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Poultry Housing Tips

Temperature Stratification During Brooding

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Temperature stratification occurs during brooding due to the simple fact that hot air is lighter than cold air. Though we are all well aware of the existence of stratification, we often underestimate the amount of stratification in a house due to the simple fact that we cannot "see" air temperature. Of course we monitor house temperature through the use of thermometers and environmental controller sensors, but the fact is that they are often unintentionally positioned at a height that does not provide an accurate picture of what is happening at chick level or the ceiling for that matter.

One way to better understand how much of a problem temperature stratification can be during brooding is by studying images taken with a thermal imaging camera. Though thermal imaging cameras do not measure air temperature directly, they can measure the temperature of surfaces within a house which can be as useful as knowing air temperatures. For instance, Figure 1 was taken in an older broiler house heated with forced air furnaces on a cold morning. The forced air furnaces' thermostats were set to maintain an air temperature of 90°F. To anyone standing in the house it felt hot enough for the young chicks present, but the thermal image of the house painted quite a different picture.

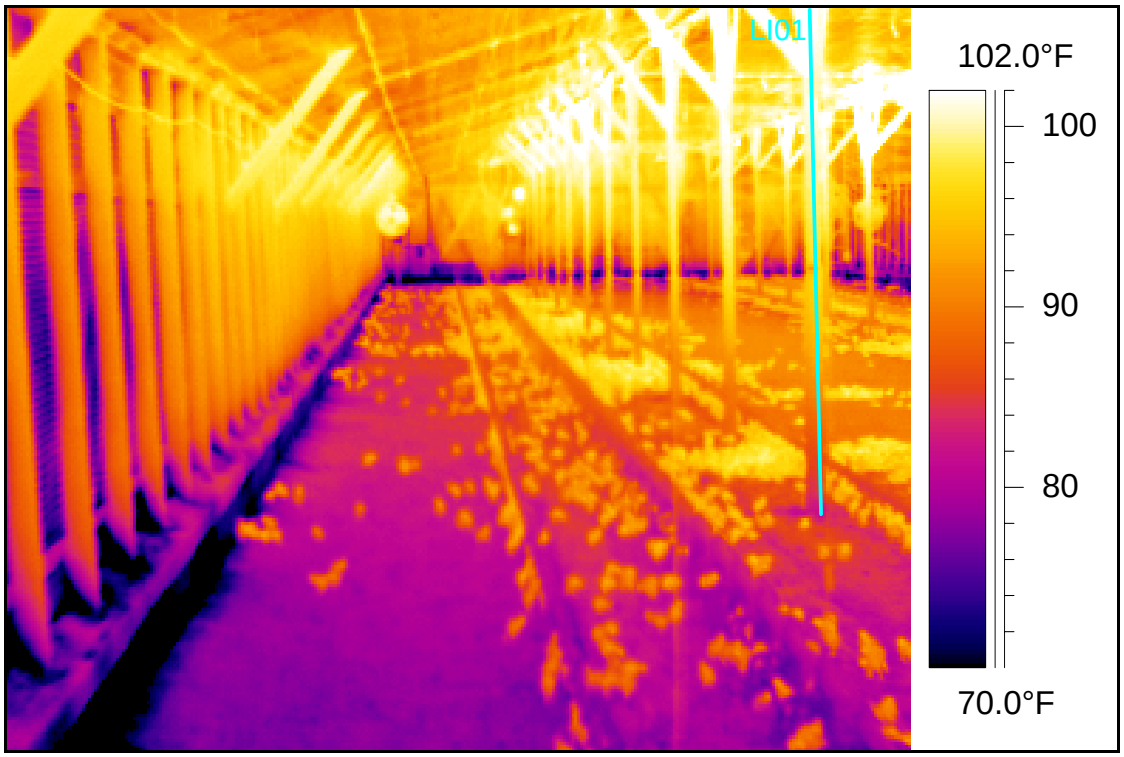

Figure 1. Thermal image of broiler house with young chicks.

PUTTING KNOWLEDGE TO WORK

From Figure 1 floor temperatures can be seen to range from the low eighties near the side wall, to the high eighties in the center of the house. The proof that the hot air produced by the forced air furnaces primarily accumulated at the ceiling can be clearly seen in a graph of the surface temperature of one of the posts in the house (Figure 2). Though the producer was trying to maintain a floor/air temperature of 90°F, the fact of the matter is the post temperature was approximately 82°F near the floor while at the ceiling it was over 100°F.

