Thermal Imaging in the Poultry Industry

Michael Czarick
Extension Engineer
The University of Georgia

ABSTRACT
Thermal imaging cameras have proven to be valuable educational and research tools in the area of poultry production. IR cameras have been used to analyze both heat loss and gain from poultry houses, measure egg temperatures in incubators, and evaluate radiant heating systems. They can also measure temperature stratification, air inlet flow patterns, and evaporative cooling system efficiency.

INTRODUCTION

It is estimated that humans receive 90% of their sensory information visually. This is true whether you are watching television or managing a poultry house. When managing a poultry house, we use our eyes to determine if the drinkers are at the proper height, the litter is in good shape, the feeders are properly filled, and last but not least, whether the thermal environment we have created is meeting the needs of the birds in the house. That is, are the chicks huddling together? Are they avoiding a certain area of a house? Are they panting? Though usually we can visually determine if the birds are uncomfortable, we cannot always see what is actually causing the problem. That is, we can't see temperature. Yes, we might have a few thermometers or temperature sensors in a house which indicate temperatures in a limited number of locations within a house, but we don't get a full picture of the thermal environment in which the birds are living. Exactly how limited our view is of the thermal environment within a poultry house is being made clear by the arrival of "relatively" inexpensive thermal imaging cameras.

Thermal imaging cameras are an extremely valuable tool. All objects that are warmer than absolute zero emit infrared light/heat that is invisible to the human eye. Infrared cameras measure the amount of "invisible" energy emitted by what it "sees" and converts it to a temperature. Software within the camera then converts the temperatures to a color so you end up with a picture where each color represents a specific temperature.

Most poultry producers are familiar with infrared or non-contact thermometers, which basically operate off of the same principle of temperature measurement as thermal imaging cameras. The difference is that a non-contact thermometer provides a single, average, temperature measurement for whatever is in its field of view. A non-contact thermometer's field of view is probably best described like a flashlight's coverage area. The further the away you shine a flashlight the larger the area it covers. So a non-contact thermometer may not only be measuring floor temperature, but bird surface temperature and feeder temperature at the same time, providing the user an average of everything within its field of view. In contrast, thermal cameras do not measure a single temperature measurement but rather tens of thousands of measurements that they convert into color to provide a visible picture of thermal environment within our poultry houses.

EXAMPLE USES OF THERMAL IMAGING TECHNOLOGY IN POULTRY PRODUCTION

Floor Temperatures

During brooding, having the proper floor temperature is crucial to the well being of young chicks. Thermometers just a foot or two above the floor are often poor indicators of actual floor temperature. This is often due to temperature stratification, air leakage, and the fact that the bedding may be damp (Figure 1). With older birds, during hot weather, thermal imaging cameras can provide an excellent picture of how good of a job we are doing pulling heat from between the birds (Figure 2).

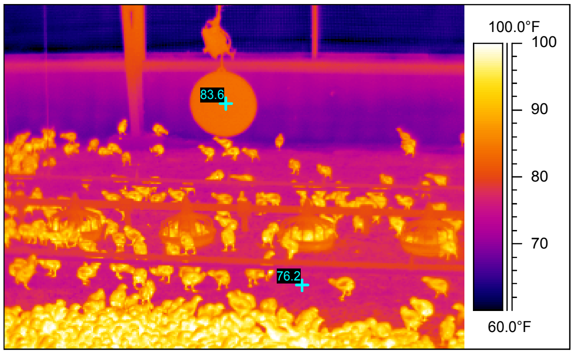

Figure 1. Floor vs. thermometer temperature.

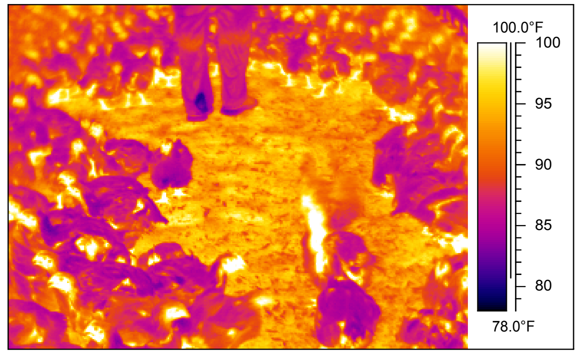

Figure 2. Floor temperature during hot weather.

