.055") was a result of the air transitioning from the relatively large tunnel door openings (833 square feet) into the small cross-sectional area of the house (460 square feet). Since the cross-sectional area of the house was roughly half that of the tunnel door opening, the air velocity doubled as it entered into the cross-sectional area of the house. As discussed in previous *Poultry Housing Tips (High*

Air Speed = High Static Pressure. July, 2010) an increase in air speed will always be accompanied by an increase in static pressure/work. The greater the increase in velocity, the greater the increase in pressure.

Immediately before to the half house curtain, the static pressure increased yet again to 0.135". Though there was no change in average air velocity between the quarter and half house there is "pipe" friction that resists the flow of air down the house which results in an increase in static pressure.

The air's passage under the half house resulted in a momentary increase in air speed which resulted in an increase of static pressure of another point and a half (measured 20' past the ½ house curtain), bringing the total to 0.15". "Pipe friction" from 20' past the half house curtain to 20' from the tunnel fans (approximately 200') resulted in an additional two points of pressure, bringing the total static pressure the fans were working against to 0.17".

It is important to realize that the relatively high static pressure measured at the fan end of this particular house was primarily a result of the high air speed this house was capable of producing. When a portion of the fans were turned off and the average air speed decreased to 540 ft/min, there was a decrease in total static pressure measured by the tunnel fans from 0.17" to 0.105", a difference of 0.065". This dramatic decrease in pressure was due to the relationship between air velocity in pressure, namely that if you double the velocity of a fluid, the pressure/work required to move a fluid through pipe or fitting increases four fold. So in this case when the air velocity was cut by 30%, the total static pressure decreased by approximately 60%.

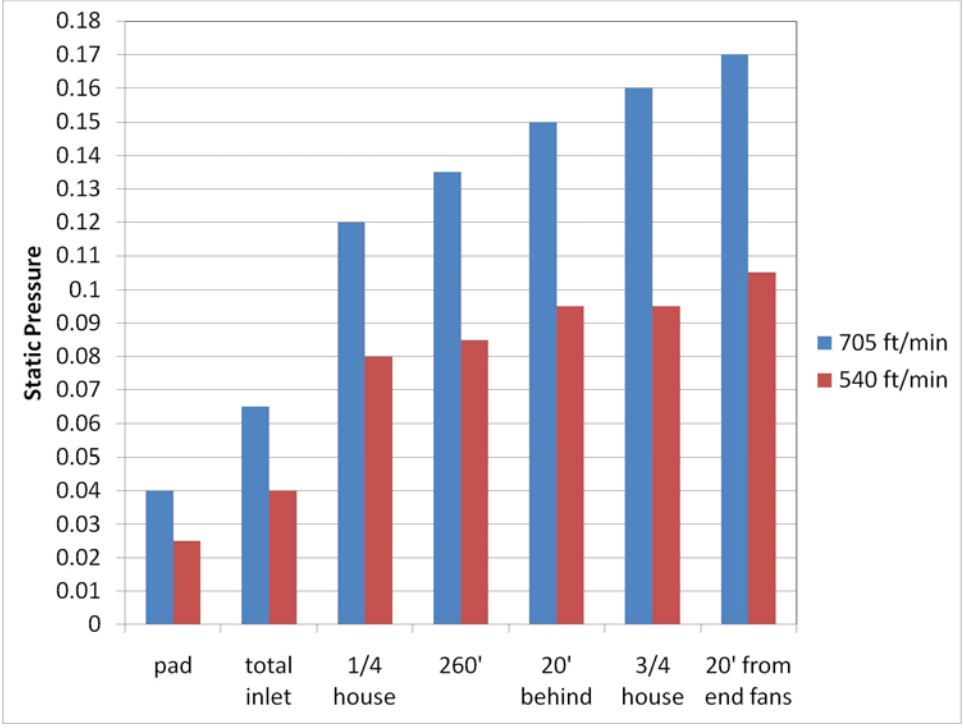

Figure 2. Static pressure measurements down the length of a 50' X 560' long broiler house.

In most houses with tunnel velocities in the 450 to 550 ft/min per range, you will not tend to see large differences in pressure between the 1/4 house and the tunnel fan end of a house and as a result the static pressure measured by controllers (typically located at the center of a house) will be within a point or two of the total pressure the fans are working against. But there are a couple of exceptions to this rule: houses with baffle/deflector curtains and broiler-breeder houses. In both these instances the the exhaust fans may have to work hard to pull the air from the center of the house to the tunnel fans due to fact that baffle curtains, as do nests and slats, act as impediments to the flow of air down a house. In these houses, the pressure at the tunnel fans may be up to five points higher at than the fans that at the center of the house. As a result, it is important that pressure is checked from time to time 20' from the tunnel fans, with all fans operating, to determine the total static pressure the tunnel fans are operating against.
Though not shown on the above charts, the static pressure was also measured at the tunnel inlet end wall. As in most

cases, this static pressure was found to be very similar to the “pad” or “tunnel inlet” static pressure (0.04"). It is important to keep in mind that the static pressure measured at the end wall does not include the pressure required to pull the air into the cross-sectional area of the house (transition pressure) or the pressure required to pull the air down the length of the house (pipe pressure) which can be a substantial portion of the total in many houses. Because of this, installing a poultry house controller at the tunnel inlet end wall can lead to the impression that the static pressure is much lower than it actually is. This can be especially problematic is if the controller is set to maintain a relatively high “tunnel” static pressure, i.e., 0.10". For instance, if the inlet pressure were 0.04" and the total static pressure at the fan end were 0.10", closing the tunnel curtain to obtain an inlet static pressure of 0.10" (an increase of six points) would cause the total static pressure (measured at the tunnel fan end of a house) to increase by the same six points to 0.16". The increased static pressure would cause an overall decrease in air speed and a corresponding decrease in bird cooling; all the while the producer remains under the impression that the house is operating at a fairly typical level of static pressure. If your controller is located at the end wall it is important that the “low/house pressure” tube runs at least to 40' past the end of the tunnel opening to obtain a more representative static pressure measurement.

Though it is not necessary to measure the total/fan end static pressure continuously, it is important for operators of tunnel-ventilated houses to be aware of the fact that the static pressure their controller is indicating may not be an accurate measure of the total static pressure if it is located in the center or tunnel inlet end of a house. Producers should measure, and make note of, the pressure at the tunnel fan end of their houses from time to time. An elevated static pressure (generally greater than 0.13") can be the result of partially closed tunnel curtains/doors, excessively lowered ½ house or deflector/baffle curtains or, more commonly, clogged evaporative cooling pads, all of which can result in reduced fan performance and therefore bird cooling.

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