The University of Georgia

College of Agricultural and Environmental Sciences
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Poultry Housing Tips

Plastic Evaporative Cooling Pads...A First Look

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Figure 1. Evaporative cooling system with plastic pads.

Little has changed when it comes to poultry house evaporative cooling pads over the last 30 years. Yes, there have been some relatively minor changes in things such as flute angles (45º X 15º vs. 30º X 30º), edge coatings, and pad thickness (6" vs. 4"), but for the most part the traditional paper pad looks and cools about the same as it did decades ago. Recently, there has been interest in a very different type of evaporative cooing pad, one constructed of plastic. It is hoped by many that a plastic pad would have a longer life, be easier to clean/sanitize, and be more tolerant of poor water quality than paper pads. Though the idea of a plastic evaporative cooling pad may sound appealing, it is important to realize there are very good reasons why we have traditionally used paper evaporative cooling pads.

Though it may not look like it, significant engineering has gone into the design and construction of the modern paper evaporative cooling pad. Pad flute size must be designed not only to maximize the cooling of the incoming air, but to minimize the resistance to air flow thus maximizing the performance of the tunnel fans. It is a delicate balancing act. The smaller the flute size, the greater the cooling, but the greater the resistance to air flow, and the more likely the pad will become clogged by dirt, algae, or even by the water circulating over the pad. The flute angles must also be designed to ensure that the water flows over the pad in such a way that the pad flutes and surfaces remain as clean as possible so as to maximize wind speed produced by the tunnel fans. By far the trickiest part of designing a quality paper pad is engineering the paper itself. Evaporative cooling pad paper is infused with resins and cured in such a way that it is not only rigid and long lasting, but "soft" and porous enough to allow water to easily wick throughout the entire pad. The wicking action is crucial when it comes to maximizing the cooling produced by a pad. First, it minimizes the likelihood of dry spots. Secondly, the wicking action of a paper pad allows it to absorb and hold a substantial amount of water. In fact, the typical one foot section of a five-foot-tall paper evaporative cooling pad can hold 0.6 gallons of water. This means that after the pad system circulation pump shuts off, a quality paper pad can continue to produce the same amount of cooling for 10 to 15 minutes and will continue to produce some level of cooling for up to 30 minutes.

Though plastic evaporative cooling pads are similar to traditional paper pads, there are significant differences. One of the most notable differences is that instead of being constructed with alternating straight path flutes/channels, plastic pads have alternating curved or "U" shaped flutes. There are small holes in the flutes that both help to increase the surface area of the pad as well as facilitate the flow of water throughout the pad. This is a key challenge with a plastic evaporative cooling pad. With a traditional paper pad, the wicking action of the paper often means that water doesn't have to be directly delivered to every square inch of a pad. A single stream of water flowing through a pad can wet a few inches of pad on either side of the stream. The same cannot be said of a plastic pad. To ensure that the entire pad stays wet the water flow through the pad system has to be significantly greater than that typically required with a paper pad so that the entire pad is thoroughly wetted.

Figure 2. Examples of plastic evaporative cooling pad

To better understand the differences between plastic and paper pads, a study is currently being conducted using a plastic pad that has been installed in a number of poultry houses overseas as well as swine houses here in the US (Big Dutchman PP150-3 http://www.bigdutchmanusa.com/environment/environment/cooling/rainmaker.html). The traditional paper pads on a 40' X 500' tunnel-ventilated broiler house in North Georgia were replaced with plastic pads in June of 2011. The five-foot-tall, 6" thick plastic pad is manufactured in two-foot sections and fits in most conventional paper pad evaporative cooling systems. Furthermore, since the pad was designed to have the similar air flow/static pressure characteristics of traditional paper pads, pad area requirements are the same for a house with the plastic pad as they are for a house with traditional six-inch paper pads. To help evenly distribute water along the top of the pad, a two inch thick paper distribution pad was placed on the top of the pad (green pad at the top of the black pad in Figure 1).

As expected, the plastic pad produced less cooling of the incoming air as compared to the paper pad (Figures 1,2, and 3). The difference in cooling was a function of outside temperature. In the morning or on days when the outside temperature was in the eighties, the paper pad tended to produce one to two degrees more cooling than the plastic pad system (i.e. 8°F vs 6°F cooling). But, as outside temperature increased and relative humidity decreased, the difference in cooling produced by the two systems increased. During one particularly hot week, when outside temperature approached 100°F, the plastic pad system produce approximately five degrees less cooling than the paper pad system (i.e. 14°F vs. 19°F).

