The University of Georgia
Cooperative Extension Service
College of Agricultural and Environmental Science/Athens, Georgia 30602-4356

Poultry Housing Tips

Attic Inlets...Cold Weather Performance in 50' Wide, Totally-Enclosed Houses

Volume 19 Number 5 **April, 2007**

Figure 1. Framing for attic inlet with insulation guard installed.

As discussed in last month's *Poultry Housing Tips*, an inlet that draws air from the attic space of a dropped ceiling house during cold weather has a number of potential advantages over traditional side wall inlets. The most valuable of which is that attic temperatures are often significantly higher than outside temperatures even during cold weather. By drawing in preheated air from the attic space, ventilation rates should be able to be increased, leading to improved air quality, drier litter and possibly lower heating costs. The key word here is "should". There are still many questions yet to be answered before we know whether or not attic inlets are a cost effective option for the typical broiler house.

To explore the possible advantages and disadvantages of using attic inlets during cold weather, extension engineers and poultry scientists at the University of Georgia are conducting studies on an attic inlet used by the swine industry for years on three different broiler farms. The counter-weighted ceiling inlet (Double L TJ4200[*]) directs air, drawn in from the attic by exhaust fans, in four different directions along the ceiling. The inlet begins to open at a static pressure of approximately 0.04" and is fully opened at a static pressure of 0.12", delivering approximately 1,800 cubic feet of fresh air per minute.

Two of the farms where the counter-weighted attic inlets are presently being tested have three 50' X 560' houses while a third has six 40' X 500' houses. The 50' X 560' houses were of particular interest due to their relatively large attic spaces (over 75,000 ft^3). The large attic space acts as a huge reservoir of hot air that can be used to ventilate the birds during cold weather. Secondly, it was hoped that the attic inlets would do a better job of uniformly distributing fresh air during cold weather, which can sometimes be a challenge in wider houses.

On the first study farm, a single 50' X 560' house was equipped with 13 counter-weighted attic inlets. Though initial results looked very promising, it was decided to increase the number of attic inlets on the second study farm to 16 to help maximize the amount heated air that could be drawn from the attic. On the second farm the counter-weighted attic inlets were evenly spaced down the length of the house and placed approximately five feet from the centerline of the house in a staggered configuration. The five-foot offset from the center line of the house was necessary in part to avoid cables supporting feeders and drinkers in the center of the house but also to prevent circulation fans positioned down the center of the house from blowing directly over the attic inlets possibly disturbing the flow of the air from the attic inlets. The 16 attic inlets provided sufficient opening to allow four 36" fans to be operated without static pressure becoming excessive (0.11"). Both the test and the control house had 90 standard (48" X 6") galvanized side wall inlets installed near the top of the side wall.

All three houses on the study farm were equipped with a modern electronic environmental controller (Choretime Choretronics 2). All the houses had six internal temperature sensors and a humidity sensor. The test house with the attic inlets was also equipped with an outside temperature sensor and one attic temperature sensor. The controllers were connected to a computer on the farm to facilitate data collection.

This particular newsletter will primarily cover our findings in the 50' X 560' house equipped with 16 attic inlets.

House Setup and Attic Inlet Operation:
Birds in both the test and control houses were brooded in the center of the house for the first 12 days then turned out into the entire house for the remainder of the growout. In the test house the attic inlets on the nonbrooding ends of the house were closed during brooding, except for the first attic inlet in both the nonbrooding ends nearest the brooding curtain. One 36" fan on each end of the house for minimum ventilation, thus pulling air from the brooding area into each of the nonbrooding ends of the house. Once the birds were turned out into the full house, all the attic inlets were opened and three 36" fans were used for minimum ventilation. This was either two in the tunnel curtain end wall and one in the tunnel fan end wall or one in each of the end walls and one located in the center of the house.