Though a twenty degree temperature difference between the floor and ceiling is problematic from a heating cost and chick performance standpoint, it also can have an adverse effect on air quality. For instance, for every 20°F increase in air temperature, the moisture-holding capacity of the air doubles. This means the air near the ceiling in Figure 1 can hold at least twice the amount of moisture as that near the floor. Having relatively dry air near the floor is essential in controlling litter moisture which, in turn, helps in combating ammonia. So not only is the hottest air far from the floor where it is most needed, so is the driest air.

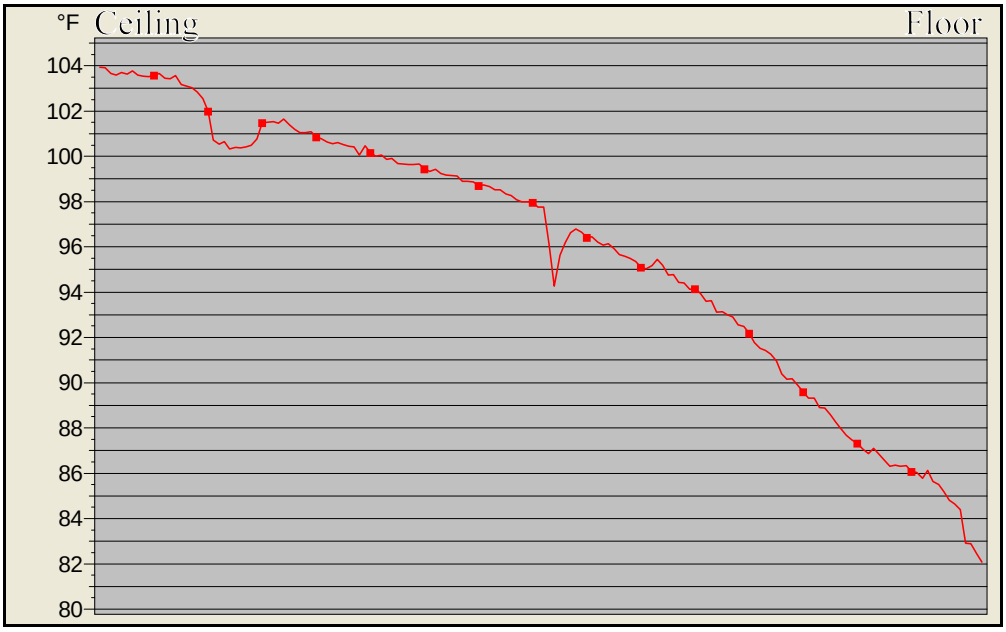

Figure 2. Graph of post temperature along blue line in Figure 1.

A point of clarification needs to be made pertaining to the apparent ceiling temperature in Figure 1. Though it appears that the ceiling is cooler than the top of the posts in Figure 1, in fact it wasn't. The truth is thermal imaging cameras, as well as infrared temperature "guns," have difficulty in accurately reading the surface temperature of reflective surfaces, which most dropped ceilings tend to be. What typically happens when trying to evaluate the surface temperature of a dropped ceiling with infrared devices is that you actually end up measuring a partial reflection of the floor, brooders, and/or sidewalls in the house and not the ceiling itself. The cleaner and more reflective the ceiling is the less accurate these devices tend to be. The good news is that since wood and litter are not reflective, a thermal imaging camera or infrared temperature gun can do a good job of accurately measuring their surface temperatures.

Figure 3 was taken in another dropped-ceiling house with young chicks heated by forced air furnaces. Again, it is quite clear that stratification is a problem. While the knee braces were over 100°F, the floor temperature, just eight feet below, was in the low eighties. The relatively low floor temperatures shown in these images are not as uncommon as you might think, especially in houses using forced air furnaces for brooding.

There are a couple of reasons why low floor temperatures often go unnoticed. First, quite simply, is that when we walk into a house we typically sense air temperature at head level, not floor level. In the case of the houses in Figures 1and 3, air temperature at head level was in fact in the mid nineties, thus giving the impression that proper brooding temperatures were being maintained. Figure 4 provides a clue as to the second most common cause of the low floor temperatures: heating system thermostat/sensor location. In order to control temperature at chick level

thermostats/sensors controlling the forced air furnaces need to be near the chicks. The thermostats controlling the furnaces in Figure 3 were approximately two and half feet above the floor (Figure 4). The producer had set the thermostats to maintain an air temperature of 90°F, which they were doing a good job of as indicated by the fact that the surface temperature of the thermostats was in fact 90°F. The problem was that there was more than a five degree drop in air temperature between the thermostats and the floor which is not that uncommon in houses with forced air furnaces (Figures 5 and 6).