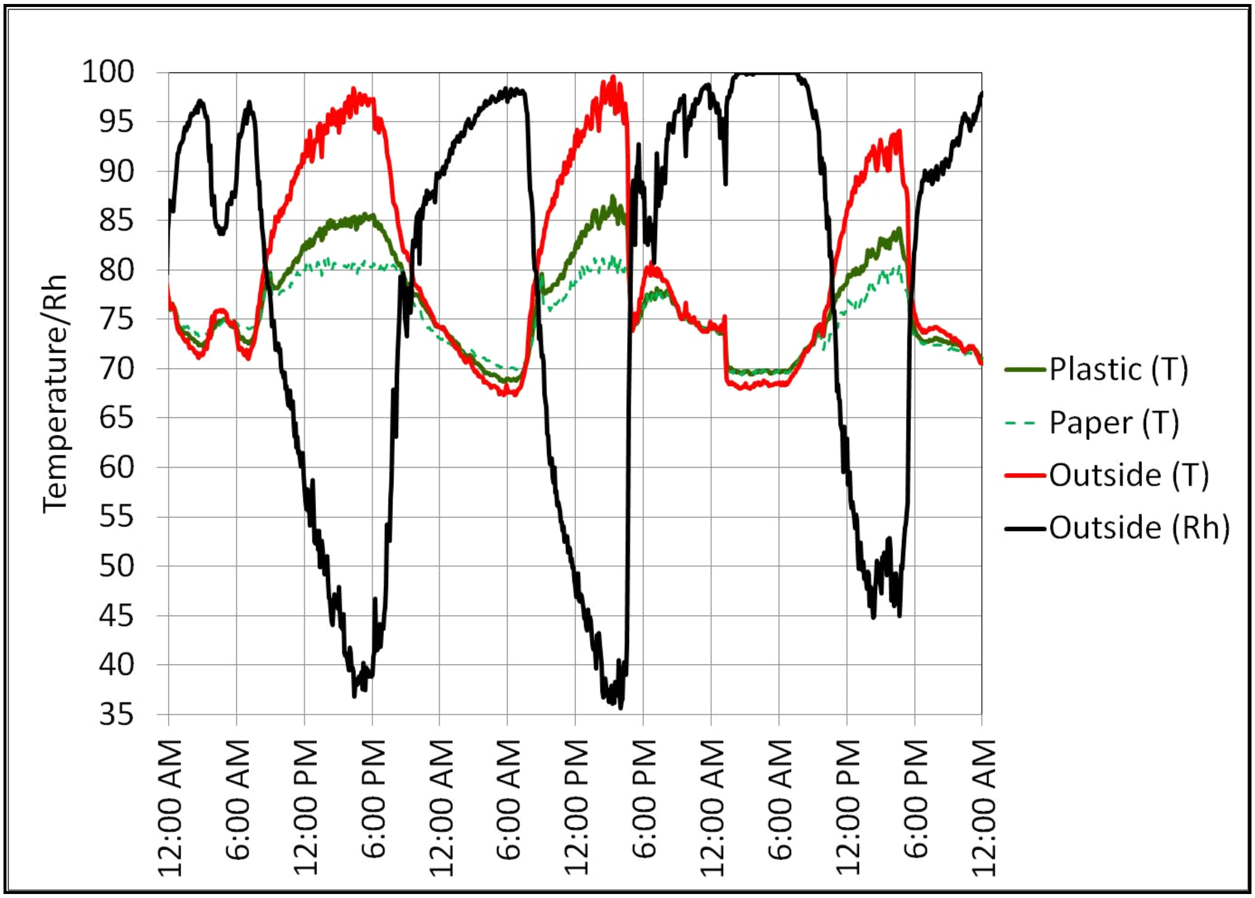

Figure 3. Inside/Outside house temperatures (plastic and paper pads)

