The Alabama Poultry Engineering and Economics

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Feature article

Renovating or Retrofitting Older Broiler Houses

Propane gas prices have been at high price levels all across the broiler belt this year. Growers are scrambling to take steps to reduce heating cost. For sure there are a lot of things that can be done to improve our houses to hold heat better and make better use of bird heat. One thing we cannot afford to do, however, is to run houses cold. University study after university study has shown the damaging effects of trying to save heating fuel at the expense of bird comfort. This is not an option.

As we react to these high fuel prices, this is a very good time to step back and look at our houses in general to determine what needs to be done to them to provide the best possible bird environment. We need to do whatever is feasible right now to save fuel, but we also need a long-term plan for reworking or retrofitting any of our houses that aren't up to date. Also being real world people, we must take a hard look at where we will get the most return for our money should we decide to do some improvements on a house.

High fuel prices call attention to need to consider renovating and/or retrofitting houses

Most class A type houses being built today have dropped ceilings and are well insulated, tunnel ventilated and evaporatively cooled. Many of these houses will also have static-pressure controlled ceiling or sidewall inlets. Many new houses will be equipped with automatic electronic ventilation controllers. Of course older houses don't have the advantage of some of this newer technology. So in retrofitting or remodeling a given house, what should you be looking for?

House must have good structural integrity to be considered for major renovation

The first thing that has to be considered is the integrity of the structure itself. How old is the house in question? Is it leaning? Does it have center posts? Does it have a dropped ceiling? How good is the ceiling or insulation? Is the roof leaking? The building has to be able to last long enough to recoup any investment in technology. If it won't, plans should be made to phase the house out of production over time.

If renovation or retrofitting is in order, the grower certainly should check signals with the company broiler manager and get information and recommendations from University Extension specialists, as well as consulting local equipment dealers and taking a look at equipment manufacturers' literature. Many of the technological options in poultry environmental control have varying applicability to particular operations, and there are so many variables involved, it is impossible to cover all details in a brief newsletter. But in most cases, if an older house is judged to be worth reworking or retrofitting, the most important items to consider (if not already incorporated) would be:

1. Improving house tightness and insulation
2. Adding static pressure-controlled vent boxes
3. Converting to tunnel ventilation
4. Adding pad-type evaporative cooling
5. Installing an automatic electronic ventilation controller

Consulting with company and University experts is essential to make sure any new technology will provide good return

Some of these items are more important to winter than summer ventilation, and some are much harder to do than others. But all have significant payoff potential.

House Tightness

The cheapest and easiest way to improve ventilation performance in an older fan-powered house is simply to tighten it up, plugging all air leaks. Why is this important? Simply because proper functioning of a ventilation system depends on having the right size and type of inlets operating. The air inlet is at least as important as the fans, whether we are running minimum, transitional, or tunnel ventilation. This means that any unplanned inlets – that is, air leaks – will degrade or defeat the functioning of the ventilation system.

How tight should a broiler house be? A good test of house tightness is to close all the inlets and doors in the house, turn on one tunnel fan or two sidewall fans and observe the inside-outside static pressure difference. (The fan or fans used should be capable of moving about 20,000 cfm at 0.05 inches static pressure.) With all inlets closed and one 48-inch fan (or two 36-inch fans) running, a good house should show a reading of at least 0.12 to 0.15 inches. In a few mostly solid sidewall houses where builders and growers have paid special attention to minimizing leaks, a test static pressure as high as 0.15 inches can be achieved with only one 36-inch fan running. In these very tight houses, running one 48-inch fan (or two 36-inch) can produce test static pressure readings as high as 0.25 inches.

Closing all inlets and running one tunnel fan is a good test of house tightness

Can a house be too tight? While it normally takes at least one tunnel fan or two 36-inch fans to operate air inlets on static pressure controllers, the tightest houses can be operated with only one 36-inch fan running. As long as the vent boxes are opening normally, this is not a problem, but a benefit.

Eliminating air leaks is critical for good ventilation and bird performance, and can save 20-25% in fuel costs

More typical are many older or neglected houses that test out at under 0.05 inches, which means they have about 14 square feet of leakage! A house that reads 0.10 inches in the test setup has about 10 square feet of leakage. Even tiny cracks can easily add up to 10-14 square feet. For example, a continuous uncaulked 1/8-inch crack under a sill plate (not uncommon!) that runs both sidewalls of a 500-foot house adds up to a 10 square foot opening!

