Energy Saving Ideas & Protecting Facilities from Lightning

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(I) Energy Saving Ideas

Introduction: The Old Farmer's Almanac has forecasted a cold and snowy 2006-2007 winter for North Carolina though the National Weather Service forecast is more favorable. Irrespective of whether the weather lives up to its reputation for unpredictability, this winter, poultry producers will certainly pay more for heating both due to the colder weather as well as the upswing in general and seasonal fuel prices. Producers should consider the following suggestions (based on Simpson and Donald, 2005; Donald, 2003) to save energy this winter.

A. Ventilation and heating system operation and management: A proper ventilation system brings in the correct amount of fresh air through the planned inlets; mixes the fresh and exhaust air streams to warm up the fresh air; and exhausts the right amount of stale air. Hence, the ventilation system not only helps maintain the proper air quality in the house but also a more uniform temperature regime that helps the birds. The heating system should ensure that the correct temperature is maintained for the birds. Specific suggestions are listed below.

a) Start with the proper minimum ventilation rate of 0.1 cfm/bird during the first week and increase 0.1 cfm/bird every week. Do not change the minimum ventilation setting irrespective of conditions inside or outside, except when the litter is very wet (also high ammonia) or very dry (dusty). Use 5-min. not 10-min. timers to reduce temperature swings.
b) Use paddle fans (updraft mode) or recirculation fans (racetrack mode) continuously during winter to mix the air within the house to ensure that some of the warmth near the ceiling gets back to the birds. Fans save 15-20% in energy cost (Donald et al., 2001).
c) Reducing your thermostat setting 2-3 F every 3-4 days will provide better bird conditions and reduce energy use compared with 5-F reductions every week.
d) Controlling both the heating and ventilation systems with the environmental controller will reduce energy use compared with controlling the heating with thermostats only.
e) Wrong location of the temperature sensors can cause the heaters to come on or off too early or too late resulting in cool temperatures or energy wastage. Location of the sensor will depend on what temperature it is measuring (e.g., radiant brooder or forced air furnace) and its height will depend on the age of the birds
f) Proper use of acidifying amendments will reduce ammonia levels in the house (Shah et al., 2006). This will reduce energy use when the litter is old or wet or if the producer is ventilating below the minimum ventilation rate. The minimum ventilation rate should not be reduced just because an amendment is being used since it will not reduce humidity.

B. Routine maintenance and minor upgrading: This can reduce energy use and improve house conditions. Due to high energy prices, many of the suggestions listed below will have short payback times.

a) Clean the burner orifices after each flock so that the brooder burns cleanly and does not waste energy; use the proper size reaming needle to ensure that the orifice is not enlarged.
b) Make sure that your temperature sensors are reading the correct temperature by comparing readings with a reliable handheld temperature sensor placed at the same location.
c) Cold air comes in through the sides, top and bottom of curtains. Install curtain flaps and boots to minimize leakage and make sure that the curtains line up straight and do not let in air through the sides. Nail and seal curtain bottom. Also seal tunnel inlet curtains.
d) Match the number of inlets to the number of minimum ventilation fans and the static pressure in the house to ensure that the right amount of fresh air is brought in at the right speed (to ensure proper mixing). Ensure that all inlets open the same width. All inlets within 8 ft of the minimum ventilation fans should be latched shut to prevent short circuiting. Make sure that there are no obstructions within 6 ft of the inlets.
e) Conduct a smoke test to identify leaks in the house. Seal all structural air leaks such as pipe holes, etc. Apply weather stripping to all doors and seal unused openings. An 1/8 in. crack running the full length of a 400-ft house on both sides has an open area of more than 8 ft^2.
f) To prevent shutters from back-drafting cold air, cover and seal all fans that are not in use with foam boards.
g) Replace curtains with solid walls, if possible. Give priority to curtains on the north side. Replacing 100 ft of 5-ft high curtains and flaps with solid walls will cost about $500.
h) Make sure that the insulation in the roof has not settled or has not been damaged by rodents.
i) Install mixing or paddle fans if you don't have them.
j) Worn pulleys and stretched V-belts can reduce airflow 30%, resulting in longer run times and possibly, poor air quality. Self tensioning system for the V-belts is money well-spent.
k) Dirty shutters and guards can reduce airflow by as much as 40%. Clean after every flock.