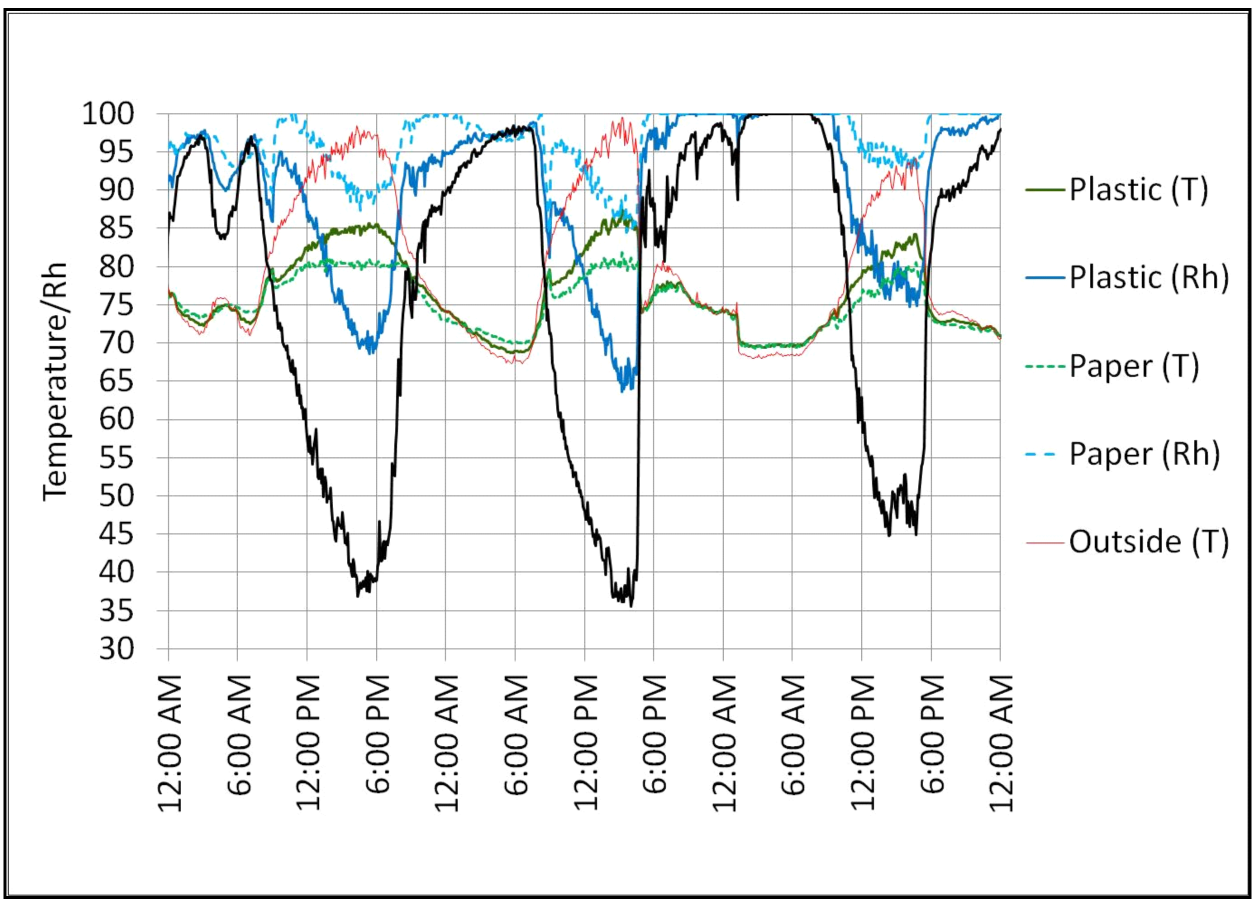

Figure 4. Inside/Outside house temperatures and Rh (plastic and paper pads)

