ALABAMA COOPERATIVE Extension SYSTEM

Auburn University

Poultry Ventilation Pointers

Tests Show Fan Shutter Air Leakage Causes Cold Weather Problems

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Tests showed air leaks even from new, clean, high-quality shutters

Over the past ten years or so a great many poultry growers have had very good results from setting up their broiler houses to use tunnel ventilation in warm weather, and sidewall-fan minimum ventilation in cold weather. This type of ventilation setup has proven very effective and efficient. However, growers and flock supervisors alike have long commented on the fact that during minimum ventilation in very cold weather it's very difficult to maintain uniform conditions from one end of the house to the other. The tunnel fan end seems always to be the cold end of the house. Most observers have pointed to air leakage through closed tunnel-fan shutters as the cause of the problem. Recent shutter testing results now give us a means of gauging the extent of this problem. The tests showed that even new, clean, high-quality shutters of the type most commonly used allowed air infiltration rates high enough to cause very significant – and unnecessary – losses in most broiler houses during cold-weather minimum ventilation.

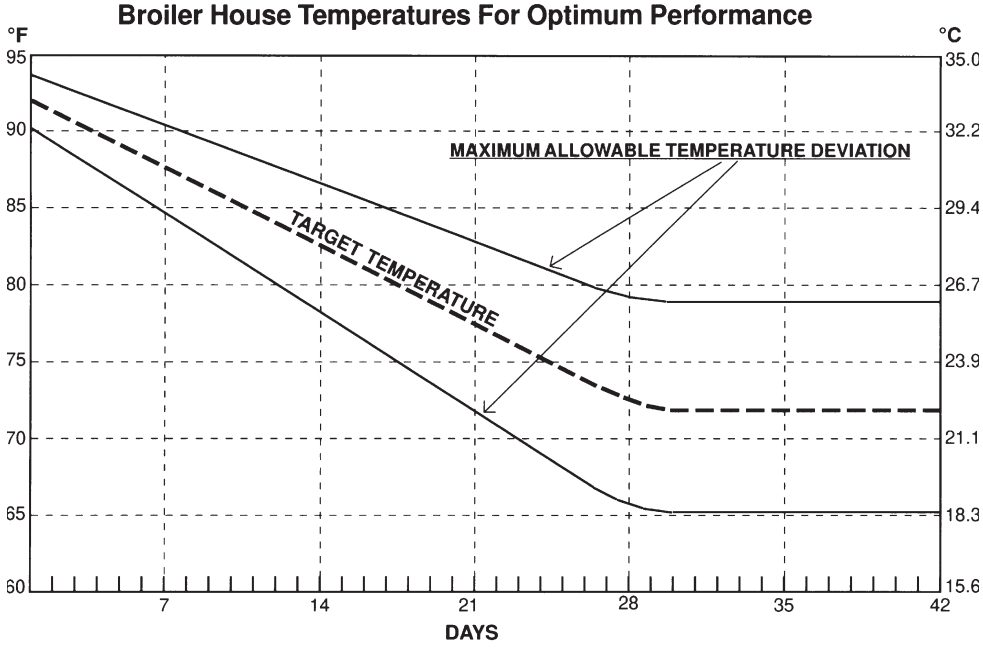
Shutter air infiltration causes house heat loss and hurts performance

In a broiler house using such leaky shutters, the direct costs for propane to make up lost house heat are probably at least $5 to $6 per day per house during cold-weather minimum ventilation. Losses from lowered bird performance are harder to put numbers to, but this is where we would have to expect the biggest loss. We can make up lost house heat only on the average, and the uneven house temperatures that are bound to result from the kind of air leakage seen in the tests will definitely hurt bird performance. It doesn't take many points of lost meat production to add up to significant financial loss.

Shutter leakage can throw temps out of safe zone during critical early weeks of growout

As the chart below shows, the first half of a growout, when a grower is most likely to be using minimum ventilation, is also the most critical time for temperature control. If fan shutter leakage causes temperatures to range more than one or two degrees off target in the first week, or more than five or six degrees off by the end of the third week, significant performance losses have to be expected.

Broiler House Temperatures For Optimum Performance



Minimum Ventilation: How It Works, and What Can Go Wrong

Minimum ventilation pulls air in at low flow rates but high velocity through high, small inlets

To understand the situation, let's quickly review what we're trying to do in the negative-pressure minimum ventilation mode during cold weather. The sidewall exhaust fans create a slight vacuum inside the poultry house, pulling outside air into the house through high, uniformly-spaced sidewall inlets that are only slightly cracked. This negative pressure allows us to bring air into the house at low flow rates (cfm) but at high velocity through the inlets (800-1000 fpm). This keeps the incoming cold air in contact with the ceiling for as long as possible, to be blended in with the warm in-house air above the flock. No cool air comes directly in contact with the birds, avoiding chilling and stress. This is one of the major advantages of negative pressure ventilation. Litter is kept in much better condition because condensation is minimized. And the use of existing building and bird heat is maximized, so heating costs are kept low.