HEAT STRESS MANAGEMENT

The effectiveness of thermal imaging cameras in evaluating the effectiveness of a ventilation system's ability to keep birds cool during hot weather is clearly demonstrated in Figures 3 and 4. Though the air temperature in both turkey houses was the same, 85oF, the thermal images of the birds clearly illustrate the difference in thermal condition of the birds. The turkeys in Figure 4 were housed in a naturally-ventilated house with poor air movement, whereas the turkeys in Figure 3 were in a tunnel-ventilated house with an air speed of approximately 700 ft/min moving over them. The higher air velocity did a superior job of removing heat from the birds as indicated by lower surface temperature.

Figure 3. Turkeys in house with high air movement.

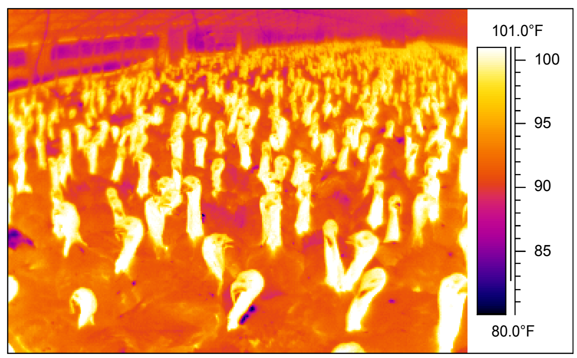

Figure 4. Turkeys in house with low air movement.

INSULATION STATUS

Trying to determine the condition of insulation in the walls or ceiling of a poultry house is very difficult. A side wall may look like it is in good condition, yet there may be fairly extensive damage to the insulation. Figure 6 is a thermal image of a side wall of a broiler house (Figure 5) taken on a warm summer day. The thermal image of the side wall clearly indicates that there are large areas of the side wall where the insulation is severely damaged.

Figure 5. Poultry house side wall.

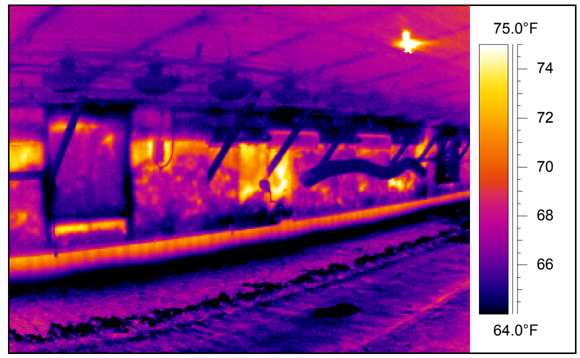

Figure 6. Thermal image of side wall in Figure 5.

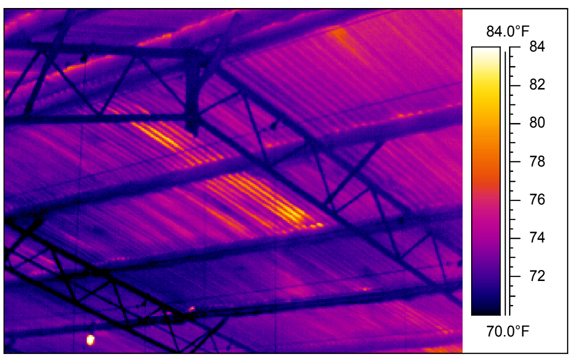

Figure 7. Ceiling insulated with spray polyurethane.

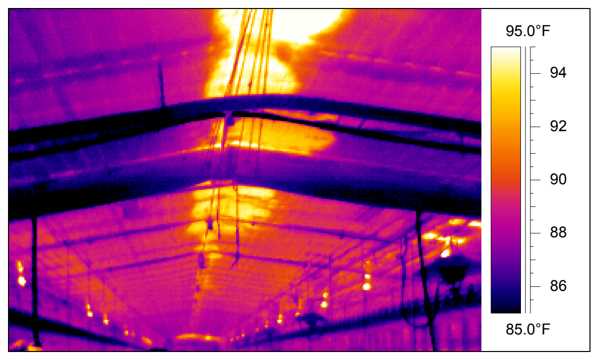

Figure 8. Missing ceiling insulation.