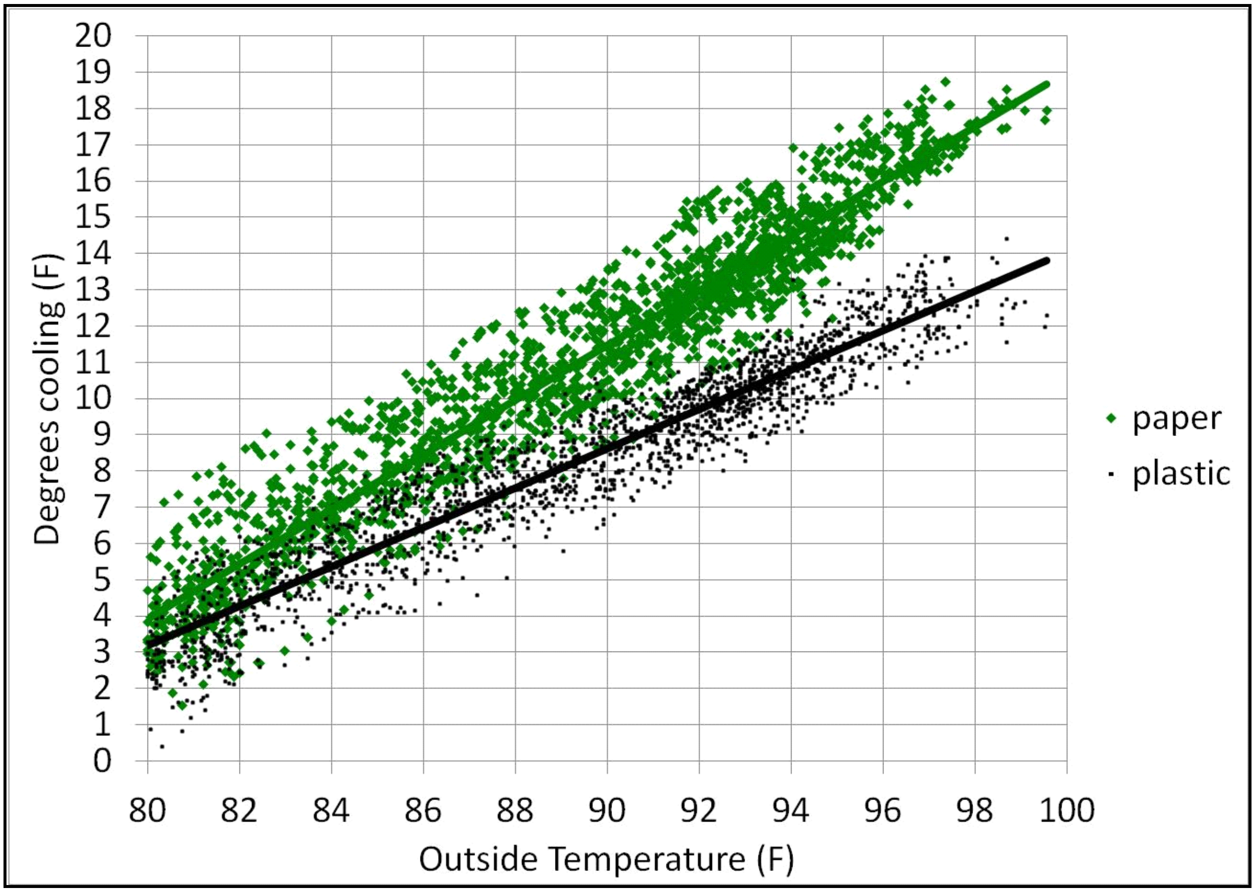

Figure 5. Cooling produced by paper and plastic pads as a function of outside temperature