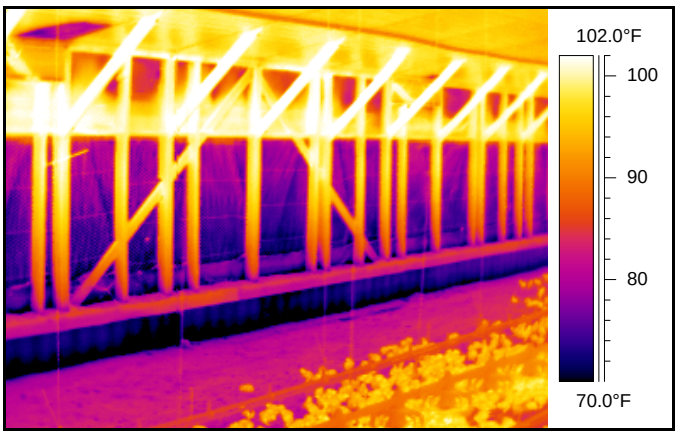

Figure 3. Thermal image of broiler house side wall during brooding.

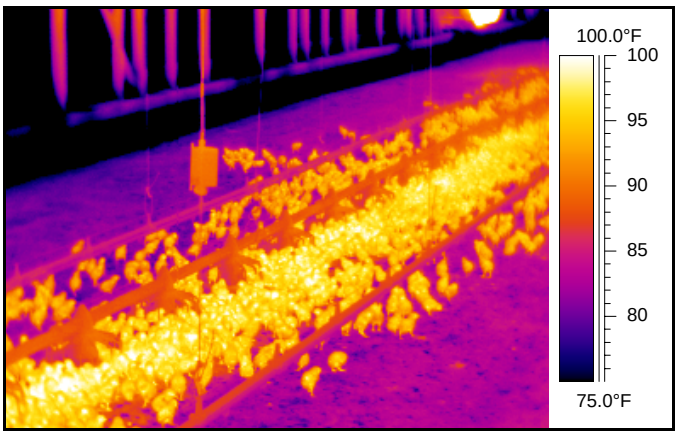

Figure 4. Thermal image of furnace thermostat.

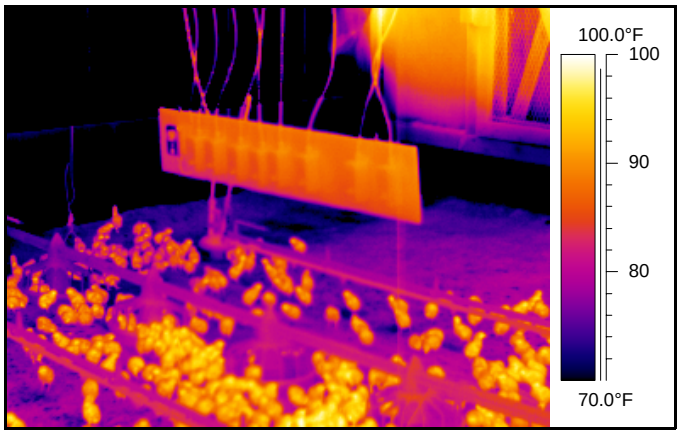

Figure 5. Back-up thermostats three feet above the floor near loose brooding curtain (back-up thermostats = 90°F, Floor 75°F).

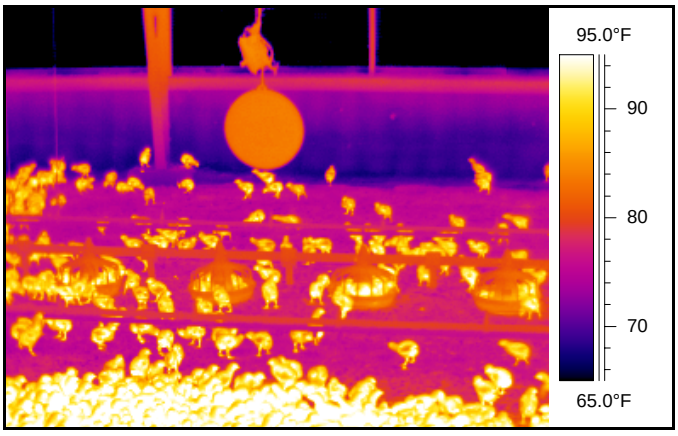

Figure 6. Dial thermometer three feet above the floor (Dial = 84°F, Floor 77°F).