The static pressure setting on the environmental controller was set to maintain a static pressure between 0.10 and 0.12". This setting was high enough so that the side wall inlets did not open during “minimum ventilation.” If the temperature increased sufficiently to cause more than four 36" fans to operate the pressure would increase to above 0.12" and the side wall inlets would begin to open. To get the side wall inlets to open what was felt to be the proper amount, approximately 1 ½", the controllers static pressure settings were automatically decreased to 0.08" to 0.10" when the fifth 36" fan came on (secondary static pressure setting).

The static pressure when center brooding with all but one of the attic inlets closed on the nonbrooding ends, and two 36" fans were operating, typically ran approximately 0.09". When in full house with all the attic inlets open and three fans operating the static pressure again ran approximately 0.09". With four fans operating the static pressure increased to approximately 0.11"

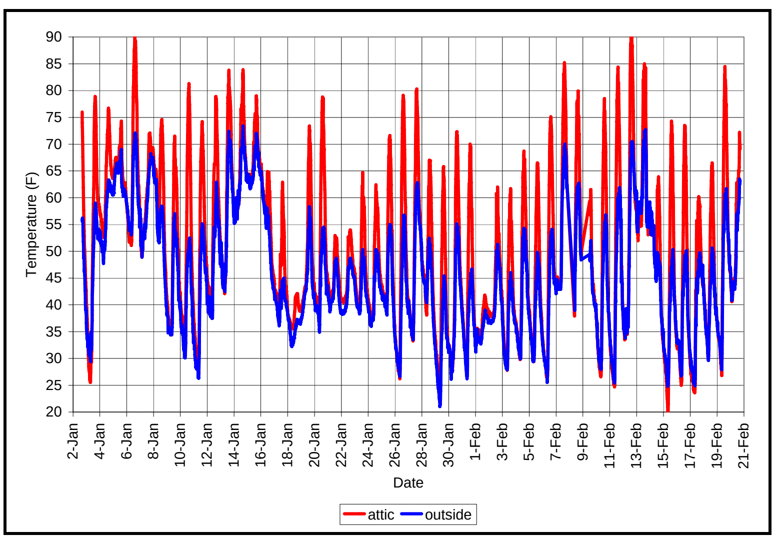

Figure 2. Outside and Attic Temperatures.

The environmental controller was equipped with a feature that automatically and incrementally increased minimum ventilation settings if the house temperature exceeded the house set temperature by 0.1°F degrees. This was found to be a very useful feature in the house with attic inlets. As the house began to warm up during the day, the timer increased, which made greater use of the hot air in the attic.

Results:
The primary difference between the test house equipped with attic inlets and the control house using standard side wall inlets was that during the day, ventilation rates tended to be significantly higher in the treatment house than in the control house. The higher ventilation rates led to lower house humidity levels which in turn resulted in drier litter and lower ammonia concentrations.

Attic and Outside Temperatures:
Outside temperatures during the study were fairly typical for January and February in North Georgia. Temperatures ranged from a daytime high of 70°F to a nighttime low of 20°F during the 52-day flock, with a good mixture of sunny and cloudy days. Attic temperatures ranged from between 5°F and 25°F above outside air temperature during the day, while at night the difference was typically less than 5°F (Figure 2).

