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Poultry Housing Tips

Using Polyurethane Foam Insulation to Totally Enclose Curtain-Sided Houses

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By far the most effective method of reducing the cost of heating a curtain-sided house is to convert it to a totally enclosed house. Side wall curtains have a very low insulation R-value, approximately 1.5 F^o*ft^2 /Btu's/hr, and as a result are typically responsible for more than 25% of the heat loss from a poultry house during cold weather. Furthermore, side wall curtains are the number one source of air leakage in curtain-sided houses further contributing to a house's heat loss. When a curtain-sided house is converted to a totally-enclosed house the increased level of side wall insulation and house tightness typically results in a fuel savings of between 30 and 50%. Bird performance also tends to increase when a curtain-sided house is enclosed due to the fact that house temperature and air quality are easier to control.

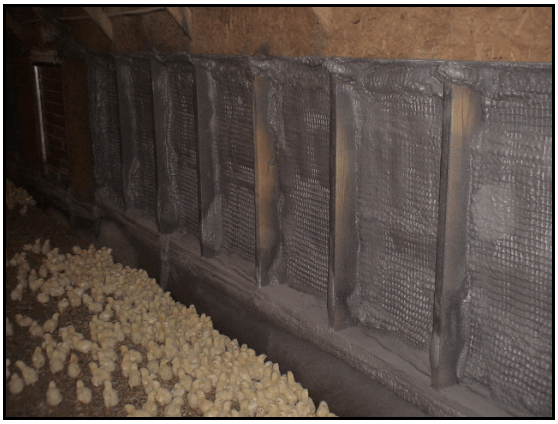

Figure 1. Curtain sprayed with polyurethane insulation

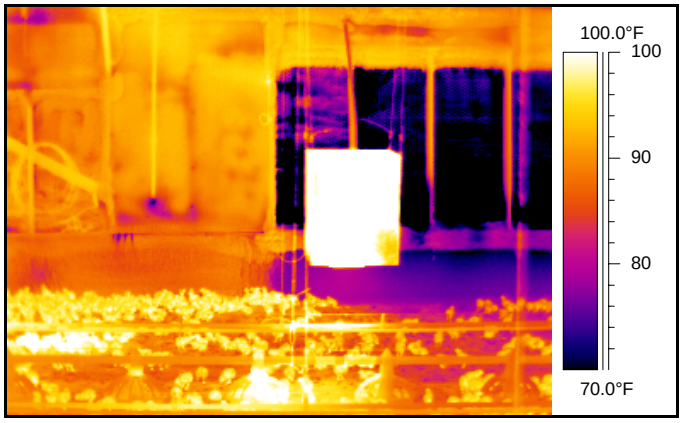

Figure 2. Side wall sprayed with polyurethane insulation next to uninsulated tunnel curtain.

The question of course is what is the best way to totally enclose a curtain-sided house. The answer to this question depends on side wall construction, cost of various building supplies and insulation materials, amount of labor required, house location, as well as other factors. One method of totally enclosing curtain-sided houses that has been gaining popularity is to spray the side wall curtains with closed cell polyurethane foam. With this method of insulation the side wall curtains are nailed closed and exhaust fans turned on to create high static pressure pulling the curtains tight up against the side wall. Professional applicators spray the side wall curtains with a mixture of chemicals that when exposed to the air quickly expands. The closed cell polyurethane foam is very sticky when first applied so it forms a tight bond to curtains and side walls. Over the course of a few minutes the polyurethane hardens to a density similar to traditional "blue/pink" polystyrene insulation board of approximately 2 lbs/ft^3, but with a slightly harder surface. Typically an inch to an inch and a half of polyurethane insulation is applied to the curtains providing an R-value of between 5 and 7 F^o*ft^2 /Btu's/hr.

One of the most significant advantages of spray polyurethane insulation over other insulation materials is that not only does the side wall become better insulated, but air leakage is virtually eliminated. Often when the side walls are insulated with other insulation materials cracks and crevices remain. Though on the surface this often does not appear significant, due to the size of the side walls in a poultry house small cracks can quickly add up to be a big problem. For instance just a couple of 1/16" cracks that run the length of both sides of a poultry house can add up to more than ten square feet of opening. Ten square feet of opening is the same as six side wall inlets when opened fully. When properly applied spray polyurethane insulation eliminates all cracks in the side wall. As a result, numerous growers have reported a static pressure increase of 10 to 15 points when tested after applying polyurethane insulation to their curtains. A change of this magnitude typically indicates that leakage has been reduced by 75% or more which can reduce heating costs significantly.