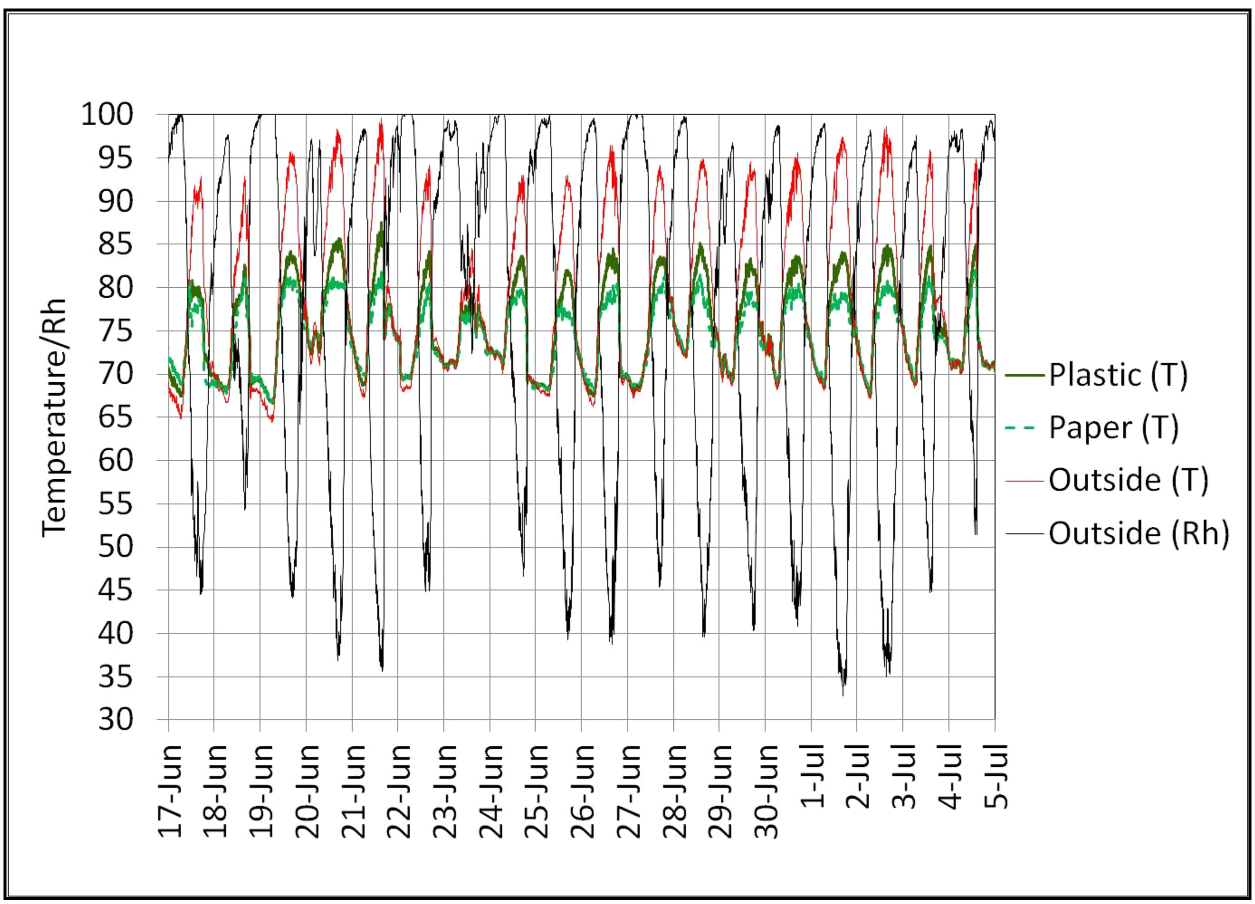

Figure 6. Incoming air temperatures in houses with plastic and paper evaporative cooling systems

It is important to realize that the reduction in "evaporative cooling" does not always result in a substantial reduction in "bird cooling." During hot weather we use evaporative cooling to lower our house temperatures to increase the transfer of heat from the birds to the air (sensible heat loss). The downside is that this cooling comes at a cost, increased humidity. For every 1ºF of cooling produced through the evaporation of water the relative humidity of the air in a house will increase approximately 2.5%. Though the air temperature is lower, the increase in the relative humidity reduces the bird's ability to cool itself through the evaporation of water off of its own respiratory system. So, though we are decreasing house air temperature using evaporative cooling, we are adversely affecting the bird's primary method of cooling itself because we are increasing humidity. In the case of the plastic pad, the higher house temperatures are accompanied by a significantly lower relative humidity, which makes it easier for a bird to lose heat through the evaporation of water off its respiratory system i.e. So, though wind speed is less effective in removing heat from the birds because it is closer to the bird's body temperature, the bird is losing more heat through the evaporation of moisture off its respiratory system because the relative humidity is lower. The question of course is, are birds better off in the plastic pad house or the paper pad house? The answer comes down to how warm a house becomes on a hot summer day.

The primary objective of any evaporative cooling system is to keep the incoming air temperature 85ºF or lower during hot weather when market age birds are present. Once the temperature starts to rise above 85ºF, the cooling produced through the movement of air over their bodies starts to decrease to critical levels. If the air temperature in a house rises above 90ºF, the cooling produced by air movement is reduced to such an extent that mortality is likely to occur with market-age birds. During the extremely hot-weather flock, both systems were successful for the most part in keeping the incoming air temperature below 85ºF, but the paper pad system was generally able to maintain an incoming air temperature closer to 80ºF (Figure 6).