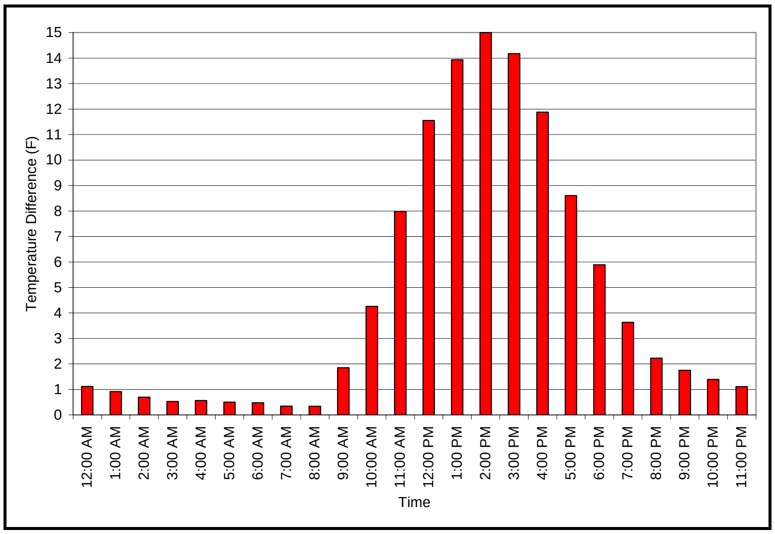

Figure 3. Average difference between attic and outside temperature for the entire 52 day flock.

Figure 3 shows the average difference between outside and attic temperatures for the entire flock. As expected, their was little difference between attic and outside air temperatures at night (less than 2°F). During the day, the sun produced significant heating of the air in the attic typically increasing attic temperature to an average peak of 15 degrees above outside air temperature in the early afternoon. The attic was five degrees or more warmer than outside air temperature for approximately ten hours a day, with an average daylight temperature difference of ten degrees

Air quality:
Though minimum ventilation settings on both the test and control houses were kept fairly similar, throughout the flock actual ventilation rates varied significantly. At night when the temperature of air coming out of the attic was about the same as outside air temperature, ventilation rates were very similar between the two houses. But, in the morning things began to change. As the air in the attic space began to warm up, house temperature dropped less and less each time the timer fans came on in the house with attic inlets. Eventually, the house temperature didn't drop when the timer fans came on and house temperature began to rise. As soon as the house temperature rose 0.1°F above the target, the controller started to automatically increase timer settings. The more the house heated up, the more the timer settings increased until the point where the minimum ventilation fans operated constantly.

The fact is that in both houses as house temperature rose during the day the timer fans settings would increase and eventually the timer fans would operate constantly. The difference was that in the house with attic inlets this happened much earlier in the day. For instance, in the house with attic inlets the timer fan could be operating constantly by 10 am but in the house using side wall inlets this may not have occurred until 1pm or later. In the afternoon when the minimum ventilation fans were operating constantly in the house using side wall inlets, in the house with attic inlets not only were the timer fans operating constantly, but an additional 36" fan or two would often be operating as well.

The increased daytime ventilation rates lead to significantly lower humidity levels in the house with the attic inlets (Figures 4 and 5). Daytime humidity in the attic inlet house ran between 5% and 20% lower than in the house using side wall inlets. The lower humidity levels were due to two factors: higher ventilation rates and the fact that air entering through attic inlets had a lower relative humidity than the outside air. For every 20°F air is heated, its moisture-holding ability is doubled and therefore the relative humidity of the air is cut in half. So, if the outside relative humidity was 50% and the air in the attic was 20°F warmer than outside air, the relative humidity of the air coming from the attic would be reduced to 25%. The combination of higher ventilation rates and lower humidity air coming from the attic resulted in significantly lower daytime humidity levels during the day, which in turn resulted in increased litter drying and lower ammonia levels.