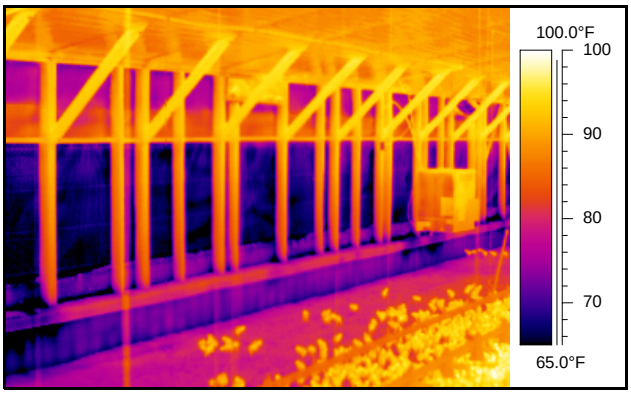

Figure 3. Curtain side wall on a cold morning.

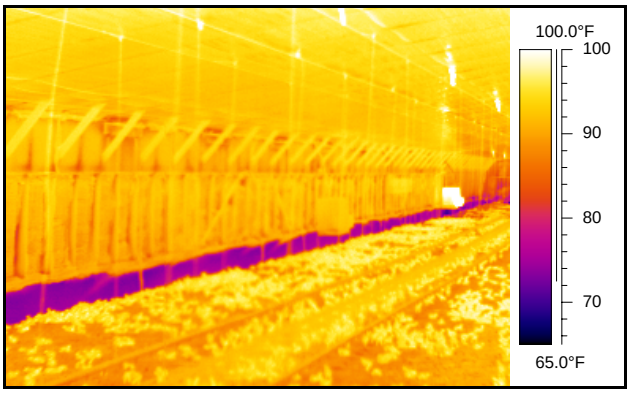

Figure 4. Curtain sprayed with polyurethane insulation on a cold morning.

Figures 3 and 4 are thermal images taken in two similarly constructed broiler houses on a morning when outside temperature was below freezing. The biggest difference between the two houses is that polyurethane insulation was applied to the curtains in the Figure 4 house. The cold curtains in Figure 3 are a strong indicator of significant heat loss through the curtain. The cold floor temperature near the curtains in the house in Figure 3 was a result of not only leakage from the curtain but radiant heat loss from the floor as heat from the floor is lost to the curtain (This is the reverse of what happens during hot weather when hot curtains radiate heat to the floor next to the side wall). Thermal images indicated that sidewall temperatures were on average 30 degrees warmer in the house where the curtains were insulated with the polyurethane insulation. The higher insulation value and increased tightness resulted in ten degree higher floor temperatures near the side wall.

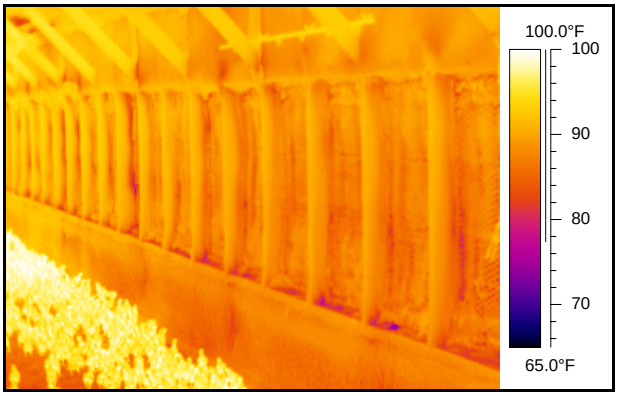

Figure 5. Curtain and concrete block sprayed with polyurethane insulation

In another house on the farm the concrete stem wall was also sprayed with polyurethane foam insulation (Figure 5). As mentioned previously most polyurethane foams have a density of approximately 2 lbs/ft^3. Though this density appears appropriate for most applications it is not hard enough for surfaces that the birds come in contact with. The concrete stem walls on the test farm were sprayed with either 5 or 10 lb/ft^3 polyurethane foam. Though the 5 lb/ft^3 foam did appear prone to bird damage, the 10 lb/ft^3 has to date held up fairly well though has shown some small signs of bird

damage (Figure 7). There were problems with the polyurethane bonding to the concrete stem walls. Over the course of the winter there were places where the polyurethane came off in large pieces. The problem was significantly worse where the concrete was insulated with the 5 lb/ft^3 polyurethane insulation. This bonding problem could have been related to poor preparation of the concrete prior to application or beetles burrowing behind the 5 lb/ft^3 insulation. In the areas of the house where the 2 lb/ft^3 foam was sprayed close enough to the ground that the birds could reach it, the birds destroyed it within a few months (Figure 6). It doesn't appear from the observations on this as well as other farms that spray polyurethane insulation is suited for insulating concrete stem walls.