The problem for the birds in the house with plastic pads was that though the incoming air temperatures tended to remain below 85ºF, temperatures within the house were often between 85 and 90ºF during the hottest part of the day (Figure 7). The higher temperatures resulted in the air moving down the house removing less heat from the birds. This is verified by the fact that with all the fans running, during the hottest portions of the day, the temperature difference between the inlet and fan ends of the house decreased to less than 3ºF. This is contrasted in the paper pad house where the temperature difference between the pad and fan ends, with the same number of fans operating, was closer to 5ºF (Figure 8). Since in a totally enclosed house it is primary the bird heat that causes the temperature to rise as the air moves from the pads to the fan, all things being equal (house construction, number of fans running, house tightness, etc.) a smaller temperature differential tends to indicate that the air moving down the house is doing a poorer job of removing heat from the birds. Yes, the lower relative humidity in the house with plastic pads would increase bird panting heat loss, but it is questionable whether it would be enough to offset the substantial reduction in heat loss due to hotter air moving over the birds.

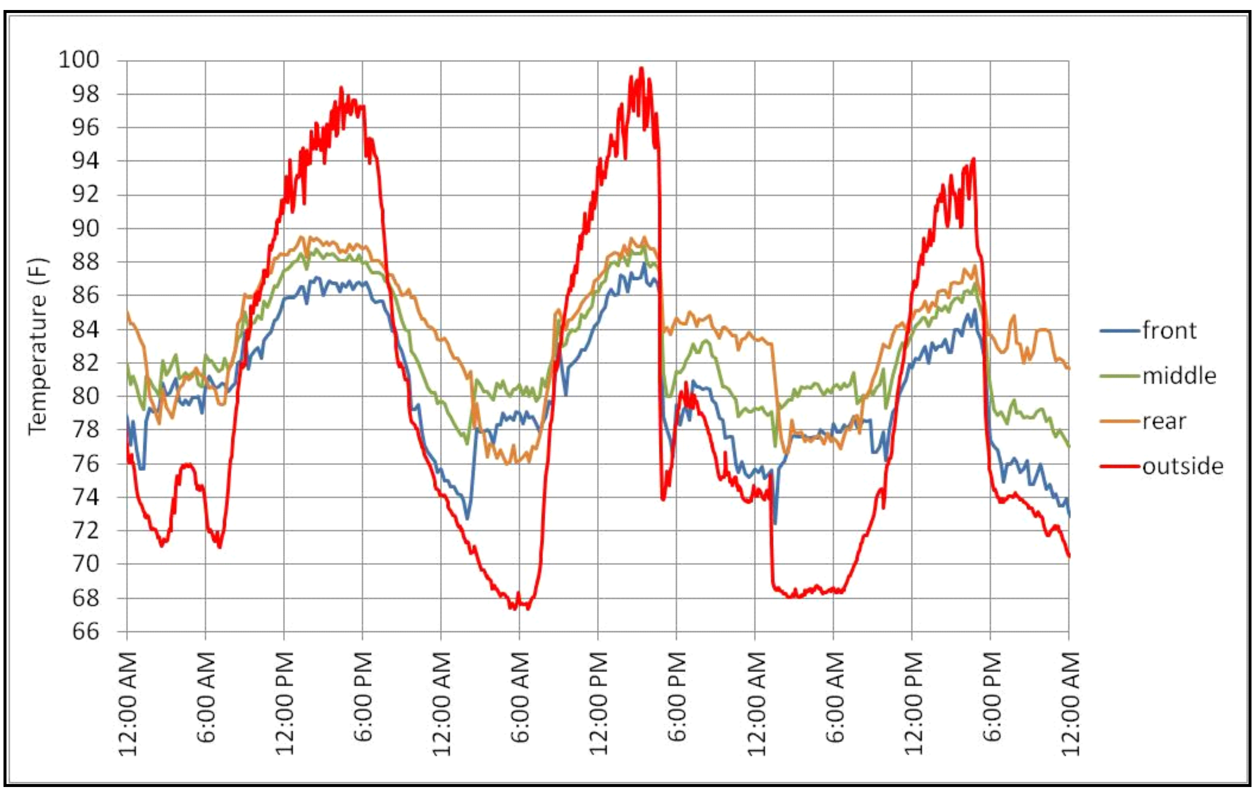

Figure 7. Plastic pad house air temperatures.