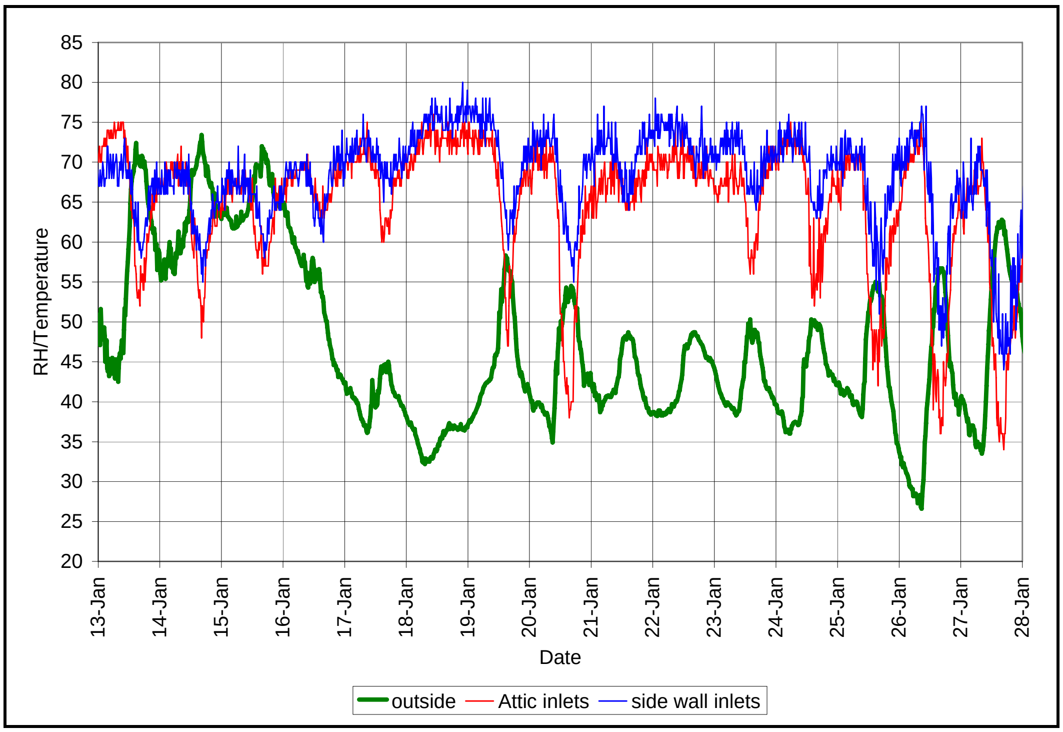

Figure 4. Relative humidity inside test and control houses and outside air temperature (Days 15-30)

An interesting effect of the attic inlets was that not only was the relative humidity lower during the day but at night and even on rainy days as well. At first this might seem impossible considering the fact that at night or on rainy days the air coming out of the attic was not significantly warmer or drier than outside air, but in fact it was true. Higher ventilation rates during the day lead to drier litter, which tends to add less moisture to the air than does damp litter. At night, when ventilation rates decreased, since there was less moisture being put into the air by the drier litter, the relative humidity tended to be lower. The same thing would happen on rainy days. Since there was less moisture in the litter, even on the rainy days, the humidity tended to run a little lower in the house with attic inlets. Though the difference in nighttime relative humidity between the houses using attic versus side wall inlets was typically 5%, or less the difference in air quality was still noticeable to the producer.

It is important to note that there were minimum differences in air quality between the study and control houses during the first 10 days of the flock. During this time, the minimum ventilation fans were typically only operating 30 seconds out of five minutes due to the fact that the houses had fresh litter. The minimal fan run time did not take full advantage of the fact that the fresh air in the attic inlet house was significantly warmer. That being said, it was observed on this farm as well as the second 50' wide test farm that on those days when the outside temperature was above 70°F and young chicks were present, there were significant differences in ventilation rates between attic and side wall inlet houses, which resulted in significant differences in the house humidity levels. The problem of course is that 70°F days are fairly rare during cold weather flocks.

