The University of Georgia

College of Agricultural and Environmental Sciences
Cooperative Extension

Poultry Housing Tips

Evaporative Cooling Myths and Facts

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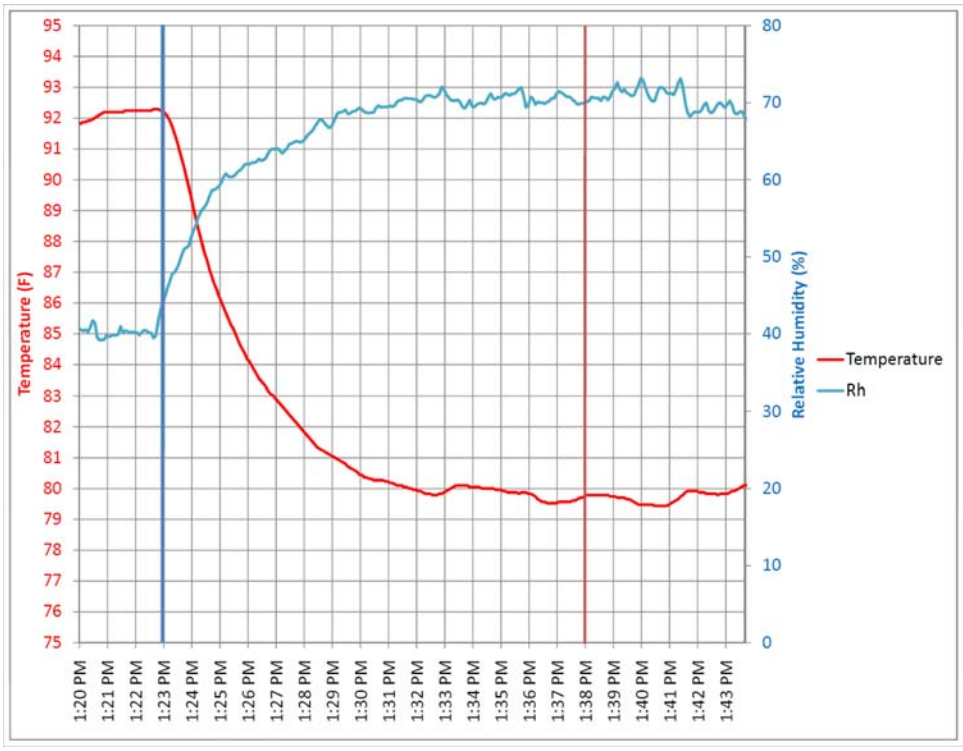

Figure 1. Cooling produced when air moves through a wetted pad.

There are a number of misconceptions about the operation of evaporative cooling pads that can result in warmer birds and reduced pad life. The most common of these are:

"A pad produces the most amount of cooling just before it dries out."
"Water running over a pad reduces the cooling produced by the pad."
"Cooling is improved by operating a pad system off a ten-minute interval timer."

The primary reason for these misconceptions is a basic misunderstanding of how an evaporative cooling pad actually reduces the temperature of the air entering a house during hot weather. Once someone has a clear understanding of what is really happening when they pull hot air through a wetted pad, it becomes fairly clear how best to operate a pad system to achieve maximum bird cooling.

Figure 1 is a graph of the incoming air temperature and relative humidity before and after water was added to a typical six-inch evaporative cooling pad system. Prior to the addition of water to the pads, the incoming air temperature was 92°F and the relative humidity was 40%. At 1:23 p.m. the pad system's circulation pumps were turned on, resulting in an immediate drop in house temperature and a rise in relative humidity. Over the course of approximately15 minutes, the incoming air temperature decreased 12°F, while the relative humidity increased 30 percent.

The relationship between the cooling produced by an evaporative cooling system and the corresponding increase in relative humidity is very linear (Figure 2). This is because it is the evaporation of water from the wetted pad that is producing the cooling. For every gallon of water evaporated from a pad system into the incoming air, approximately 8,500 Btu's of sensible heat (air temperature) is converted to latent heat (air humidity). The reduction in sensible heat reduces the temperature of the air, but the corresponding increase in latent heat increases the relative humidity of the air. The greater the temperature reduction, the greater the increase in the relative humidity. The actual temperature of the water has essentially no effect on the amount of cooling produced by a pad system (*Poultry Housing Tips*. August, 2006).