The performance difference between tight and loose houses is staggering. Loose houses use much more fuel and have poor litter quality and poor temperature control. Field results have shown that houses with leak test readings as low as 0.05 inches will use 20-25% more fuel than those with leak test readings of 0.15 inches. Looking at the positive side, having a tight house makes it easier in cold weather to keep fuel costs down with little or no bird chilling or litter caking. In hot weather, a tight house means birds get maximum cooling, since all air enters through the cooling pads and there is less heat buildup from inlets to fan end of the house. So in ranking where first money should be spent on an older house to get the maximum return, tightening up the house would be at the top of the list.

Here's a short checklist of key house tightness points:

Sidewall and tunnel curtains, fan shutters and uncaulked sill plates are most common air-leak sources

1. The most common air-leak source is above and below sidewall curtains. Fasten bottom of sidewall curtain to wall with a nailing strip, and install flaps to stop air coming over the top of the curtain (see illustration, page 3).
2. In a tunnel house, install flaps on tunnel curtains too (see illustration).
3. Weather-strip and seal doors very thoroughly.
4. Clean fan shutters (frequently), and cover any unused fans with plastic sheeting or old curtain material.
5. Between growouts, test the house with smoke bombs and seal all structural leaks with expanding urethane foam. Still plates are another major source of air leakage (see illustration), and probably should be sealed without waiting for a smoke demonstration. If clean fan shutters leak and cannot be covered, replace them.

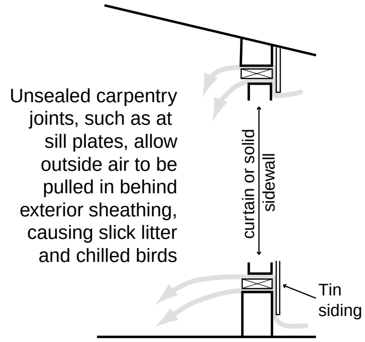
The smoke bomb is invaluable, and will show leaks that are otherwise undetectable. Smoke-testing is best done on a day without too much wind. The best test is to close the air inlets, turn on several fans, and walk around outside the house holding the smoke bomb along the sidewalls, top and bottom curtains, closed fan shutters, doors, and anywhere a carpentry joint might be unsealed. You will need a helper inside the house, of course, to see where smoke is entering. Be careful in holding a smoke bomb near a curtain, since it will burn curtain material if it touches.

Smoke bomb is essential tool for finding otherwise undetectable air leaks

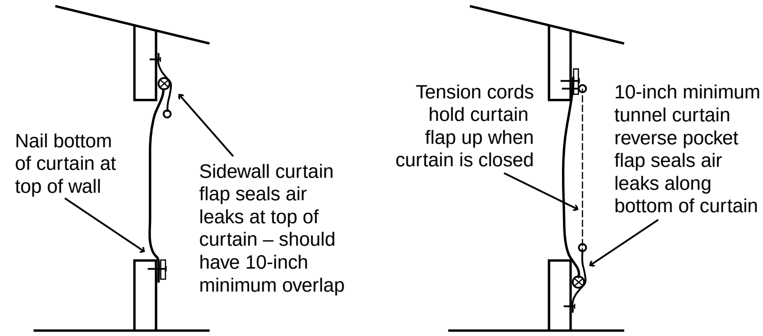
While checking for tightness, it's good to check insulation also, repairing any tears or gaps. Ceiling insulation in a dropped-ceiling house should be at least R-19. Older houses should be checked and insulation added if needed, since loose insulation tends to settle and lose insulating value over time. In an open-truss house, the absolute essential is to have at least R-8 foam or beadboard under-roof insulation. This insulation not only saves fuel costs in winter, it protects birds in summer from solar heat re-radiated from an uninsulated roof. If sun heat is allowed to re-radiate into the house from an uninsulated or poorly insulated roof, it can add as much heat as an entire flock of mature broilers produces.