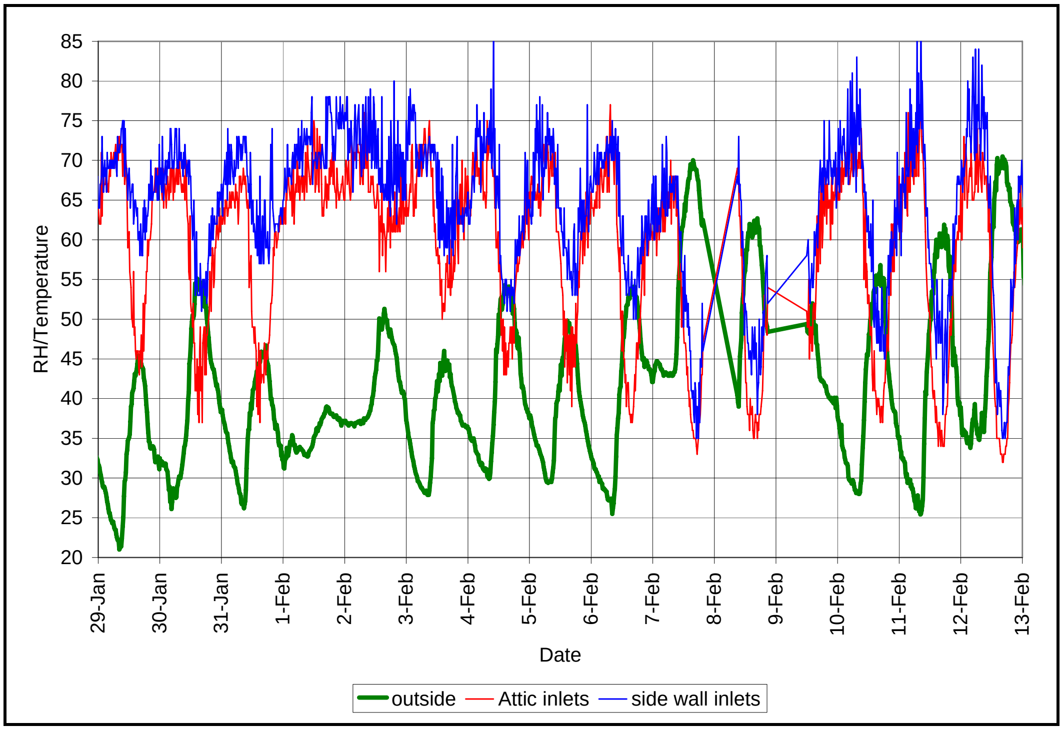

Figure 5. Relative humidity inside test and control houses and outside air temperature (Day 31-46).