Figure 7 is a thermal image of the ceiling of a poultry house insulated with sprayed polyurethane insulation. The difference in ceiling temperatures is a clear indicator that the insulation is not of a uniform thickness. The hotter sections of the ceiling indicate areas where the insulation was not sprayed on thick enough to minimize heat gain from the hot metal roof. Figure 8 is a thermal image of a dropped ceiling poultry house where the insulation has shifted, leaving a significant portion of the ceiling un-insulated. Both of these insulation problems would have been difficult to detect without the aid of a thermal imaging camera.

HOUSE TIGHTNESS

Keeping a house tight during cold weather is crucial in terms of both maximizing bird performance and minimizing fuel usage. Cold air can be clearly seen leaking in from a loose side wall in Figure 10 through the use of a thermal camera. Figure 11 provides an excellent illustration of hot air leaking from the side wall curtain of the same house.

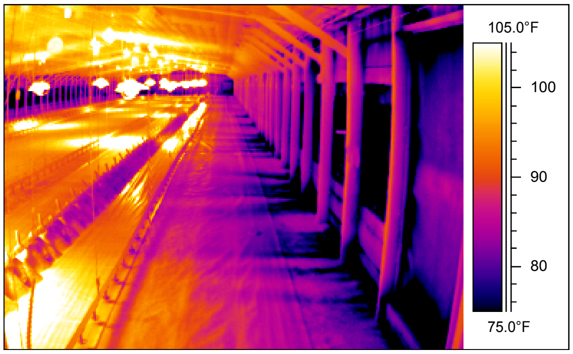

Figure 10. Cold air leakage.

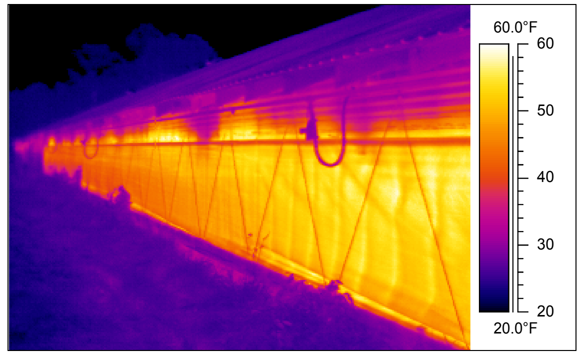

Figure 11. Hot air leaving poultry house.

EVALUATING HEATING SYSTEM PERFORMANCE

Radiant heater/brooders are a very popular method of providing supplemental heat for young chicks. Though they do a significant amount of air heating, the reason for their popularity is the fact that they do a good job of heating the floor using radiant energy. With a thermal imaging camera it is very easy to evaluate the floor heating performance of a radiant heater/brooder as well as compare the effectiveness of different types of radiant heaters/brooders.

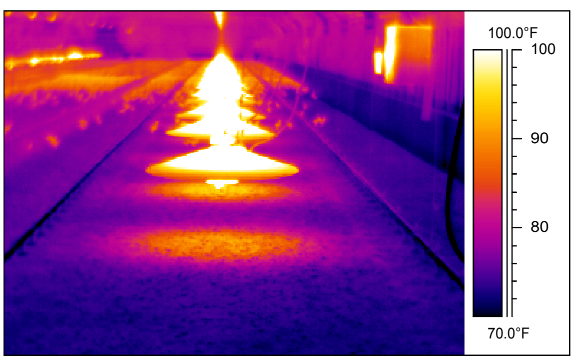

Figure 12. Conventional poultry brooder.

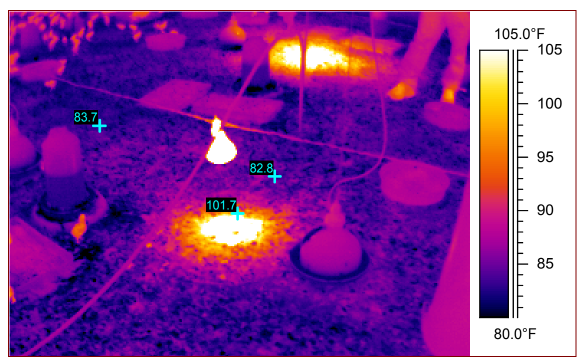

Figure 13. Poultry heat lamp.