A tighter house not only reduces energy use but is easier to ventilate and hence, has a more uniform thermal environment. Before you tighten the house, measure the static pressure with all inlets and doors shut and a single 48 in. fan running. If you static pressure is lower than, say, 0.1 in. of water column, you should consider tightening your house using suggestions listed above.

C. Major retrofitting and new construction: Due to high energy prices, there is interest in making existing houses more energy efficient and building more energy efficient houses. Only retrofit structurally sound houses, otherwise, you may lose money. A thermal imaging camera can help identify cold spots for targeted retrofitting, particularly in the ceiling where the insulation has shifted. Specific suggestions are listed below.

a) Sidewalls and endwalls need insulation value of R-8 to R-11, doors need R-5 to R-8 and the ceiling should have a minimum of R-19. Insulating endwalls is good investment.
b) Curtain sided walls can be insulated to form solid walls. Spraying 1.5 in. of closed cell foam insulation on top of curtain increased the R value from 1 to 10 reducing heat loss by 75-80%.
c) If you are considering replacing fans, do not just consider the initial price and airflow rate at 0 in. static pressure. Fans in broiler houses operate at 1/8 in. water column or higher and you need to select fans that give the desired airflow rate at the higher static pressure. Further, consider the efficiency of the fans (cfm/watt) at the design static pressure; higher efficiency fans will save electricity by moving more air per watt than less efficient fans. Installing cones on fans will increase cfm and efficiency.

d) Replacing incandescent bulbs with light emitting diode (LED) bulbs will save money in the long run. While LED bulbs are much more expensive than incandescent bulbs, they last 50 times longer and consume 1/50th the power (Van Wicklen, 2005).
e) European style inlets allow for better air distribution that conventional inlets. While they are more expensive, only half as many are required (Czarick and Fairchild, 2004).
f) When building new houses, the producer may wish to switch from propane to natural gas, depending on its availability. Natural gas provides 20% more BTU per dollar than propane.
g) Wider houses (50-60 ft wide) cost less to build per square foot and also consume less energy per pound of bird raised.

(II) Protecting Facilities from Lightning

Lightning has been extremely damaging this summer of 2006. Duke Power indicates that poultry farms have suffered ten fold the damage this year as compared to normal. The reasons are largely two fold. Reason one is that North Carolina has overtaken Florida as the "Lightning Capital of the U.S." for this past year. The second reason is poultry controls have become more sensitive to electrical disturbances as the industry has move away from electro-mechanical control device and migrated to solid state and micro-processor based units. This migration has occurred largely without premise wiring adjusting to the power quality needs of these modern day devices. Fortunately the technology exists to greatly reduce the chance of poultry equipment from being damaged by lightning. The best approach to protecting facilities is an ordered systematic approach.

Step 1: Insure facility is properly wired. It is imperative that the wiring system be properly installed and maintained. Surge devices will not function properly with faulty or inadequate wiring! This is especially critical in older facilities that have been modified or may have never been wired properly. The entire facility should have a thorough inspection by a qualified licensed electrician or an electrical inspector. One very common wiring error they may find is ground neutral splices downstream of the service. This causes neutral current to flow on the equipment grounding conductors. Under normal operating conditions the equipment must have no current flowing on it. In general conductors need to be properly sized and all splices done properly. All equipment should be grounded and bonded.