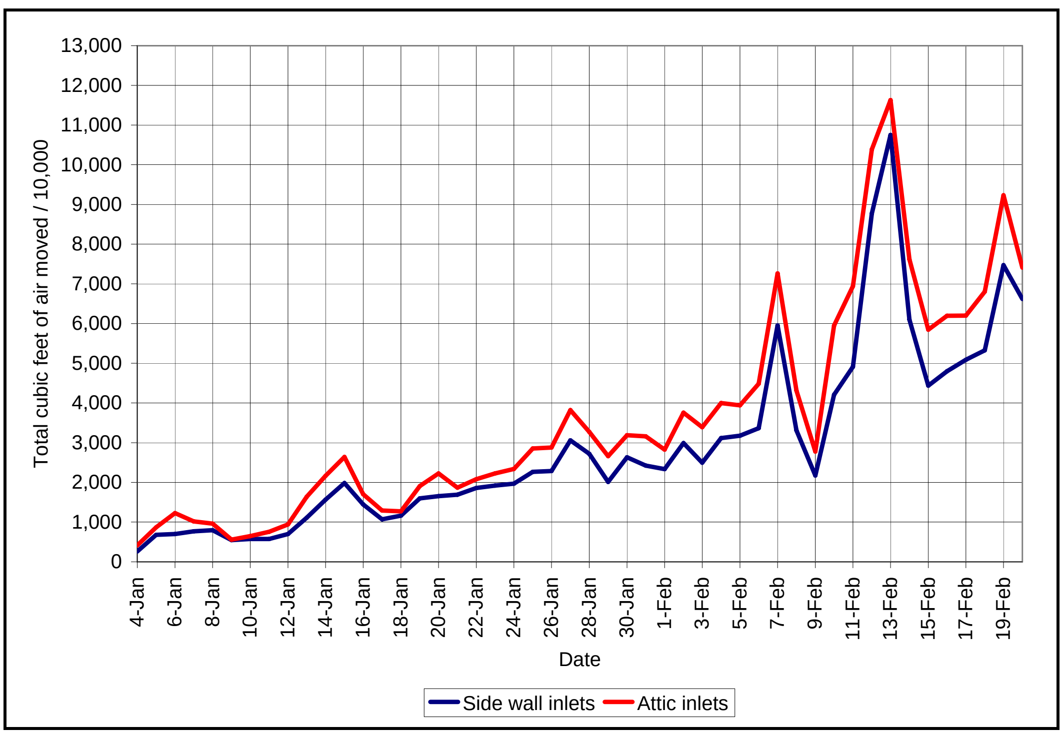

Figure 6. Daily total air moved in test and control houses (Days 6 - 52)

Ventilation Rates:

The houses' electronic environmental controller kept up with how many hours all of the exhaust fans ran each day which made it possible to determine the total amount of fresh air brought into the test and control house each day throughout the flock (Figure 6). The total amount of air moved through the house with attic inlets each day was between 10% and 30% higher than in the house using side wall inlets. As you would expect, the biggest difference in ventilation rates occurred during daylight hours where ventilation rates in the house with attic inlets was often 50 to 100% higher than in the house utilizing side wall inlets. A similar difference in daily ventilation rates was observed on the first study farm where the 50' X 560' house was equipped with 13 attic inlets.

Electricity Usage:

Though ventilation rates were higher in the house with attic inlets, it did not result in a substantial increase in electricity costs. The fact is that exhaust fan runtime during cold weather is relatively minimal when compared to summertime runtime. So even though the fans ran on average 20% more, the actual power usage of the fans was so little that a 20% increase in power usage was fairly insignificant (Figure 7).

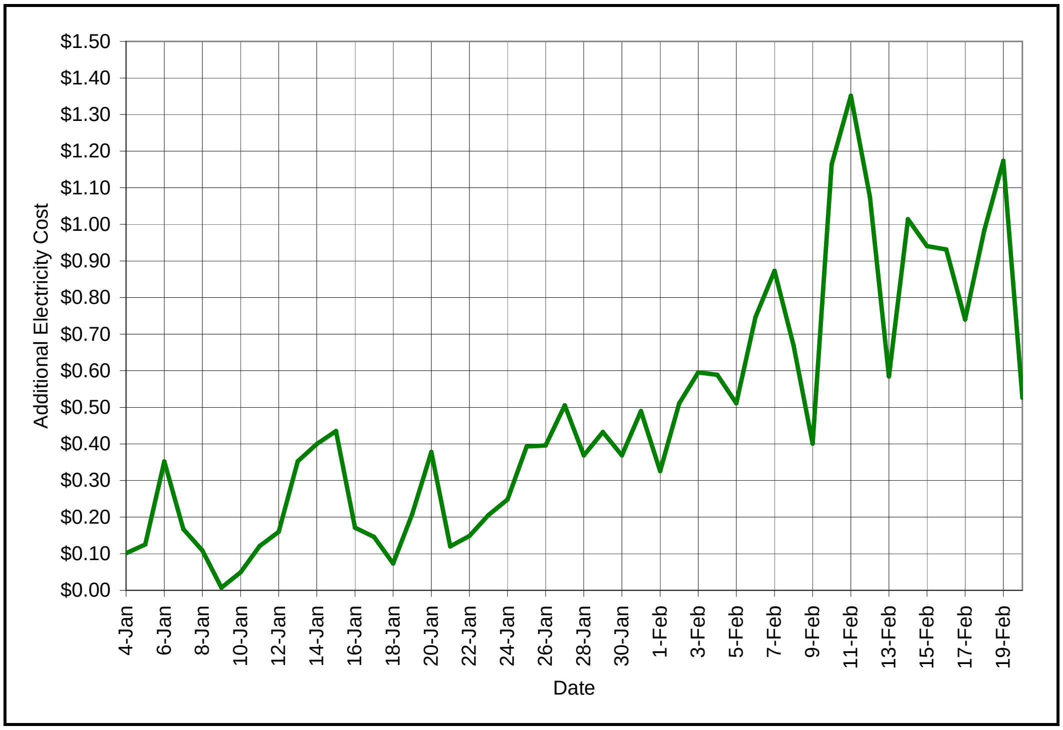

Figure 7. Additional cost of electricity used in house with attic inlets.