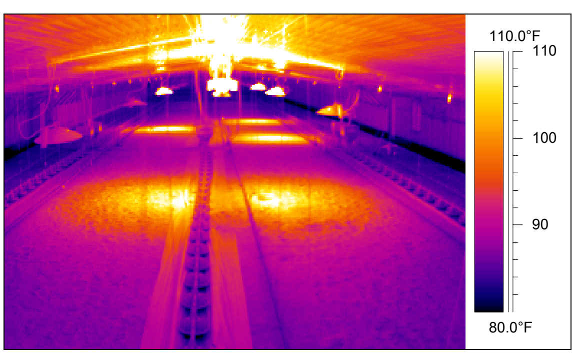

Figure 14. Floor heating patterns of two different types of radiant brooders.

TEMPERATURE STRATIFICATION

Temperature stratification can be a significant problem any time you are trying to heat a poultry house. Warm air tends to accumulate near the ceiling far from the birds that we are typically trying to heat. By looking at different surface temperatures within a poultry house, the level of temperature stratification that exists can clearly be discerned (Figure 15). Figure 16 shows how a simple roll of paper towels hung from the ceiling can be used to examine how air temperature stratifies from the ceiling to the floor of a poultry house.

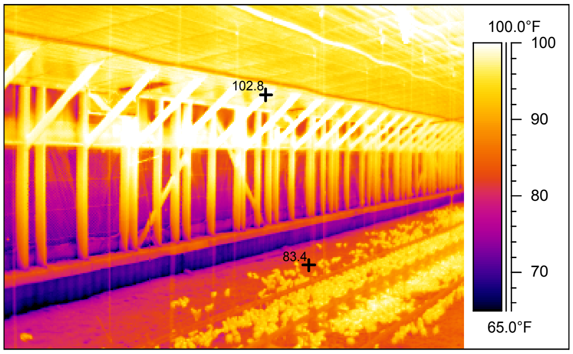

Figure 15. Temperature stratification.

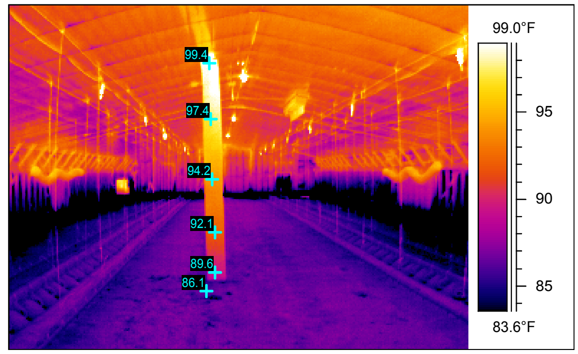

Figure 16. Temperature stratification.

AIR INLET PERFORMANCE

During cold weather, controlling how the air enters a house is crucial when it comes to maximizing bird performance and health. Traditionally, poultry producers have relied on some type of smoke emitter to determine air flow patterns from air inlets. Though very effective, smoke emitters can lead to smoke-filled houses and frightened birds. Thermal imaging cameras can be used as an indirect indicator of how the air is moving across the ceiling of a poultry house and how much it is warming as it moves across the ceiling.

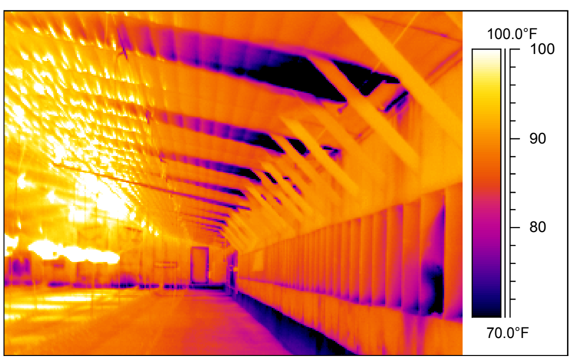

Figure 17. Cold air entering through air inlet.

