

# Tunnel Ventilation in Poultry Housing

ANR-897

## What Is Tunnel Ventilation?

Tunnel ventilation gets its name because in this type of system the poultry house is converted into something like a wind tunnel. In a tunnel ventilation system, all exhaust fans are placed at one end of the house and all air inlets at the other end. Ventilating air is drawn uniformly through the length of the house at a velocity of at least 350 to 400 feet per minute (4 to 4.5 mph). This high-velocity air flow through the house provides significant cooling for the birds. Evaporative cooling can provide additional protection against birds' overheating.

Tunnel ventilation is a warm-weather system. Introducing all ventilating air at one end of the house can cause chill stress on

birds in cold weather. During hot weather, larger birds conditioned to tunnel house temperatures will suffer heat stress if power fails even if the house is immediately opened up. For this reason, a back-up generator is essential.

Tunnel houses are usually designed to operate at static pressures ranging from 0.06 to 0.10 inches. Houses using curtain-wall or sidewall exhaust fan systems can be adapted to tunnel ventilation. As in other negative-pressure ventilating systems, a tight house with no air leaks is needed for successful operation.

## Benefits Of Tunnel Ventilation

Tunnel ventilation with evaporative cooling can enable a grower to provide close to optimum conditions for bird perfor-

mance in hot weather. Managed properly, tunnel ventilation not only prevents mortalities from heat but keeps birds feeding and growing at a good rate. Also, growers have found that tunnel ventilation allows them to maintain wintertime stocking rates throughout the year rather than reducing bird density during the hot months. The result can be higher net returns to the grower, compared with other summer ventilation systems. The hotter the weather, the better the pay-off from tunnel ventilation is likely to be.

## Lowering Effective Air Temperature

Air velocity in a tunnel-ventilated house is high enough to create a wind-chill effect on the birds, so that they feel an "effective temperature" lower than the actual outside air temperature. For example, if air at 90°F is moved over the birds at 350 feet per minute, it feels to the birds like about 75°F air.

Figure 1 shows the effective temperature experienced by birds for different air velocities when outside air temperature is 90°F. The wind-chill effect becomes less pronounced as temperatures rise toward 100°F. When air temperature is the same as or higher than the birds' internal body temperature (slightly above 100°F), the air begins to warm the birds instead of cooling them. Under these conditions, evaporative cooling

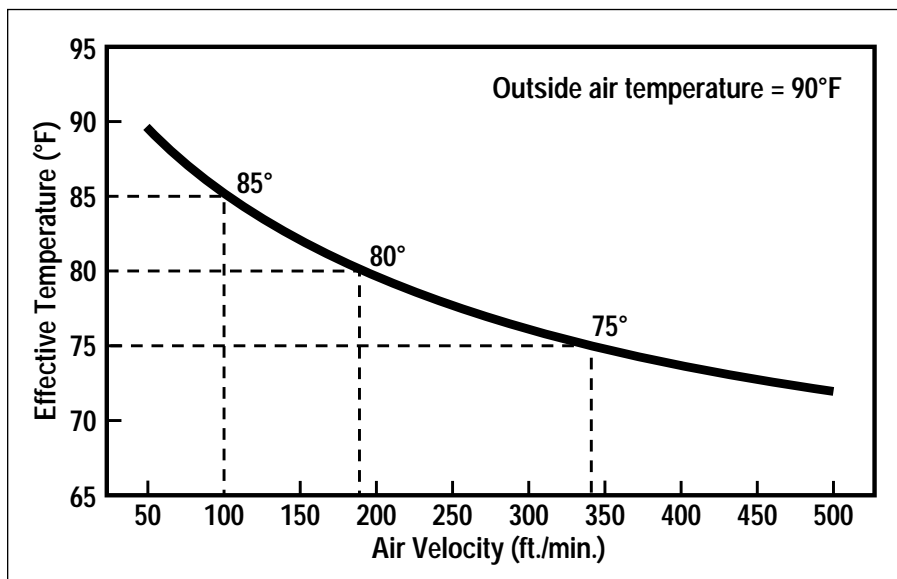


Figure 1. Effective temperature for broilers created by different air velocities when actual air temperature is 90°F.

to lower the actual air temperature is needed to prevent heat stress.

## Sizing And Locating Air Inlets And Fans

All air inlets and fans are placed in the building endwalls and/or in the sidewalls next to the endwalls. If sidewall installation is used, the arrangement should be balanced, with fans or inlets in both sidewalls, not just in one side. Figure 2 shows a typical tunnel ventilation system.