KEY STEPS TO ELIMINATE AIR LEAKAGE

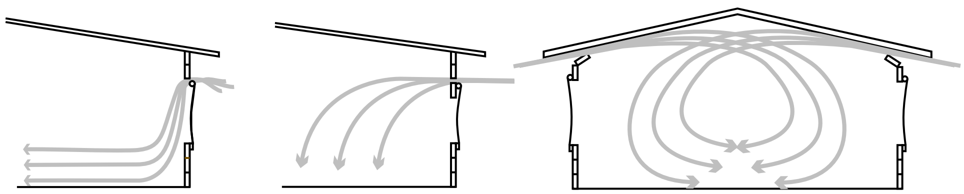
Caulk or seal all carpentry joints



Install flaps on sidewall & tunnel curtains



AIRFLOW ADVANTAGES OF ADJUSTABLE VENT BOXES

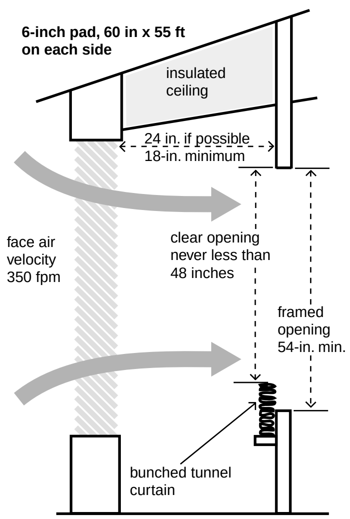


Curtain crack — Fixed board crack — Adjustable vent boxes

Adjustable vent boxes are the only way to provide proper airflow to keep cold air off birds. Static pressure-actuated controls are the only way to maintain consistently proper adjustment of these inlets.

"DOG-HOUSE" VS DIRECT-MOUNT PAD COOLING SYSTEMS

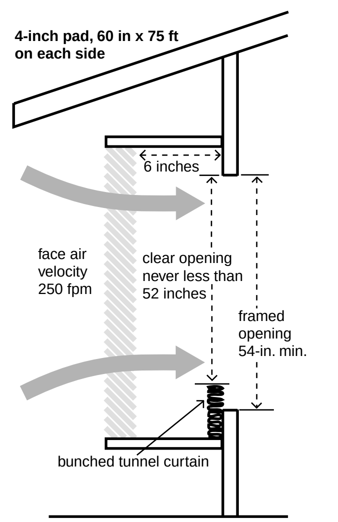
Doghouse style installation features



Six-inch recirculating evaporative cooling pad installed in "doghouse" (left) usually gives highest possible cooling efficiency. Direct-mount pad systems (right) are usually less efficient but also less expensive and can be more feasible for retrofitting older houses.

For either type installation, enough cooling pad area must be installed to keep air velocity through pad and house static pressure from going too high. Offset of pad from house and clear tunnel inlet opening can also be critical for good ventilation system performance.

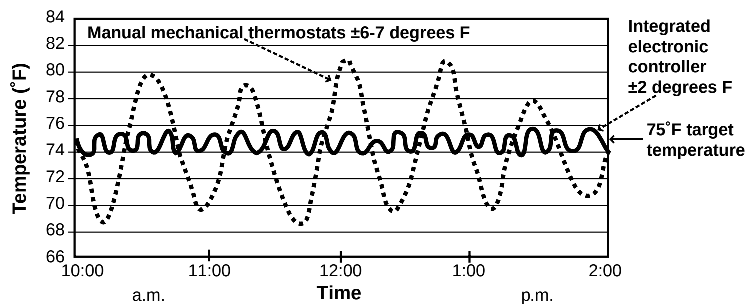
Direct-mount installation features



Note: Drawings illustrate pad system installation, and that tunnel curtains are shown as attached at bottom of inlet, as is done in some situations, instead of at top, which is more typical, is not intended as a recommendation.

ADVANTAGES OF ELECTRONIC CONTROLLERS

Integrated electronic controllers give much closer and more consistent temperature than manual thermostats. Maintaining consistently optimum temperature is key to getting best bird performance.



Static Pressure-Actuated Perimeter Air Inlets (Vent Boxes)

As remarked above, air inlets are as important as fans. And you can make a good case that having the right number, type and distribution of air inlets is the real key to managing in-house conditions.

The only perimeter air inlet that gives proper incoming airflow is a static pressure controlled vent box

The illustrations on page 3 show the airflow patterns that result from using three different methods of bringing air into the house. It is extremely important in cold-weather ventilation to keep cold outside air from flowing directly onto birds, and the only inlet which produces the airflow pattern needed is an adjustable vent box. The size of the opening is critical, and this varies with the number of fans running and changes in static pressure. Manually adjusting these inlets to consistently maintain proper airflow, however, is next to impossible. Vent boxes actuated by static pressure sensors, often called "power vent machines," accomplish proper adjustments automatically, providing much better conditions for birds than would otherwise be possible.