It is important to realize that stratification is not linear from floor to ceiling. In other words, just because air temperature may decrease five degrees from the ceiling to a few feet below the ceiling doesn't mean that it will decrease five degrees from the few feet above the floor to the litter. The fact is that cold air seeping in through cracks tends to hug the floor, displacing warm air from the floor, leading to a sharp drop in air temperature near the floor commonly referred to as a thermocline (Figure 7). A good example of a thermocline can be seen in Figure 8. The temperature of the post a few feet above the floor is relatively constant. Within a distance of approximately 12" the temperature of the post dropped seven degrees! (Figure 9). The rapid drop in temperature was due to cold air from the off-brooding end leaking into the brooding end of the house. Though the thermal camera was a good tool to document the problem, the cool air was easily felt by simply kneeing down to chick level.

Another point to keep in mind is that the level of stratification is not constant; it changes with heating system runtime and house tightness. This means that you can't simply compensate for the lower air temperature at floor level by setting heating system thermostats a few degrees higher. This is because during mild weather you might find a three-degree difference between a thermostat a few feet above the floor and the air temperature next to the floor while during very cold weather the difference may increase to ten or more degrees. If you want to control air temperature

near the floor during brooding thermostats/temperature sensors should be approximately one foot above the floor. This height should be increased as the chicks grow as to keep thermostats and temperature sensors out of their reach.

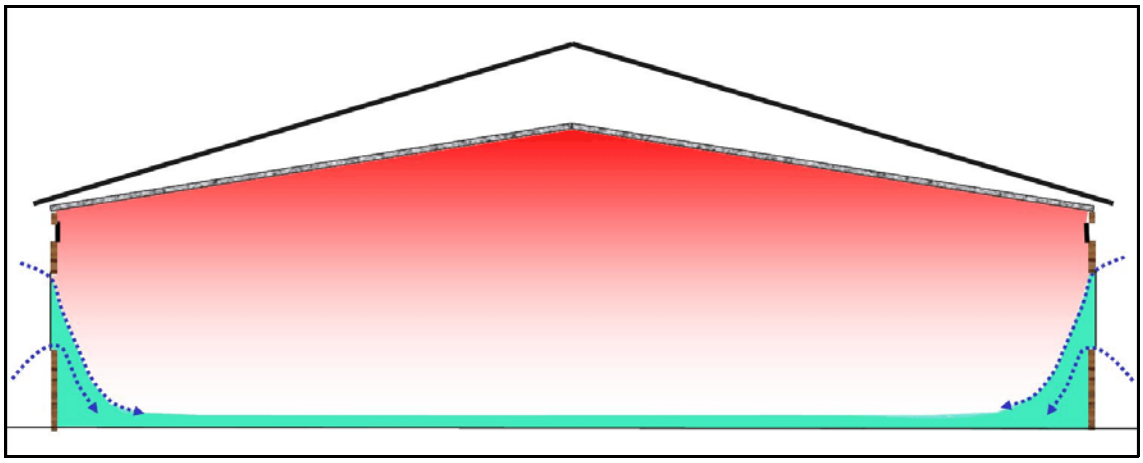

Figure 7. Leakage forming a layer of cold air next to the floor.

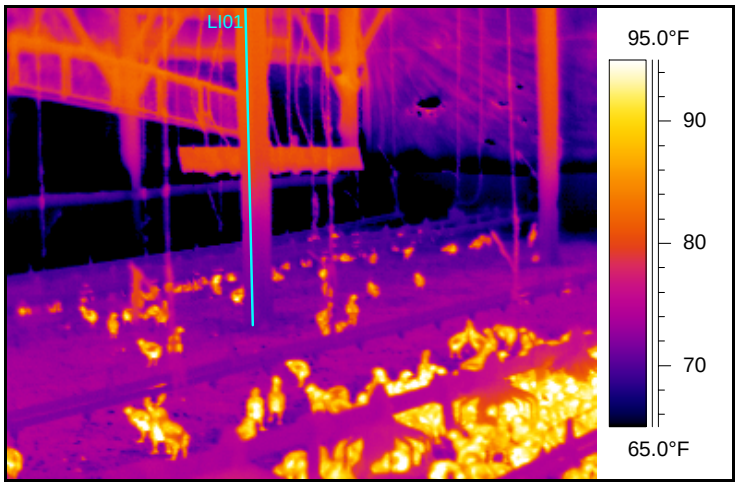

Figure 8. Thermocline near half house curtain.