ELECTRICAL SYSTEM EVALUATION

Historically, one of the primary uses of thermal imaging technology has been in the area of electrical system maintenance. Heat is a telltale sign of possible electrical system problems. Overheated circuit breakers are often a sign of an overloaded circuit. Warm electrical wires are a good indicator that a wire is undersized. Though, as is often the case there are other ways of determining the existence of such problems, a thermal imaging camera provides a very quick and, more importantly, safe method of evaluating a poultry house's electrical system for potential problems.

Figure 18. Lighting receptace

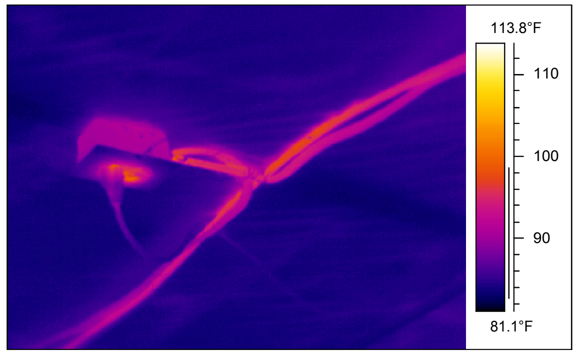

Figure 19. Thermal image of overheating wire (Figure 18).

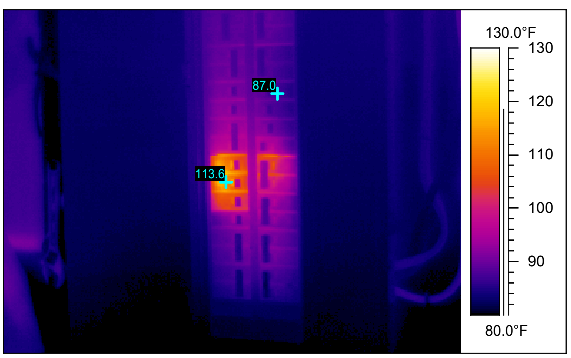

Figure 20. Warm circuit breaker.

EVAPORATIVE COOLING SYSTEM EFFICIENCY

During warm weather, poultry houses are cooled using paper evaporative cooling pads. As water is circulated over the paper pads, air is drawn through the pads by large exhaust fans located at the opposite end of the house. Cooling results as water on the pad is evaporated into the incoming air. The precise amount of cooling produced depends upon incoming air temperature and humidity but generally varies from between 5 and 25°F. Though pads can be visually inspected to determine if they are being properly wetted by the water circulation system, a thermal imaging camera can be a very powerful tool in determining not only if the pads are properly wetted, but also allow the loss of cooling to be calculated.

Figure 21. Poultry house evaporative cooling pad.

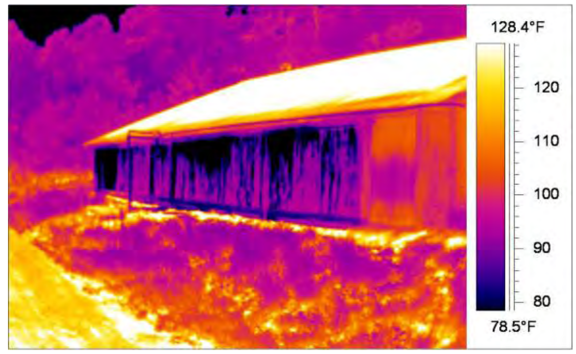

Figure 22. Thermal image of pad partially wet.

Figure 21 shows a typical paper evaporative cooling pad installed on a 40' X 500' broiler house. The exhaust fans can be seen at the opposite end of the house. Figure 22 is a thermal image of an evaporative pad on a hot summer day (92°F) where the water distribution system is not functioning properly. The properly wetted portions of the pad are 10 to 15°F cooler than areas of the pad where the water distribution system is not functioning properly. Since approximately 75% of the total pad area is relatively dry, the cooling of the incoming air is significantly reduced.