Vent boxes should have thumb latches so they can be latched closed when needed

In looking at older houses that still have good structural integrity, very high on the list for retrofit items is the addition of static pressure-controlled vent boxes. In general terms you want enough inlets put into a house to be able to run about 50% of your tunnel fans pulling air through those inlets. If you don't have tunnel or plan to go to tunnel, you need enough inlets to control fan ventilation until it is suitable to go to natural ventilation. The usual design criteria is to have 15 square feet of inlet area for every 10,000 cfm of fan capacity that will be used. A rough rule is that it takes 12-15 vent boxes (8" x 44") for each 48-inch fan that will be run in power vent mode. Vent boxes should have thumb latches so individual vents can be latched closed when needed. We install enough inlets to handle half the total installed fan capacity, but when we are using only one or two fans, as in brooding, we also need to cut back on the number of inlets that will open.

Tunnel Ventilation

Almost 100% of the newer houses being built in the Southeast are tunnel ventilated. The benefits of tunnel have been well documented by university and field studies for all sizes of birds. But the larger the bird being grown, the more valuable tunnel ventilation is and the more important getting high enough wind speed is.

Tunnel house should have at least 500 fpm airflow, higher for larger birds

Older tunnel houses are often under-powered, so if an older house being considered for retrofit already has tunnel ventilation, it's a good idea to check the installed tunnel fan capacity. The minimum requirement is fan capacity to generate at least 500 feet per minute air velocity. If a tunnel house isn't running at least close to 500 fpm, it probably is not paying its way. If broilers are being grown to very large sizes, many companies are designing for 600 feet per minute.

The best test of tunnel fan capacity is to use an air velocity meter to see if the fans are pulling the air velocity needed. This should be done after a house has been tightened up. In a new installation, or if additional fans are needed, the arithmetic to find needed fan capacity is to multiply the cross-section area of the house by the air velocity needed. For example, in a 40-foot wide house with a 9-foot ceiling, the cross-section area is 360 sq ft. If we want 500-fpm air velocity, 360 sq ft X 500 fpm = 180,000 cfm. If the fans installed won't pull at least 500 fpm, they need to be serviced or replaced, or additional fans must be installed.

If new fans are to be installed, check cfm capacity and both initial and operating costs

If new fans are to be installed, make sure they will pull the needed cfm's <u>at the static pressure they will be operating against</u>. Fans are often advertised for a given cfm capacity at 0.05 inches static pressure. But tunnel fans used in transitional ventilation, or with pad cooling, will usually be operating at closer to 0.10 inches. Two other important rating specifications to check are the *airflow ratio* and the *cfm/watt ratio*. In both cases, higher numbers are better. A fan with a high *airflow ratio* maintains more of its 0.05-inch cfm rating as static pressure goes up, which is highly desirable. A fan with high *cfm/watt ratio* will be cheaper to run, and may be cheaper to own in the long run, especially as electric rates go up. Good belt-drive fans are preferred for tunnel ventilation because they generally move more air at less cost than direct-drive fans.

If tunnel is to be installed in a house without a dropped ceiling, baffles must be installed. These are curtains hung at 30- to 50-foot intervals across the width of the house, with the bottom edges at about the height a dropped ceiling would be. Essentially, these baffles deflect the air stream below this level, effectively reducing the cross-sectional area of the "tunnel" that the ventilating air flows through. Baffles raise the static pressure the fans must work against, with closer spacing and lower height producing higher pressure. This means baffle spacing and height may have to be adjusted to get adequate airflow and not overload fans. Note that baffles are a band-aid, and the best house for tunnel ventilation is a well-insulated dropped-ceiling house.

Baffles are needed to make tunnel ventilation possible in an open-truss house

If you live in a warm climate, installing tunnel on an existing house that has good structural integrity would have to be high on the list of items that would have good cost benefit ratio.

Pad Type Evaporative Cooling

Because wind-chill effects begin to fall off as temperatures approach 100 F, evaporative cooling is becoming standard, along with tunnel ventilation. Pad cooling has become much more common than in-house fogging, primarily because pad systems are easier to manage and do not risk wetting the house down. The difficulty with in-house fogging is that if more water is put into the air than it can absorb, water drops on the birds and litter. A fogging system must be managed so that just the right amount of water is fogged into the air to get maximum cooling, but staying just this side of wetting the house. However, properly designed in-house fogging with tunnel ventilation can be very efficient and effective if operated properly.

Added cooling capability and easier management are making pad cooling the system of choice

Another reason why pad cooling is now more common is that broiler producers are seeing the benefits of installing more cooling capability, which can only be achieved by pad cooling.