The house design should aim for an air velocity of 400 feet per minute or more, exchanging house air about once every minute. To find the total fan capacity needed, simply multiply the air velocity wanted times the cross-sectional area of the house. For example, in a house 40 feet wide by 400 feet long, if ceiling height is 8 feet, cross-sectional area will be 320 square feet (8 feet  $\times$  40 feet) and the fan capacity required for 400 feet per minute air velocity will be:

$$400 \text{ ft./min.} \times 320 \text{ sq. ft.} = 128,000 \text{ cfm.}$$

Houses of this size typically use six to eight 48-inch fans to get this total fan capacity. The total house volume will be 128,000 cubic feet (8 feet  $\times$  40 feet  $\times$  400 feet), so house air will

be exchanged about once every minute.

Total inlet area should be large enough to insure smooth and uniform airflow through the house at about 400 feet per minute. If the inlet area is too small, air velocity at the inlet end will be too high. When fans alone are used, the total inlet area should be as close to the house cross-sectional area as possible, consistent with maintaining static pressure. Additional inlet area is needed when evaporative cooling is used, as explained below under Cooling With Evaporative Pads.

If needed, the house cross-sectional area can be effectively reduced by hanging deflector curtains from the ceiling across the width of the house. This is especially helpful in open ceiling houses. The deflectors are usually made of curtain material and should be spaced not less than 40 feet apart down the length of the house.

## Selecting Fans

Ventilating fans must be designed to move air against pressure in order to perform as expected. The design static pressure, air inlet area, cooling pads, fan enclosures, shutters, and guards all affect the amount of air that will be moved

through the house. Shutters alone can reduce fan capacity by 10 to 25 percent, compared with free air delivery. Choosing fans can be difficult because manufacturer rating systems vary and may not include testing with shutters and guards in place. Fans are often rated at free air delivery and at 1/8-inch (0.125 in) static pressure.

Most fans on the market today have been tested by the Air Movement and Control Association (AMCA). A testing program at the University of Illinois rates commercially available fans at various static pressures with shutters and guards in place and in addition provides energy efficiency ratings. For a copy of the test booklet, send a check for \$5 payable to University of Illinois to Steve Ford, 1304 W. Pennsylvania, Agricultural Engineering Sciences Building, Urbana, IL 61801.

## Using Evaporative Cooling

The combination of tunnel ventilation and evaporative cooling can be very effective in reducing hot-weather heat stress. Evaporating or vaporizing water lowers the air temperature and raises the relative humidity of the air. If outside air relative humidity is below 75 percent, evaporative cooling can almost always bring air temperature down at least into the 80° to 85°F range. The lower the outside relative humidity, the more cooling can be expected.

Generally, evaporative cooling should be started when outside air temperature hits 85°F but only if relative humidity is below 75 percent. At higher relative humidity, wetting of birds and litter is more likely, and cooling effect is limited. Care should be exercised to avoid wetting of birds or litter.

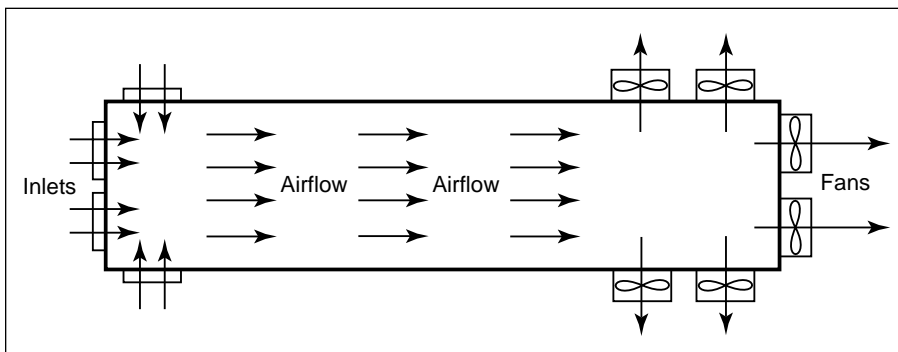


Figure 2. Fan and inlet arrangement for a typical tunnel ventilation system. Cooling air sweeps through the house at a high, uniform velocity.

Tunnel-ventilated poultry houses can use evaporative pads, foggers, or misters for cooling. Fan and pad systems, along with very high-pressure, low-volume fogging systems, can come close to providing an optimum growth environment for the birds.