Figure 6. Bird damage to 2 lb/ft^3 polyurethane insulation

Figure 7. Very little bird damage to 10 lb/ft^3 polystyrene insulation applied to concrete stem wall.

Figure 5 depicts the house where both the curtain and the concrete stem wall was sprayed with polyurethane foam. From the thermal images it is clear that there is very little heat loss from the wall and leakage has been totally eliminated. With the concrete footer insulated, floor temperatures were slightly warmer next to the side wall than they were in the house where the concrete was not insulated. The biggest advantage of insulating the concrete was that the problem of condensation forming on the concrete during cold weather was eliminated.

The reduction in air leakage significantly improved the performance of the house's inlet ventilation system. The lack of leakage can be seen in Figure 8 where the only fresh air entering the house when the fans come on is through the air inlets at the top of the ceiling.

The producer noted that his fuel usage this past winter was approximately half of what he used the previous winter even though this past winter was a colder winter. He also noted that his fuel usage was approximately half that of his neighbors with similar curtain-sided houses who had chicks placed at the same time. Bird performance has improved significantly since the conversion which the producer attributes to improved environmental control.

Figure 8. Air entering through inlets in a house where the curtain was sprayed with polyurethane insulation.

As with any insulation product there are potential problems. First, and most importantly, spray polyurethane insulation is prone to damage by darkling beetles. The amount of damage done depends on a variety of factors, but primarily the beetle population. On the farm in the images above there was in fact very little evidence of beetle damage six months after the insulation was applied. For the most part, darkling beetle damage was limited to a few small burrowing holes which tended to be more prevalent near the floor (Figure 9). Darkling beetle damage was exacerbated in areas where the birds had access to the insulation and had pecked away the insulation's harder surface exposing the softer insulation underneath (Figure 10). It has also been observed on this and other farms that beetles often tend to burrow into the insulation from edges or even from the back of the insulation where it softer.

Though the beetle damage was minimal on the test farm it is important to note that on some farms there has been severe beetle damage after a period of only one year bringing to question on how good of a job it will do tightening and insulating a house in the long run. The primary reason for the relative lack of damage on this specific test farm was the fact that the producer cleaned out his houses every flock or every other flock. This is backed up by the fact that in many countries where houses are cleaned out every flock that spray polyurethane insulation has been used successfully for years with essentially no damage. It is crucial that producers who use spray polyurethane insulation are on a comprehensive beetle control program. The house must be treated for beetles every flock if damage to the spray foam insulation is to be kept to a minimum. If a producer can't control their beetles it is questionable if spray polyurethane insulation is the right choice for enclosing their curtain-sided houses.

Figure 9. Small holes caused by darkling beetles.

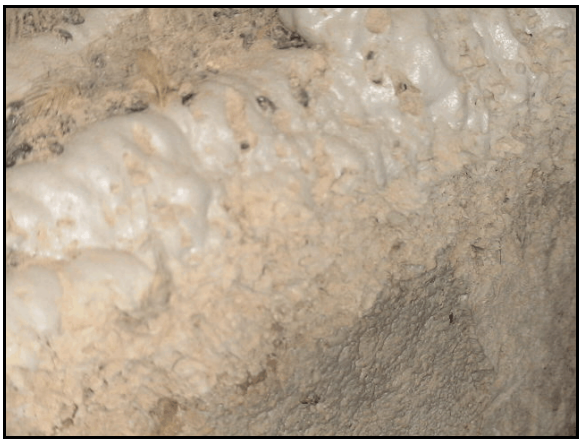

Figure 10. Bird and beetle damage where the crack between the concrete stem wall and plate was sealed using 2 lb/ft^3 foam.

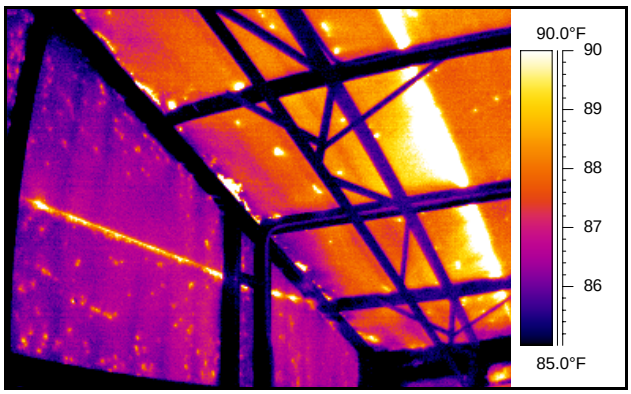

Figure 11. Thermal image of beetle damage of polystyrene board insulation (ceiling/end wall).