Whether a fogger-on-pad or recirculating system is used, the most critical design point in pad cooling is to match the total pad area to the installed fan capacity. And the most common mistake made in pad systems is not having enough pad area. A reasonable goal is to achieve the desired cooling efficiency with the least pad area required, and at the same time keep house static pressure from rising above 0.10 inches. If not enough pad area is installed, static pressure is forced too high, which reduces the output of the fans below the rated cfm's we are counting on. Not having enough pad area also means lower cooling efficiency because air velocity through the pad will be too high. The lower the air velocity through a wetted pad, the higher the cooling efficiency.

Critical for success in evaporative cooling is having enough total pad area, matching installed fan capacity

A second major concern is that the pad installation be designed to allow airflow into the house from the pad in a smooth transition which will not excessively increase static pressure. Direct mount pad systems are sometimes the most feasible way to add pad cooling to an older house. It is particularly important with direct mount systems to make sure the installation is properly designed for good airflow into the house.

Pad cooling add-on must be properly designed for good airflow into the house

In looking at redoing an older house that needs evaporative cooling getting rid of the fog would be high on most people's list. The Cadillac of pad cooling systems is the 6-inch recirculating system placed in a dog-house room on the side of the house. This is also the most expensive and can be difficult to do in a retrofit or remodeling. However, evaluation and price comparison of direct mount vs dog house style cooling systems should be done if a cooling system is in your remodeling plans.

Any grower contemplating adding any kind of evaporative cooling should make sure there is an adequate water supply available. Typical cooling systems (foggers or pads) will use about 8 gallons per minute per house, and this amount of water is not readily available in all areas. If foggers or spray-on pad systems are used, water quality also must be high, to avoid excessive clogging.

Electronic Integrated Controller

For a good, tight house that has vent boxes and tunnel ventilation with evaporative cooling, an integrated electronic control system would be the next improvement to consider. An integrated electronic controller provides consistent control of the in-house environment 24 hours a day, 7 days a week. It also eliminates the labor of changing individual settings on separate controls such as thermostats. However, a good human manager is still needed to oversee and operate the integrated control system.

A good system will be easy to learn, which usually means having a good display screen and being menu-driven. It should be capable of keeping heating and ventilation systems from fighting each other, and moving the house automatically from heating to minimum ventilation to transitional to tunnel and evaporative cooling (and back). It also should have enough data channels so you don't have to add extra contactors. An important part of a good integrated controller is adequate built-in protection against power line spikes and surges.

A good control system also will include zoning capability, allowing the manager to place temperature sensors in various parts of the house and set up the controller to use different sets of sensors for different conditions. For example, the controller would work only off sensors in the brood area for early growout minimum ventilation, but work only off sensors at the fan end of the house for hot weather tunnel ventilation.

Zoning capability makes for more flexible and effective control

The most advanced controllers now allow for data collection and display, so that a manager can, for example, look at previous house temperatures at different intervals. This capability is extremely useful for troubleshooting. Data display, such as temperature history, may be incorporated into the unit, or available through PC (personal computer) monitoring. Remote monitoring and control are now also possible, usually through PC compatibility. This is a desirable option in controllers, allowing a manager or owner to check on house conditions from his own living room and take care of troubles as they arise. Computer interfacing is likely to become more important in the future, and integrators may eventually require such capability.

The Bottom Line

Reality is that in most of the U.S. broiler belt, houses without at least most of the capabilities and equipment mentioned here are not as competitive as they could be. Improvements such as power vent boxes, tunnel ventilation, evaporative cooling, and integrated controllers are paying off in new construction, and should be considered in any older houses that have good structural integrity and are capable of being adequately tightened up. To determine feasibility, the grower must look carefully at the possible returns over time, in consultation with the company broiler manager.

Technology retrofit may be needed to keep an older house more competitive

Sources of Inexpensive Tools for Testing and Tightening

Smoke bombs: Regin HVAC Products, 203-922-0033, *www.regin.com*. Recommended: S-103 cartridges.

Expanding polyurethane foam: Small cans in building supply or hardware stores; larger quantities at Moore Products, Norcross GA, 800-241-5807 (ask about applicators suitable for poultry house use).

Windspeed meter: West Marine, 800-262-8464, *www.westmarine.com*. Recommended: Kestrel 2000 (windspeed/temp) or Kestrel 3000 (windspeed/temp/humidity).

Static pressure gauge: Davis Instruments, 800-573-2189, *www.davisontheweb.com*. Recommended: Dwyer 2000-00 magnehelic

For more information on these and other useful Tools of the Trade, check out Auburn University on the Web at *www.poultryhouse.com.*

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