Step 2: insure proper grounding. Grounding is one aspect of wiring where we must go beyond the requirements of the National Electrical Code (NEC). While the NEC only alludes to a 25 ohm (Ω) resistance The Institute of Electrical and Electronic Engineers (IEEE) and other authorities on power quality recommend a lower Ω value on systems to power electronic equipment. It is best to attempt where practical to have ground resistance $<10\Omega$'s. This may require multiple ground rods spaced at least as far apart as they are long. Rods that are driven deeper will give the best results with depths of 20-40' common. The objective is to have contact with moist highly conductive soil.

Achieving a low resistance ground is only part of the equation. All equipment and that includes electrical as well as communication must be grounded to the same point. Separate grounding systems lead to differences of potential which will elevate to damaging level during lightning events. IEEE puts it plainly in the IEEE Standard 142-1991 (Emerald Book) "Most lightning damage to electronic equipment occurs when a facility employs the use of multiple earthing references that are not intentionally, and effectively, bonded together. Under lightning and electrical system fault conditions, "step," "touch," and "transferred earth" potentials can develop between multiple earthing connections that are not part of a common grounding electrode system. Proper bonding between electrode systems can reduce the voltage drops between them and establish an equipotential plane

within the facility so as to enhance personnel safety. For example, lack of bonding between the electrical system electrode and the communications system electrode may result in damage to modems, telephone answering machines, etc., during lightning and system fault conditions."

Be methodical and thorough when grounding as something missed, such as a phone line, can prove disastrous. Many experts state that 90% of lightning damage may be avoided by proper grounding. Conversely, no surge protective system will function with proper wiring and grounding. Completing these first two steps is paramount making the facility prepared for the installation of surge protective devices (SPDs).

Step 3: Select and install SPDs: Surge protective devices work by shunting current to ground. Most have metallic oxide varistors (MOVs) wired from phase to ground and/or phase to neutral. Under normal operating conditions, they have a very high resistance (Ω) value and pass no current. When a threshold voltage is reached for instance, 150 volts on a 120 volt MOV, the resistance will change to a very low value and shunt the excessive voltage and thus the current to ground. This usually happens very quickly (fractions of an AC cycle) but occasionally the events last longer and may cause extreme heat. It is important that any SPD purchased meet UL certification 1449 second (1998) edition which addresses this potential problem. SPD may also employ chokes and coils which impede the high frequency current that lightning produces. In general, you get what you pay for with SPDs, but there are some exceptions. Buy from a reputable manufacturer and an established supplier.

IEEE and other experts recommend multilevel SPDs to protect facilities from lightning and surges. The service entrance is the point of entry for power and often lightning. This equipment requires the most protection with the highest current carrying ability. Equipment installed at the service entrance may be sized to handle a 300K amp surge. The SPD at the service will bear the brunt of the strike but it will allow some "let through" current that must be dealt with. It also important to note that lightning may not always take a path through the service entrance equipment. For these reasons, we must add SPDs at all sub panels and other downstream equipment such as well pumps. These devices have lower current ratings as our upstream SPD has taken the brunt of a surge. Consequently, the downstream device usually cost less than one designed for a service. A SPD for a building panel will have a current rating of 150-160K.

Phone and data lines need protection as well. SPDs for phone and data lines are designed for 10K amps. It bears repeating that these device need to have an adequate ground that is part of the facility ground system NOT a separate ground.

Controls may require a dedicated circuit protected by a SPD or have one installed at the equipment. Some manufacturers have recommendations on this but it is strongly recommended that the controls have the third stage of protection IEEE recommends which is point of use protection.

Summary and Conclusions: Lightning protection should be thought in same way as a bio-security program. There is a large wash area for trucks (service entrance), foot baths at every door (building panels), and coveralls and boots for workers who enter the buildings (point of use). It is the same principle of protecting every potential entrance point with larger measures taken upstream where the potential is greater. SPDs cannot be installed and forgotten. They need to be inspected frequently particularly after storms. For this reason it is advisable to purchase units with visible indicators that indicate if they still function after a storm. Whenever the wiring system is changed, insure the changes do not compromise the system.

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