Unplanned openings put cold air on birds, waste house heat

The main thing that can go wrong with this scenario is air entering the house through *unplanned openings*. A house under negative pressure, say at 0.08 inches of water, will draw air through every curtain crack, door crack, ceiling hole, and closed fan shutter in the building. These cracks will also leak when minimum ventilation fans are not running, but air leakage is greatly accelerated when fans are operating. Unplanned, accidental infiltration of outside air disrupts the desired air circulation pattern, chills the birds, causes drafty conditions and temperature variations, results in excessive loss of house heat and increased heating bills, etc. The colder the outside air, the more devastating infiltration can be.

Fan Shutter Tests Show Severe Air Leakage

In winter we often have eight to ten 48-inch fans not being used while birds are young and weather is cold. Recently, Auburn agricultural engineers made an effort to document the amount of air leakage or infiltration through the closed shutters of these fans. Test data are summarized in the table below.

Test results: airflow through a "closed" fan shutter at up to 350 cfm

To evaluate shutter losses, different types of commonly used, high-quality fan shutters were tested in a laboratory, under negative static pressures of 0.08 and 0.10 inches of water. The amount of air leakage through a completely closed shutter was measured in cubic feet per minute (cfm). The tests were done with new, properly-operating 48-inch aluminum and PVC shutters. They turn out to be a major source of air infiltration. The results showed air flowing through these supposedly closed shutters at a surprisingly high rate, ranging from 270 to 350 cfm.

To interpret this, you can put pencil to paper and figure out that in a typical 400-foot house with eight tunnel fans, 300 cfm per shutter would mean a total leakage of 2400 cfm, which would completely change warmed in-house air for cold outside air about once an hour. This suggests the degree of heat loss to be expected. Further: during minimum ventilation the *design* ventilation rate may be

Fan Shutter Air Infiltration Test

48-inch shutter type	Static pressure (inches)	Measured air leakage per shutter (cfm)	Heat loss per shutter with 40°F temperature difference (Btu/hr)	Heat loss per shutter per hour, assuming 20% fan run time (Btu)	Value of heat lost per day per house (20% fan run time)
Aluminum	0.08	270	12,240	2,448	$4.70
	0.10	304	13,786	2,757	$5.29
PVC	0.08	301	13,651	2,730	$5.24
	0.10	351	15,917	3,183	$6.11

Aluminum shutters tested slightly better than PVC, but losses are still high

Assumptions: Propane gas cost @ $0.80/gallon and heater efficiency 90%; eight 48-inch fans/shutters per house. Calculations do not include wind infiltration through shutter louvers when minimum ventilation fans are not operating.

as low as 10,000 cfm. So an accidental, unwanted, additional 2400 cfm air flow coming from one end of the house is going to seriously disrupt the desired minimum ventilation air circulation and temperature profile in the house.

What Are the Probable Direct Dollar Costs?

In addition to the numbers for infiltration rates found, the table on page 2 shows the calculated consequent heat losses, and the dollar costs for make-up heat under typical conditions on a per-house per-day basis. You might try figuring from these numbers what loss you would expect for the whole winter season, based on how many cold-weather days you would be operating strictly on minimum ventilation with no tunnel fans running. For example, if you guess you would be doing sidewall-fan-only ventilation for 21 days each during two winter growouts, the total loss per house for PVC shutters at 0.10 s.p. would be over $250 ($6.11 X 42 = $256.62).

Heat loss alone may cost several hundred dollars per house

Remember, this $250 or more is just the most conservative estimate of direct, out-of-pocket excess propane costs. We're ignoring:

1. The infiltration losses that will occur when no fans are running (a lower rate of infiltration and harder to measure, varying according to how windy it is outside – but it's going on about 80% of the time); and

2. Losses that will also happen on days when it's cold and we're still using sidewall air inlets only but the birds are larger and we need to turn on one or more of the tunnel fans to boost the ventilation rate (infiltration will continue through shutters that are closed, but the bad effects will be less pronounced because the infiltration rate will be smaller in relation to the total ventilation rate).

What Happens to Bird Performance?

