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Tunnel Ventilation of Broiler Houses [1]

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Functions of a Ventilation System

Proper ventilated housing is essential for profitable poultry production in Florida. There are basically five reasons why we must ventilate poultry houses:

- to remove heat
- to remove excess moisture
- to minimize dust and odors
- to limit the build up of harmful gases such as ammonia and carbon dioxide
- to provide oxygen for respiration.

Of these five, the two most important are removing built up heat and moisture. The time of the year determines which of these is of primary concern.

During the summer, the most important thing that a ventilation system does is to remove heat from the house. Birds give off heat as they grow. During cold weather, or when chicks are little, this heat is beneficial. During the summer, however, bird body heat, combined with the heat from outside air and from solar radiation, causes reduced feed consumption, reduced growth, and increased mortality. Ventilation and cooling systems remove the heat added to a broiler house by bird body heat and by solar radiation. As birds near market weight, they give off relatively large amounts of heat. A flock of 25,000 four-pound chickens can give off 1,000,000 BTU/hr of heat. Eighty tons of refrigeration would be required to remove this amount of heat. For comparison, a typical 3,000 square foot home would require about 5 tons of cooling.

During the winter, the most important function of a ventilation system is to remove moisture from the house while conserving heat produced by the birds and brooders. A flock of 25,000 four-pound chickens give off about 40 gallons of moisture per hour. When a house is closed, the ventilation system must be operated on a timer to remove the moisture produced by birds or damp conditions and condensation will result.

What is Tunnel Ventilation?

Tunnel ventilation is a system where exhaust fans are located at one end of the house and two large openings are installed at the opposite end. Air is drawn through these openings, down the house, and out the fans, like a wind tunnel (see Figure 1).

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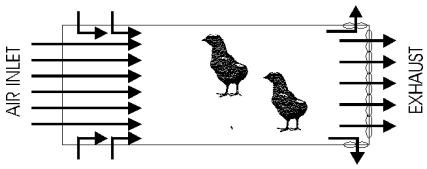

Figure 1. Illustration of tunnel ventilation.

Tunnel ventilation is a type of exhaust system. The fans act like pumps to move air through air outlets. Pumping air out of a house produces a lowered air pressure inside the house. The outside air pressure then forces air into the house through air inlets. In a typical curtain-sided house, the air inlets are located along the length of both sides of the house. Air enters and quickly loses about 50% of its velocity as it spreads out. In a tunnel ventilated house, air only enters the house at the end and moves down the house just like water moving through a pipe. The air entering the house can be cooled by drawing it through evaporative cooling pads or by the use of fogging nozzles located throughout the house.

A disadvantage of tunnel ventilation is that more exhaust fans are required than are used in typical curtain-sided houses. The extra operational costs for tunnel ventilation must be balanced against the increase in weight gain and reduction in mortality that can be achieved during extremely hot weather.

How does Tunnel Ventilation Work?

Air movement is one of the most effective methods of cooling birds during hot weather. As air moves over a bird's hot body, heat is removed from the bird, making it feel cooler. The greater the amount of air movement, the greater the cooling effect produced. Cooling produced through air movement is commonly referred to as the "windchill effect".

Tunnel ventilation results in rapid air movement down the length of the house. Air velocity is usually in the range of 350 to 400 feet per minute (fpm), which is equivalent to 4 to 5 mph. Velocities in this range result in a cooling effect equivalent to up to 10°F temperature drop. This effect decreases as air temperature increases, but still produces cooling even when temperatures reach the mid to high 90s which are are common during Florida summers. When more cooling is desired, an evaporative cooling system is needed.

It must be remembered, however, that while tunnel ventilation works effectively to improve bird comfort and performance during hot weather, it is not intended for cold weather ventilation. During cold weather when the ventilation rate is reduced to a minimum, tunnel ventilation can work against you by generating large end-to-end differences in air temperature, humidity and aerial contaminants such as ammonia and dust.

A ventilation system alone can never reduce inside temperatures to levels below temperatures outside the building. If lower temperatures are desired, then a cooling system must be utilized. Evaporative cooling is the most commonly used cooling system in Florida.