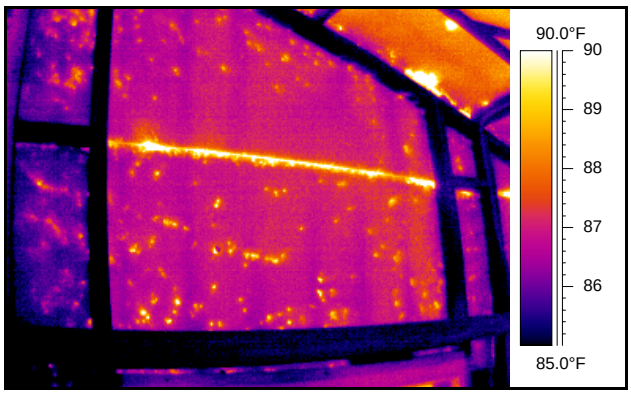

Figure 12. Thermal image of beetle damage of polystyrene board insulation (end wall).

Figure 13. Beetle damage of polystyrene insulation. Dark spots are holes where beetles have burrowed into the insulation.

Figure 14. New sill sealer.

It is important to realize virtually any form of insulation installed in the side walls is prone to damage by darkling beetles (Figure 13). For instance, the thermal images in Figures 11 and 12 are of the ceiling and end wall in a house insulated with polystyrene board insulation during the summertime. The light spots are areas of increased heat gain due to burrowing of darkling beetles in the insulation. The greatest amount of damage is typically done at the cracks between pieces of board insulation where beetles have access to the softer inner part of the board insulation. The thermal images also show one of the potential weakness of polystyrene board insulation, that if not installed properly there can be significant leakage of air from outside the house from cracks between insulation boards (Figure 11).

Fiberglass batt insulation is also prone to beetle damage but to a much lesser degree. Darkling beetles are known to destroy the paper backing which can allow the insulation to settle in the side wall. The damage does not to be as great for the most part because the beetles do not have easy access to the fiberglass in a stud wall as they do in the case of most applications of spray polyurethane or polystyrene insulation. Even the sill sealer used in most houses is prone to beetle damage (Figure 14). After a two year old house was blown down by a tornado it was discovered that 30% of the sill sealer was destroyed due to darkling beetles. Once the sill sealer is destroyed leakage at the sill plate can become a significant problem.

Another problem noted on the test farm was that the spray polyurethane was prone to damage from chunks of wood and rocks thrown by the shavings truck when fresh bedding was being added to the house. The small holes, though not significantly affecting heat loss did offer another avenue for the darkling beetles to have access to softer inner core of the spray polyurethane insulation.

To a large extent the issue of beetle damage and damage during the spreading of shavings could likely be eliminated by switching to a higher density foam. The concrete stem wall sprayed with the 5 and 10 lb/ft^3 foam did not show any signs of beetle damage on the test farm. The downside of using higher density foams is a significantly higher initial cost. Another possible solution is to spray the polyurethane insulation with some type of coating to make it harder for beetles to burrow into the insulation. This too would add cost but could significantly improve the life of the product in houses with high beetle populations.

One other challenge noted on the test farm was once the house was totally enclosed, tunnel curtain leakage was dramatically increased. Though not a problem exclusive to houses where the curtain is sprayed with polyurethane insulation the fact is that once a house is totally enclosed extra effort must be taken to insure that the house tunnel curtain seals tightly. In most curtain-sided houses the tunnel curtain is a problem area when it comes to leakage but

many times the magnitude of the problem is masked by the fact that the entire side wall is somewhat leaky. Once a house is totally enclosed side wall curtain leakage is eliminated throughout a house except for the tunnel curtain which magnifies the problem significantly (Figure 15 and 16).

The other area that must be tightened in order to obtain maximum benefit of totally enclosing a house is the brooding curtain. Like the tunnel curtain, leakage from the brooding curtain often goes unnoticed because of the large amount of leakage from the side wall curtains. Once leakage from the side wall curtains is eliminated by totally enclosing the house, brooding curtain leakage becomes more evident (Figure 17). For similar reasons it is also important to make sure side wall and tunnel fan shutters seal tightly (Figure 18).