House Temperature:

Average house temperatures in the control and test houses were very similar over the course of the flock (Figure 8). During the day the house with the attic inlets typically ran a degree or two warmer than the house using side wall inlets, which was never viewed by the producer as a problem. It is important to note that though the attic inlets were left operating for the entire flock they did not lead to problems with excessive house temperatures on warmer days with older birds when the objective was to cool the birds. This was due to the fact that the amount of air that could enter through the attic inlets was relatively minimal when compared to what could enter through the houses side wall inlets. Specifically, the maximum amount of air that could enter through the houses 16 attic inlets is approximately 29,000 cfm, which seems like a lot, but when compared to the side wall inlets capacity of 130,000 cfm is less than 20%. Furthermore, what generally was happening was that the slightly higher house temperatures in the house with attic inlets caused more fans to run, which in turn resulted in more air movement, which in turn resulted in a lower effective air temperature. At no time did the producer feel that the attic inlets were causing harmful environmental conditions. That being said, it would be advisable to close the attic inlets during summertime when maximum cooling is the goal.

Litter conditions:

The producers on both 50' X 560' study farms commented on the fact that not only was the air quality better in the houses with the attic inlets but there was also significantly less litter caking. Had the farms caked-out between flocks, the amount of cake could have been documented. But, both producers are on a program of cleaning out after every flock, making it very difficult to quantify the amount of litter caking in the treatment and control houses.