We also haven't gotten to the much larger losses expected from reduced bird performance. If birds are not getting the optimum environment they need, their performance will suffer. The inability of tunnel fan shutters to keep out unwanted cold air means that not only is the fan end of the house likely to be too cold for optimum bird performance. We should realize also that the other end of the house may well be several degrees too warm; the exact temperature distribution in the house will depend on where the temperature sensors are located, how the controller is set up, etc.

Small temperature variations can cause big performance losses

A few degrees up or down may not seem like much to us, but it greatly affects bird performance. Remember, we're running minimum ventilation mainly during the first part of a growout, when birds are small and temperatures more than two or three degrees off optimum will cause significant reduction in performance (see chart on page 1). And we know that it is difficult or impossible to make up lost meat production in later stages of the growout.

What Can Be Done?

Routine maintenance to stop air leaks is vital for good winter ventilation

What to do? The first thing is doing the essential routine maintenance – checking doors, curtains, ceilings, etc, to tighten up houses as much as possible. Houses with sidewall curtains are especially prone to air leakage, or infiltration. Patching cracks, tightening up curtain straps, fixing ceiling holes, ensuring good overlap of curtains on the sidewall are things we can do, and should be doing at this time of year. Successful cold weather ventilation requires a tight house.

Test results show closing off shutters on fans not in use is well worth doing

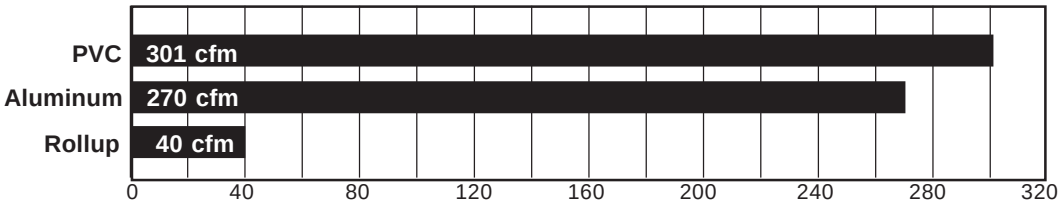
The next step is to deal with the fan shutters. First, make sure all shutters are clean and operating normally. Remember, the tests reported above were performed on new, clean shutters operating as designed. Defective fan shutters, or shutters that have been allowed to get so dirty they won't close properly, will cause

even worse problems. Second, close off shutters on fans that are not being used. The critical period is the first few weeks of a growout during cold weather, when birds are small and the tunnel fans will not be turned on. Some growers have cut insulation board to put over shutters of fans that are not being used. Others have used plywood, or just taped plastic over the shutters. Covering unused fan shutters is inconvenient – but it is obviously worth taking the time and trouble to do.

New shutters allowing very little air leakage are coming onto the market

The infiltration factor certainly should be taken into account whenever you are buying new or replacement shutters. Several manufacturers are working on better-sealing shutters. One of these, a roll-up type shutter, was tested in the same lab setup used for the louvered shutter tests and found to allow far less air leakage. Initial cost is slightly higher, and the product has been in the field only about a year, but this device certainly shows promise. The figure below shows graphically how much less leakage the roll-up allowed as compared to the louvered shutters tested, at 0.08 static pressure. Heat loss and dollar cost figures are calculated in the same way as in the table on page 2.

Tested air infiltration through closed shutters at 0.08 static pressure (cfm)



Heat losses: 13,651 Btu/hr for PVC
12,240 Btu/hr for Aluminum
1,814 Btu/hr for Rollup

Dollar costs: $5.24/day for PVC
$4.70/day for Aluminum
$0.69/day for Rollup

Summing Up the Situation

Air leakage through closed tunnel-fan shutters raises fuel cost, hurts bird performance

Any air infiltration from unplanned openings can disrupt minimum ventilation in cold weather. We now have data showing the amounts of air flowing through closed shutters of tunnel fans. The resulting heat loss and uneven temperature distribution in the house affects both fuel costs and bird performance. Heating fuel costs are a direct out of pocket expense to most poultry growers, so saving a dollar in fuel puts a dollar in a grower's pocket if bird performance does not suffer. The test information presented here shows that the dollar cost of heat losses due to air infiltration through closed fan shutters during cold weather is not pocket change on most modern broiler farms.

What to do – close off leaky shutters now, look for better-sealing shutters down the road

Cutting fan-shutter air infiltration should give even greater income-dollar benefits by improving performance. Our minimum-ventilation/tunnel-ventilation house setup is excellent and is paying off; but we do need to take steps to stop air leakage through our currently-installed shutters; and carefully evaluate the cost-effectiveness of better-sealing shutters as they become available. Further testing of both older and new type shutters is under way to document the effects of closed-shutter air infiltration on house temperature and uniformity.