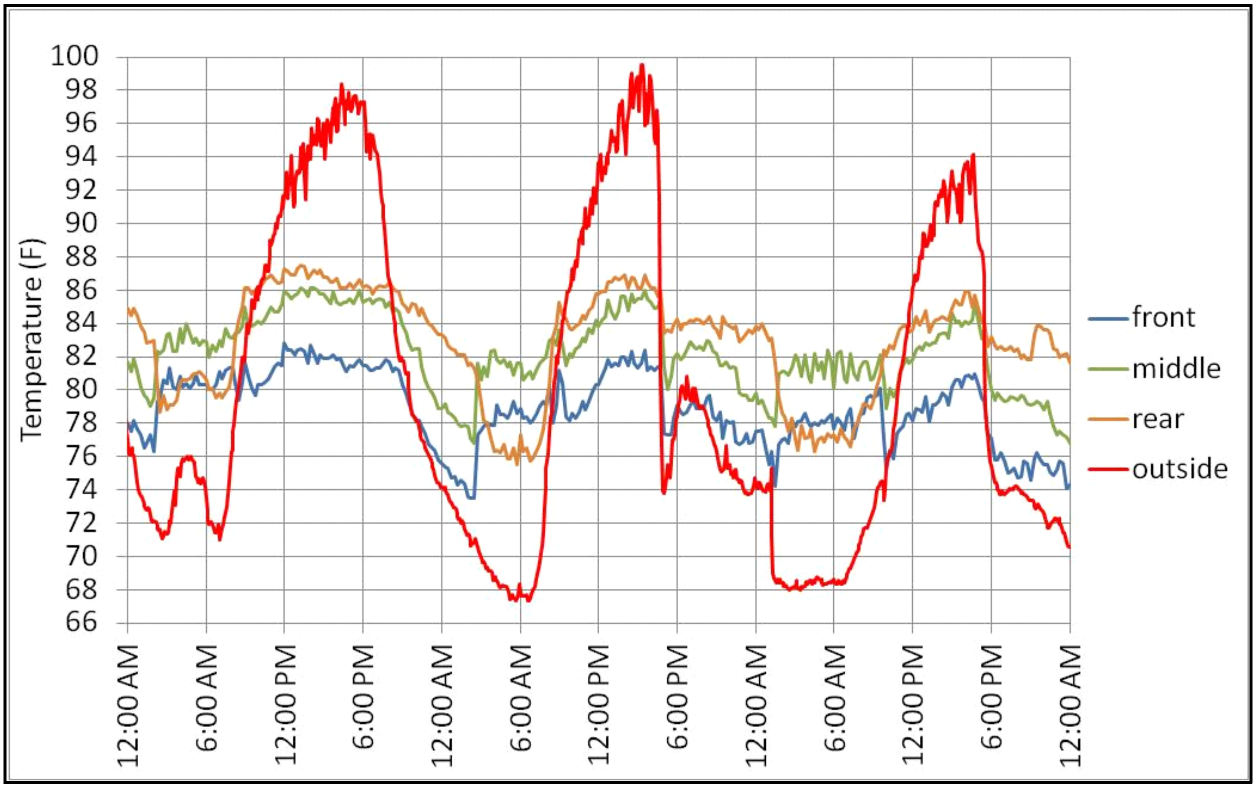

Figure 8. Paper pad house air temperatures

Interestingly enough, the plastic pad system produced cooling similar to that which would be expected with a traditional two-inch paper fogging pad system (Figure 9). Though fogging pads did a relatively good job of cooling the birds during hot weather, many producers, especially those growing larger birds, felt that more cooling was needed to keep their birds comfortable especially during very hot weather. To increase bird cooling, most fogging pad houses were equipped with fairly substantial fogging systems, typically consisting of 60 to 120 one-gallon-per-hour nozzles and a 200 psi booster pump. With the addition of the interior nozzles most producers found that the fogging pad system could produce nearly the same amount of cooling as that of a six inch paper pad system. The interior nozzles would only be required as inside temperatures start to approach 85^{o}F, which would generally coincide with outside temperatures in the mid nineties or higher. At this point the inside relative humidity would be low enough so that an interior fogging system could be used without the threat of substantial house wetting. Since the plastic pad system cooling efficiency is very similar to that of a two-inch paper fogging pad system, it would stand to reason that if a producer chose to install a plastic pad they would probably also need to install an interior fogging system for use when outside temperature climbed past the mid nineties.