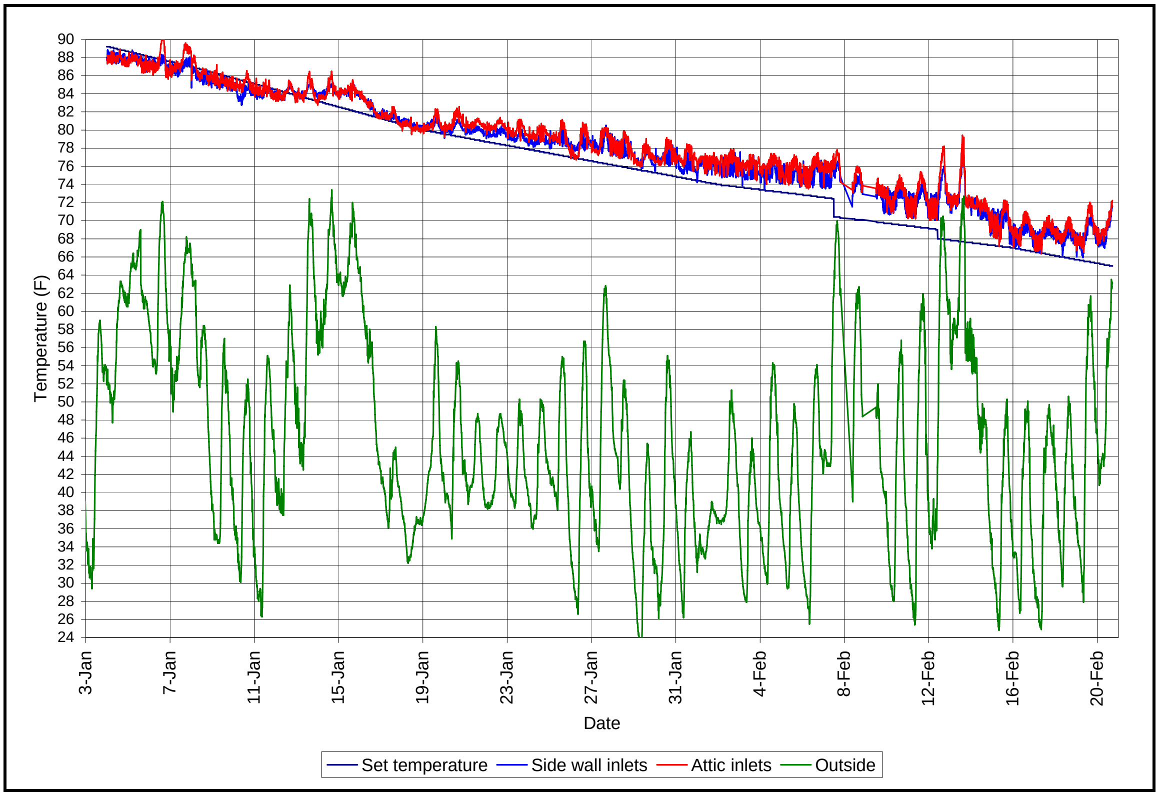

Figure 8. Average house temperature and outside temperature (Days 6 - 52)

Fuel Usage:
Though the house with the attic inlet used significantly less fuel (25%), there was also a difference in the number of circulation fans between the treatment and control houses. This made it difficult to determine how much of the fuel savings were attributable to the attic inlets and how much was due to the fact that the house with attic inlets had a total of eight 1/15 hp circulation fans while the side wall inlet house had only six. Plans have been made to install additional circulation fans in the control house so that potential fuel savings can be accurately documented.

It is important to note that though it is difficult to measure, there was a substantial difference in "effective" fuel usage. That is, had the producer increased ventilation rates during the day in the house with side wall inlets to match those seen in the house with attic inlets, the difference in fuel usage between the two houses would have been dramatically greater.

Inlet Machine Operation:
The attic inlets were the only inlets that opened and closed during timer fan operation which dramatically reduced the work load of the house's inlet machine. In fact, for the first couple weeks of the flock studied, the attic inlet house's inlet machine did not operate at all, where in the control house the inlet machine opened and closed the side wall inlets over 3,000 times. This should not only increase inlet machine life, but reduce incidences of inlet cables breaking as well as time spent adjusting side wall inlet openings.

Costs:
The cost of 16 attic inlets (TJ4200), shipping, and installation was a little less than $1,800. Had the inlets been installed when the house was originally built, the total cost would have probably been closer to $1,200.

Disadvantages:
There have been minimal problems with attic inlets. One downside of the counter-weighted attic inlets is that they do need to be manually closed when you don't want air to enter through them when either partial house brooding or during hot weather. Though at times it may require a ladder often the inlets can typically be closed using a stick with a hook on the end and reaching up and closing or opening the deflector above the counter-weighted inlet door. Another

potential downside of a counter-weighted attic inlet is that they can collect a fair amount of dust over the course of a flock. If left uncleaned for multiple flocks the accumulation of dust could affect the performance of the attic inlets and as a result they should be dusted off after ever flock.

Conclusions:

Though testing still continues the benefits of installing attic inlets in a totally enclosed 50' wide house appear clear: higher ventilation rates can be maintained during cold weather without sacrificing house temperature or fuel usage resulting in improved air quality and reduced litter caking. How the inlets perform during more mild times of the year, possible benefits of using attic inlets between flocks to help draw off moisture and ammonia from built-up litter, as well as their use in traditional 40' wide houses will be addressed in future *Poultry Housing Tips*.

Michael Czarick
Extension Engineer
(706) 542-9041   542-1886 (FAX)
mczarick@engr.uga.edu
www.poultryventilation.com

Brian Fairchild
Extension Poultry Scientist
(706) 542-9133
brianf@uga.edu

Color copies of the newsletters as well as others can be downloaded from www.poultryventilation.com

To receive Poultry Housing Tips via email contact us at mczarick@engr.uga.edu