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Poultry Housing Tips

Reflective/Ceramic Roof Coatings

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The following are claims made by some of the companies selling reflective/ceramic roof coatings to poultry producers:

> "Reduction of outside (under the metal) temperatures by as much as 28°F with an average change in temperatures of 14°F"
>
> "Reduction of temperatures within the level of the growing environment of as much as 14°F during peak daytime periods of heat (usually noon to 3 P.M.), with average reductions measuring 10°F"
>
> "Reduction of energy consumption during the daylight hours by as much as 40%"
>
> "Tunnel fans run as much as 50% less frequently..."
>
> "...foggers get 8°F reduction instead of 3°F - 4°F"
>
> "...interior temperatures are reduced by 4°F - 8°F"

From these claims it seems that reflective/ceramic roof coatings are the answer to the poultry industry's hot weather related problems. But are they?

One of the most common misconceptions about poultry houses is that during hot weather most of the heat that causes heat stress enters the house through the ceiling. If you have ever been on the roof or in the attic of a poultry house on a summer day you can understand why people make this assumption. Studies have shown that metal roofs can get as hot as 160°F and attic temperature can easily exceed 130°F in the Southeast. So it stands to reason, a hot roof equals a hot house.

The fact of the matter is that under most circumstances the number one source of heat in a poultry house is the birds. As birds digest feed, heat is produced. The bigger the bird, the more feed it eats and the more heat it produces. A bird will produce about five Btu's of heat each hour for every pound of body weight. So a three pound bird will produce 15 Btu's of heat and a six pound bird will produce 30 Btu's of heat each hour. This may not seem like a lot of heat until you consider that there are usually close to 20,000 birds in a 40' X 400' house, bringing the total Btu's of heat produced each hour to 500,000 or more.

What about the ceiling? Well the truth is that if the ceiling is insulated, relatively little of the heat produced by the sun makes it into the house. Table 1. illustrates the amount of heat gained by a house through bird heat production and through the ceiling under different levels of insulation and different bird sizes on a typical summer day. As you would expect, the smaller the bird, the less heat produced, and the greater amount of ceiling insulation (higher R-value), the lower amount of heat which moves through the ceiling.

Bird Weight (lbs)	Bird Heat 19,000 birds (Btu's/hr)	Ceiling Heat Dropped Ceiling R-value = 21 (Btu's/hr)	Ceiling Heat Dropped Ceiling R-value = 12 (Btu's/hr)	Ceiling Heat Dropped Ceiling R-value = 6 (Btu's/hr)	Ceiling Heat Open Ceiling R-value = 7 (Btu's/hr)
3	285000	44000	77000	154000	190000
4	380000	44000	77000	154000	190000
5	475000	44000	77000	154000	190000
6	570000	44000	77000	154000	190000

Table 1. Heat produced by birds and heat entering through the ceiling (40' X 400' house)

Most poultry houses have a ceiling R-value of about a 12 (hr*ft^2*F/Btu's). Even with a relatively small bird (4 lbs.), the birds are producing five times the amount of heat which is coming through the ceiling. The heat produced by larger birds is often seven times the amount of heat which enters the house through the ceiling.

This is not to say that the ceiling heat does not have an effect on house temperature. It does. But, the effect is relatively small as compared to the heat produced by the birds.

Air entering a house is warmed by the heat produced by the birds and the heat coming through the ceiling. How much the air heats up is determined by the amount of heat produced in the house and how long the air stays in the house. Table 2. shows how much of an effect different bird sizes and insulation levels have on air temperature in a conventional curtain-sided house with a slight breeze blowing.

Bird Weight	Bird Heat 19,000 birds	Ceiling Heat Dropped Ceiling R-value = 21	Ceiling Heat Dropped Ceiling R-value = 12	Ceiling Heat Dropped Ceiling R-value = 6	Ceiling Heat Open Ceiling R-value = 7
3 lbs.	1.86 F	0.29 F	0.5 F	1 F	1.24 F
4	2.47	0.29	0.5	1	1.24
5	3.09	0.29	0.5	1	1.24
6	3.71	0.29	0.5	1	1.24

Table 2. House air temperature increase due to the addition of bird and ceiling heat (no roof coating - 160^{o}F metal temperature, 130^{o}F attic temperature)

If the breeze diminishes, the degree to which the ceiling heat causes the air temperature to rise would increase, but so would the bird heat. For instance, if the breeze were cut in half, ceiling heat in a house with five pound birds would cause house temperature to rise about 0.6^{o}F, and bird heat would increase the temperature of the air by about 6.2^{o}F over outdoor temperature.

But, what would happen if the roof/attic were cooler? Yes, the house would be cooler but by how much? Table 3 illustrates the effect of reducing metal roof temperatures from 160°F to 110°F. This is about the amount of temperature reduction produced by most of the reflective/ceramic roof coatings.