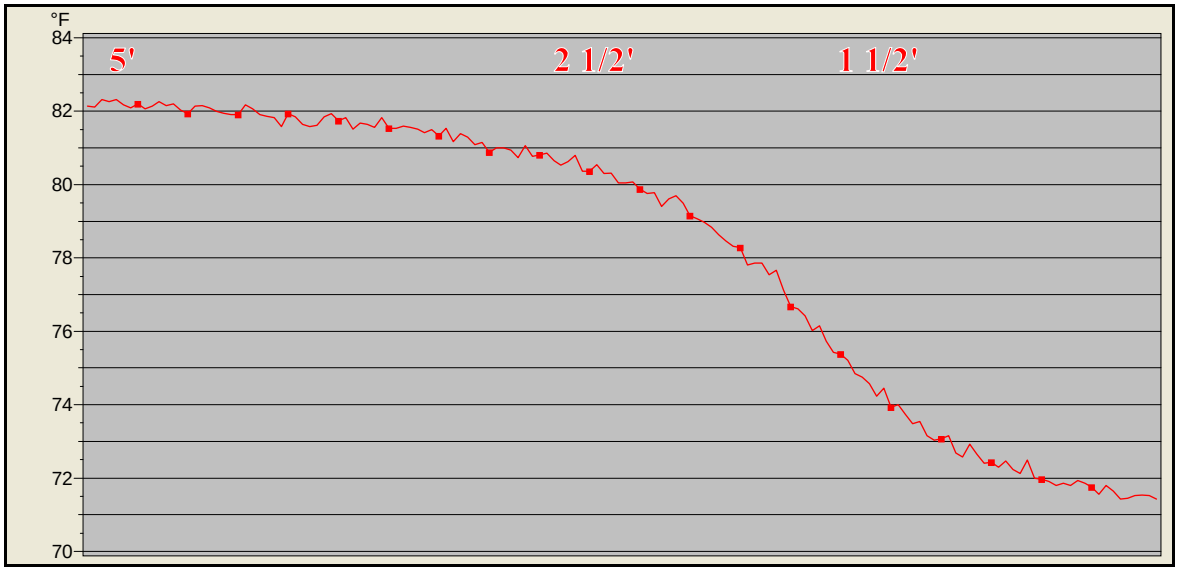

Figure 9. Temperature along blue line in Figure 8.

Though the above images were taken in houses where forced air furnaces were used during brooding, it is important to realize that stratification also occurs in houses with pancake or radiant brooders (Figure 10). The primary difference is that in the immediate vicinity of a brooder the floor temperature will tend to be higher than air temperature thus minimizing the problems associated with the stratification of the air. But, for those birds outside the radiant zone of a brooder, air temperature is very important to their comfort and thus stratification can result in significant problems.

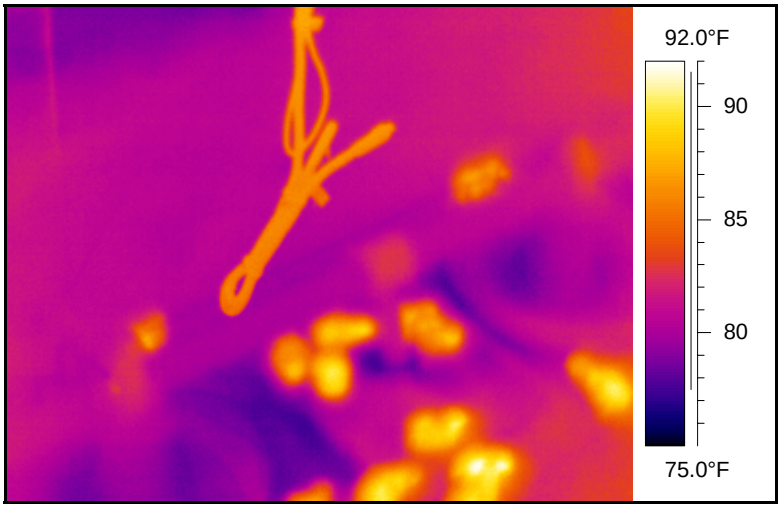

Figure 10. Evidence of stratification in house with radiant brooders. Sensor two feet above floor 86°F, floor 80°F.

The first step in minimizing problems related to temperature stratification during brooding is simply being aware of the fact that the environment at floor level can be very different from that just a couple feet above the floor. Environmental controller temperature sensors or heating system thermostats should be installed approximately one foot above the floor on the water line nearest the side wall of a house. Floor temperatures should be checked by simply putting your hand on the floor or through the use of an infrared thermometer. Circulation fans can be used to break-up stratification, thereby making thermostat/sensor height less of an issue (*Poultry Housing Tips: Vol15 No 10, Vol13 No1, Vol12 No 4*). But, the most simple method of knowing if the floor is warm enough is to simply look at the chicks. If the chicks are huddling...they are probably too cool.

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