EVALUATING HATCHERIES

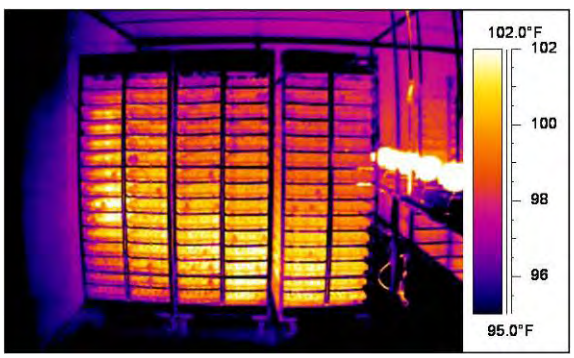

Figure 23. Profile view of rack of eggs in incubator.

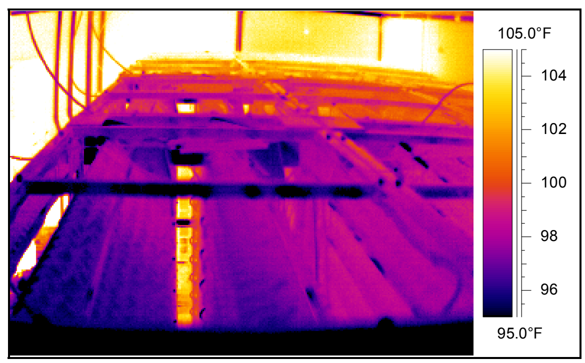

Figure 24. Top view of multiple racks of eggs.

Fertilized eggs are placed in large machines for incubation and hatching. To maximize the number of chicks hatched as well as the viability of hatched chicks, machine temperatures have to be regulated to within a tenth of a degree over the course of the approximately month-long hatching process. To ensure that all the chicks within each machine hatch at the same time, it is very important that variations in temperature within the machine are kept to a minimum. Thermal imaging cameras have proven to be a very effective tool in not only examining temperatures within incubators, but also evaluating the status of fertilized eggs within the machine.

Like all living things, the eggs within an incubator produce heat. How much heat depends upon the age of the egg. The older the egg, the larger the chick embryo, the greater the amount of metabolic heat produced. To keep temperatures uniform within in the machine, high volumes of air need to be constantly circulated within the machine. Problems with air circulation can lead to hot and cold spots within the machine.

Figure 23 is a profile view of just one of row of egg racks of an egg incubator. The warm band of eggs in the lower right hand corner is an indicator that the machine's circulation system is not doing a proper job of removing excess heat produced by the eggs from this area of the machine and adjustments need to be made. Figure 24 is a top view of the multiple rows of egg racks. This image was taken at an early stage of the incubation process where the embryos are not producing a significant amount of heat and therefore supplemental heat is required to maintain proper air temperatures. From the figure it is clear that the rear portion of the machine is running significantly warmer than the front of the machine. The problem was due to the supplemental heat not being evenly distributed throughout out the machine.

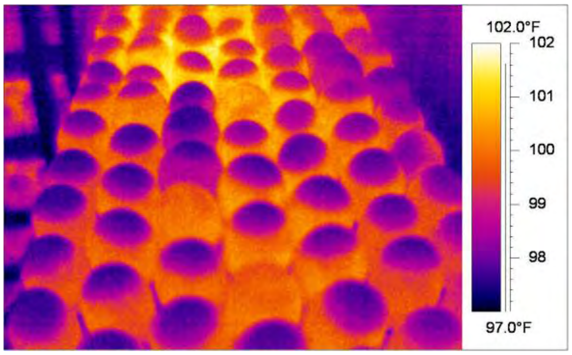

Figure 25. Thermal image of a tray of eggs in an incubator.

Figure 25 is a thermal image of a tray of eggs in the latter stages of the incubation process. The dark/cool spots are the air cells of the eggs. To insure maximum hatchability the eggs should be placed in a tray with the air cell at the top (pointed side down). Those few eggs seen in the image that don't have visible air cell were placed in the machine upside down. The cool/dark eggs are ones that have died somewhere in the incubation process or may be infertile. Though these problems are detectable using other methods, infrared thermography allows the hatchery manager to determine the status of the eggs in a fraction of the time.

ABOUT THE AUTHOR

Michael Czarick is an Extension Specialist at the University of Georgia who specializes in poultry house environmental control and energy conservation.