Bird Weight	Bird Heat 19,000 birds	Ceiling Heat Dropped Ceiling R-value = 21	Ceiling Heat Dropped Ceiling R-value = 12	Ceiling Heat Dropped Ceiling R-value = 6	Ceiling Heat Open Ceiling R-value = 7
3 lbs.	1.86 F	0.08 F	0.15 F	0.27 F	0.41 F
4	2.47	0.08	0.15	0.27	0.41
5	3.09	0.08	0.15	0.27	0.41
6	3.71	0.08	0.15	0.27	0.41

Table 3. House air temperature increase due to the addition of bird and ceiling heat (roof coating - 110°F metal temperature, 100°F attic temperature)

Even if we totally eliminated the heat entering the house through the ceiling, it would have only a minimal effect on house temperature, less than 2°F in most cases. This is because the ceiling insulation has already reduced the amount of heat flow from the attic by more than 90 percent.

What effect would a roof coating have on a house with poor ceiling insulation? From Table 1., if a drop-ceiling house had an R-value of 6 instead of a 12, heat entering the house through the poorly insulated ceiling would increase house temperature by about one degree. A painted roof would reduce this to about 0.27°F. The worse the ceiling insulation, the more effect painting the roof would have. The fact is that even in houses with poorly insulated ceilings, university field studies on reflective/ceramic roof coatings have shown reduction of house air temperature by at most a few degrees.

Where coating a roof would have the biggest effect would be in a house with holes in the insulation. In this case, hot air from the attic space could be drawn into the house by exhaust fans or even by circulation fans. This 130°F air could increase house temperature five degrees or more. If the roof was painted, the air would not be that hot in the attic, resulting in a significantly cooler house. But the question is, if you have holes in your ceiling, how much heat are you losing during cold weather. Table 4. estimates how much heat (gallons of propane) is lost through a ceiling during the first week of brooding in houses with different levels of insulation. As you can see, poor ceiling insulation can cost you more during cold weather than during hot weather. Painting the roof would do little good during cold weather. So, if you have problems with heat loss or gain through your ceiling, your money would be much better spent on reinsulating the ceiling rather than painting the roof.

Outside	Inside	Ceiling Heat Dropped Ceiling R-value = 21	Ceiling Heat Dropped Ceiling R-value = 12	Ceiling Heat Dropped Ceiling R-value = 6	Ceiling Heat Dropped Ceiling R-value = 6 (holes in ceiling)
30°F	90°F	45 gals.	78 gals.	156 gals.	216 gals.

Table 4. Ceiling heat loss during brooding

Though the numbers given in the above charts are theoretical, studies conducted on reflective/ceramic roof coating in agricultural structures by The University of Florida, North Carolina State University, and The University of Georgia have shown them to be fairly accurate. The following is an abstract of a paper written on the subject of reflective roof coatings for livestock and poultry housing by engineers at the universities mentioned above:

> *"A reflective roof coating was demonstrated to reduce temperatures by 3.6 to 5.4°F in totally enclosed poultry housing with no ventilation (or birds). However, similar results did not occur in studies of well-ventilated poultry and dairy housing. Reductions in roof temperatures of well-ventilated housing did occur, but similar reductions were not found in interior dry bulb or black globe temperatures at animal level and no production benefits resulted.*
>
> *Reflective roof coatings can reduce the temperature of galvanized steel roofing materials and the temperatures of enclosed attics. However, these coatings add expense to structures and their effectiveness drops rapidly with time as they weather and accumulate dirt. They are most beneficial for poorly-ventilated structures. For well-ventilated structures, they do not offer great benefits. The addition of reflective roof coatings will seldom be economically justified for well-ventilated livestock and poultry structures." (Bucklin, et al., 1993)*

This is not to say that there are no benefits to applying a reflective/ceramic coating to a roof. The coatings may increase the life of rusted roofs, seal nail holes in the metal, generally improve the appearance of your houses, and decrease house temperature during hot weather a degree or two. But, if you are looking to make big reductions in heat stress related problems, your money would be better spent replacing worn out insulation, adding stirring fans, or installing a high pressure fogging system.

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Dr. John Worley came aboard effective September 16, 1995 as an Extension Engineer. He will be working in the areas of farm structures and waste handling. John will be available to answer questions on poultry housing, including the structure, wiring, and manure handling. If you need help please give Dr. Worley a call.

Bucklin, R.A., R.W. Bottcher, G.L Van Wicklen, M. Czarick. 1993. Reflective Roof Coatings for Heat Stress Relief in Livestock and Poultry Housing. Applied Engineering In Agriculture. Volume 9. Number 1. Pages 123-129. American Society of Agriculture Engineers. St. Joseph, MI.