Figure 9. Two inch fogging-pad system


Figure 10. Interior of plastic pad after one year of use

Another issue noted with the plastic pad system was its tendency to waste water. With the high water flow rates required to ensure the plastic pads stayed thoroughly wetted there was significant more sprayed on the ground around the system as compared to the paper pad system. Though this could have probably been reduced by reducing the amount of water flowing over the pad, it would have likely resulted in a reduction in cooling. It is important to note that the pads were installed in a distribution system which was designed to be able to circulate the large volume of water required to properly wet plastic pads. Had the pads been installed in a more typical "low volume" water distribution system i.e., one utilizing undersized submersible pumps, it is likely that the cooling produced by the pads would have been lower. Another factor to keep in mind is that plastic pads weigh significantly more than traditional paper pads (Dry weight of 11.25 vs. 2.5 lbs lbs per linear foot for a five-foot-tall pad). As a result plastic pads should only be installed in distribution systems capable of supporting the additional weight.

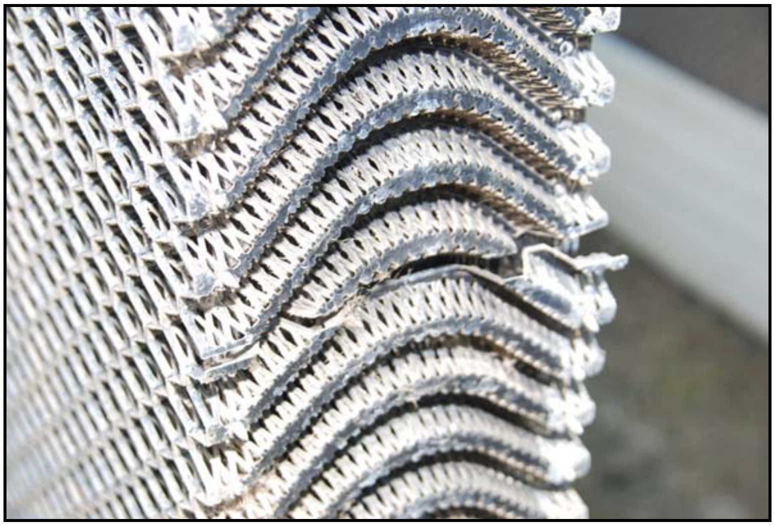

Figure 11. Unglued piece of plastic pad

One year after the installation of the plastic pad there appeared to be relatively minimum buildup of dirt and minerals on the pad (Figure 9). The lack of mineral buildup on the pad was expected due to the farm's overall good water quality. There were a few instances of the glue holding the pieces of the pad together coming loose, but overall the plastic pads have held up very well (Figure 11). It is important to note that as with paper pads, over time as dirt and dust accumulate in the pad, the cooling produced by the pad will tend to increase. This is because the dirt in the pad will not result in increased pad surface area, but will tend to improve the wicking ability of the pad. But, the increase in cooling will be slight, possibly a degree or so during very hot and dry weather. The other thing to keep in mind is that though the cooling produced by the pads could increase when they get dirty, the air flow through the pad/house could be reduced, possibly resulting in an overall decrease in bird cooling.

Plastic pads are probably not for the typical poultry farm. Many producers would likely find the reduced cooling, higher initial cost, and/or the need for a significant number of interior fogging nozzles to increase cooling to that of a traditional six-inch paper troublesome. That being said, if a producer has highly basic water, the need to sanitize their pads, or possibly water with very high mineral content, a plastic pad could be a possible option. As to how the pads will hold up over multiple seasons and or frequent cleanings with possibly very strong cleaners to remove mineral buildup, that remains to be seen.

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