Evaporative Cooling

Evaporative cooling refers to the cooling effect produced when water evaporates. The energy used to evaporate water is taken from the air, cooling the air as energy is removed. Evaporative cooling is the most inexpensive way to cool air. The pumps and fans needed for evaporative cooling are less expensive to buy and much less expensive to operate than conventional air conditioning that uses refrigerants and compressors.

Evaporative cooling has big advantages when costs of installation and operation are considered. However, two disadvantages are that 1) as water is evaporated, the humidity of the air is increased; and 2) the amount of cooling that can be produced depends on the air's relative humidity. The higher the relative humidity, the lower the evaporative cooling effect. Yet, even in humid Florida, evaporative cooling can be effective. Figure 2 demonstrates that during the hottest part of the day, relative humidities are lowest.

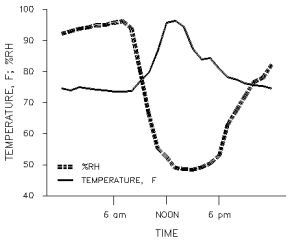

Figure 2. A typical August day in Florida.

Cooling Inside the House

A variety of evaporative systems can be used. Evaporative cooling pads alone, or in combination with fogging nozzles, or fogging nozzles alone, are all effective options.

Evaporative cooling pads resemble paper air filters and are placed over the large air inlets in a tunnel-ventilated house. They are wetted using fogging nozzles or by dripping water over them. As the air drawn into the house by the tunnel fans moves through the wetted pad, water evaporates off the pad, reducing the temperature of the air.

Evaporative cooling pads at the air inlet produce the coolest air entering the house, but are more expensive to install and require more fan power to pull air through the pads. Pads also can have problems with algae buildup and will need to be periodically replaced.

Fogging nozzles at the air inlet are less expensive to install than cooling pads, but do not cool the air as quickly. They also can produce wet litter near the inlet if they are not properly adjusted. In addition nozzles have problems with clogging.

Systems using evaporative cooling pads alone will have problems with a temperature increase as the air moves down the length of the house. As a consequence, many systems use evaporative cooling pads in combination with fogging nozzles or use fogging nozzles alone.

An effective layout of fogging nozzles is to run them in lines from sidewall to sidewall. They should drain to main lines running the length of the house. Each line should have separate controls.

The amount of water added to a house by fogging nozzles must be regulated. On very hot days, all of the nozzles should be used for maximum cooling, but on cooler days only one-half or one-third of the nozzles may be needed. The water flow rate to nozzles should be regulated so that they do not put out more water than can be evaporated into the air. Water droplets falling to the floor result in wet litter. Leaking nozzles and plumbing can also create problems.

Use one gallon per hour nozzles if water quality permits. Two gallon per hour nozzles clog less frequently, but also are more likely to cause litter wetting.

Place fogging nozzles 60 feet or more away from exhaust fans. Water going through fans will cause increased dust buildup on shutters.

Maintaining Systems

The critical mechanical factors that must be maintained for proper operation of tunnel ventilation are:

- The house must be tight. Air will always follow the path of least resistance. If there are holes in the walls or ceiling, hot air will enter through these holes, rather than through the inlet openings at the end of the house.

- The fans must operate properly. To work, tunnel ventilation requires high air velocities. Keep shutters and fan blades clean. Dust buildup can reduce air flow by as much as 30%. Do not shield fans with chicken wire. Use 1"x2" or 2"x4" welded wire fencing because it does not collect feathers as easily and is easier to clean. Make sure fan belts are tight. Loose belts can reduce air flow by 40%. Protect fan and fogger thermostats from moisture if you are using a fogger system. If they get moist, they will shut off equipment early.

- Nozzles must be clean. Nozzles will clog periodically. When they clog, they do not cool and may drip water onto litter. Stainless steel nozzles clog less, but are more expensive.

Summary

A properly designed and operated tunnel ventilation system is an effective option for cooling birds. The combination of high air velocity and evaporative cooling can be used by producers to increase feed consumption, increase growth and reduce mortality when growing heavy birds during Florida's hot summer weather.