**Cooling With Evaporative Pads.** In a fan and pad system, outside air is cooled as it is drawn through wetted pads usually placed outside the air inlets. An advantage of external cooling pads is that water which is not vaporized drips off the pad outside the house and not onto the house floor. Fogging lines are often used to wet the pads. Placing the pads across the air inlets restricts the inlets, so total inlet area must be larger when evaporative pads are used. For example, a typical recommendation might be 72 square feet of pad area for each 48-inch fan. The type and thickness of pad used, inlet area, and fan capacity must be matched to maintain the air velocity and ventilating capacity (cubic feet per minute) needed. Some pad systems add several fogging lines inside the house to smooth out temperature variations as air moves through the house.

**Cooling With Fans And Foggers.** When foggers or misters are used in a tunnel house, they are spaced through the building so that cooling is distributed throughout the house. High-pressure, low-volume foggers, operating at 200 psi or more and with a flow rate of 1 gallon per hour or less, are more efficient and carry less risk of wetting the birds or the litter. This is because they produce smaller droplets of water, which are more likely to be kept aloft in the air stream long enough to evaporate.

Low-pressure, high-volume systems are much less expensive and can help reduce mortalities but produce less cooling effect and have to be monitored more closely to avoid wetting down the house.

## Controlling Bird Migration

In a tunnel house, birds tend to migrate toward the air inlet end of the building. Crowding as a result can reduce bird performance markedly. To control migration, fences should be put up at least every 100 feet. These can be made from 2-inch by 4-inch welded wire connected to a PVC framework about 18 inches high.

Several factors contribute to migration, including a natural tendency for birds to face into a wind so that when they move they walk in that direction. However, in hot weather birds will also tend to move toward a cooler area. If the inlet air velocity is considerably higher than the velocity reached after the air has spread in the house, the birds may be moving toward this higher velocity and more cooling air. Also, the air at the inlet end will naturally be a few degrees cooler. Since the air moving through the house is picking up heat from the birds, the air will warm several degrees by the time it reaches the fans.

Bird migration within fenced areas may occur naturally, but if this crowding is pronounced it may signal inadequate airflow, which causes large temperature differences. Usually inadequate airflow results either from inadequate fan capacity, which may be caused simply by dust build-up on fan blades and shutters, or from air leaks in the ceiling or walls.

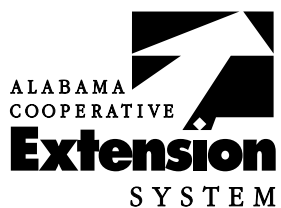
## Tips On Operating A Tunnel House

- A tunnel ventilation system is designed to cope with high summertime temperatures. In milder weather, the system can be operated at less than capacity, that is, with fewer fans running. However, if it is too cool to tunnel ventilate with at least half the fans running, sidewall inlets or curtain ventilation should be used. Moving the air too slowly through the house risks allowing temperature, carbon dioxide, ammonia, and humidity to rise to dangerous levels before the air gets to the fan end.

- Fan thermostats can be set to bring fans on in stages. Thermostat settings will depend on bird age. The younger the bird, the fewer the feathers, the more easily heat is removed from the bird. For fully feathered birds, the system normally should be set to run at full capacity by the time the air temperature reaches 80°F.

- Evaporative cooling thermostats should be set to start cooling at 80° to 85°F. Staging can include switching fogging lines on in succession and switching from low to high pressure settings. Evaporative cooling should never be used at night or before 10 a.m. because the humidity will be too high.

- Use an air velocity meter to monitor actual airflow in the house. What counts is air velocity at bird level, which usually will be slightly lower than air velocity at chest height.



## ANR-897

---

James O. Donald, *Extension Agricultural Engineer*, Professor, Agricultural Engineering

---

Appreciation is extended to L. Bynum Driggers, former Extension Specialist, North Carolina State University, for his permission to use some of the material in this publication.

---

**For more information**, call your county Extension office. Look in your telephone directory under your county's name to find the number.

---

Issued in furtherance of Cooperative Extension work in agriculture and home economics, Acts of May 8 and June 30, 1914, and other related acts, in cooperation with the U.S. Department of Agriculture. The Alabama Cooperative Extension System (Alabama A&M University and Auburn University) offers educational programs, materials, and equal opportunity employment to all people without regard to race, color, national origin, religion, sex, age, veteran status, or disability.

UPS, 5M07, Rev. 11:95, ANR-897