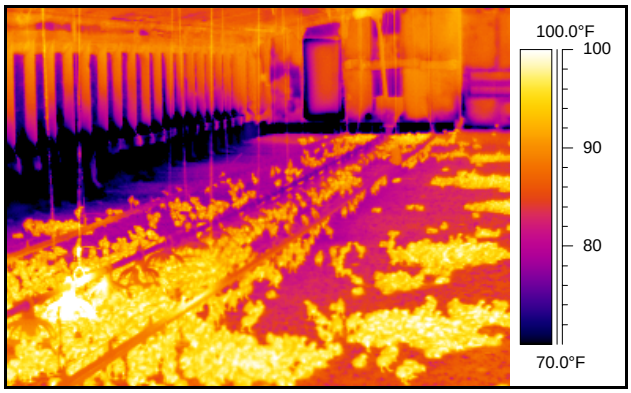

Figure 15. Cold floors due to tunnel curtain leakage.

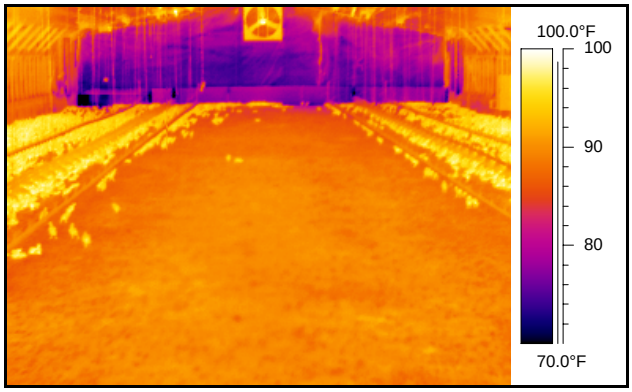

Figure 16. Warm floors in the center of the brooding area.

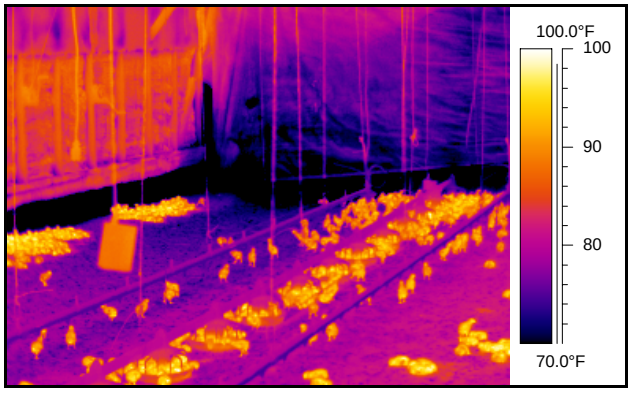

Figure 17. Leakage from brooding curtain.

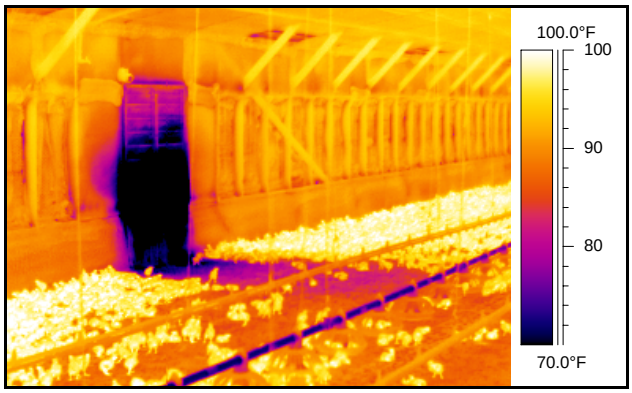

Figure 18. Leakage from poorly closing exhaust fan shutter.

One last point to be aware of when it comes to spraying side wall curtains with polyurethane insulation is that sunlight tends to degrade polyurethane insulation. Over time exposure to sunlight causes the surface of polyurethane insulation to become chalky and crack which results in a reduction in its insulating ability. Even though the polyurethane insulation forms a tight bond with the curtains initially, over time as the curtain degrades and the polyurethane insulation becomes exposed to sunlight, the bond may be compromised and the house may become looser and less insulated. For this reason, it is probably best that when spraying side wall curtains that producers plan for sometime in the future to cover the exterior side wall curtains with sheet metal.

Totally enclosing curtain-sided houses with spray polyurethane insulation is a viable option for many poultry producers. Costs for spraying a four foot curtain in a 500' house runs between $3,500 and $5,000. With propane prices well over a dollar a gallon many producers are finding they can pay for insulating their houses within a few years. The biggest question is how long the spray foam polyurethane insulation will last. If beetle populations are kept to a minimum, and

the insulation is protected from sunlight it is not unreasonable to expect a life as much as ten years. But if beetle populations are not controlled, a producer could be looking at a situation where a house may need to be re-insulated in as little as five years.

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