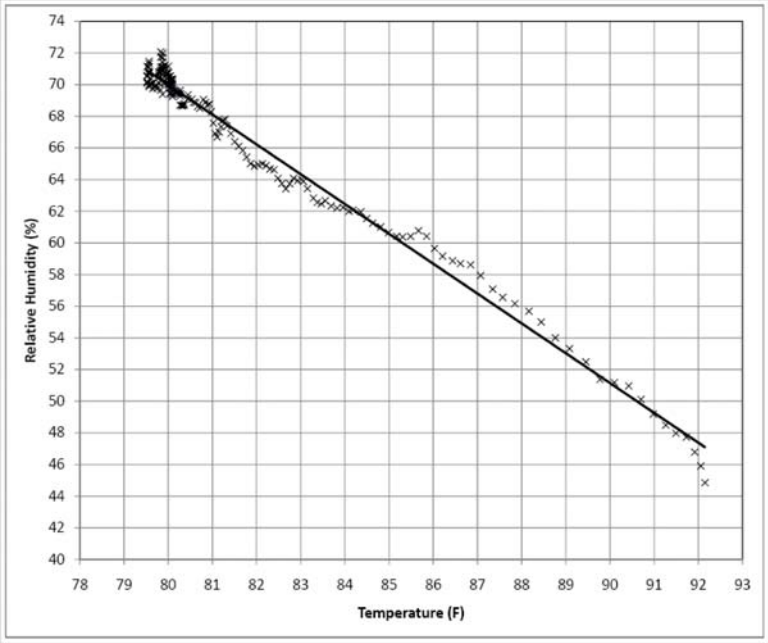

Figure 2. Temperature vs. Relative humidity of the air entering through a wetted pad.

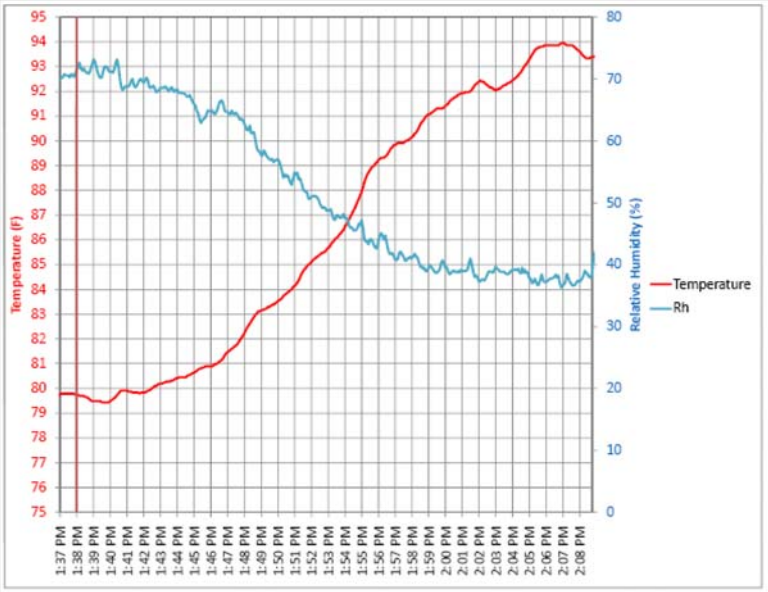

Figure 3. Cooling and Rh produced by a pad as it is drying.

Though the cooling starts as soon as water is added to the pads, maximum cooling is not achieved until the pads are fully wetted, which typically takes between 10 and 15 minutes depending on the type and condition of the pad as well as the amount of water circulating over the pad. During the wetting period the paper pad is acting like sponge soaking up a significant amount of water. For instance, a new 5' X 1' X 6" pad weighs approximately 2.5 lbs when dry. Fully wetted, the pad will weigh approximately 7.5 lbs. This means that pads in two 60' X 5' evaporative cooling systems, typical for a 40' X 500' house, are capable of holding over 70 gallons of water. So even when the water circulation pumps are turned off, there are still 70 gallons of water being held by the pads which is capable of cooling a significant amount of hot air. For instance, when the outside temperature is 90°F and the relative humidity is 40%, as was the case illustrated in Figure 1, water will evaporate from the pad system (120' X 5' X 6") at a rate of approximately five gallons per minute. So this means that even after the water circulation pumps are turned off, the pads are technically capable of maintaining the same level of cooling for approximately 15 minutes. Now, of course the level of cooling will not be constant after the circulation pumps are turned off. As the pads begin to dry, the cooling of the incoming air will gradually decrease until the pads are fully dry and cooling is no longer produced. This phenomenon can be seen in Figure 3. Even though the pad system circulation pumps were turned off at 1:38 p.m., there was essentially no change in the cooling (or humidity) produced by the pads for approximately five minutes. As the pads began to dry, the level of cooling produced by the pads began to decrease and continued to decrease until the pads were completely dry, some 30 minutes after the water circulation pumps were turned off.

Another thing to notice from Figure 1 is after the water circulating over the pads was turned off at 1:38 p.m., the cooling did not increase; it remained the same. Basically the water flowing over the pad did not adversely affect the cooling produced by the pad. It did not affect the amount of air moved by the fans either. The static pressure was measured before and after the water circulation pumps were turned off and did not change (0.08"), thus indicating that water flowing over the pads did not make it harder for the fans to pull air into the house. Had there been a significant change in static pressure after the circulation pumps were turned on, this would have been an indication that the pads were very dirty and in need of cleaning. In some cases the dirt and algae on pads will "expand" when wetted, essentially clogging the pads and reducing air flow into a house. The solution to this situation would be to simply clean the pads, not to reduce water flowing over the pads through the use of an interval timer. It is important to keep in mind the high volume of water that flows over a pad is not only to make sure it is fully wetted, but to help keep the pads clean as well.

It is also important to note that water circulating over the pads did not lead to the "over saturation" of the incoming air with moisture. Whether the water was circulating over the pads (1:36 p.m.) or not (1:40 p.m.), the wet pads were producing the same level of cooling and therefore the relative humidity of the incoming air remained unchanged (Figure 1).

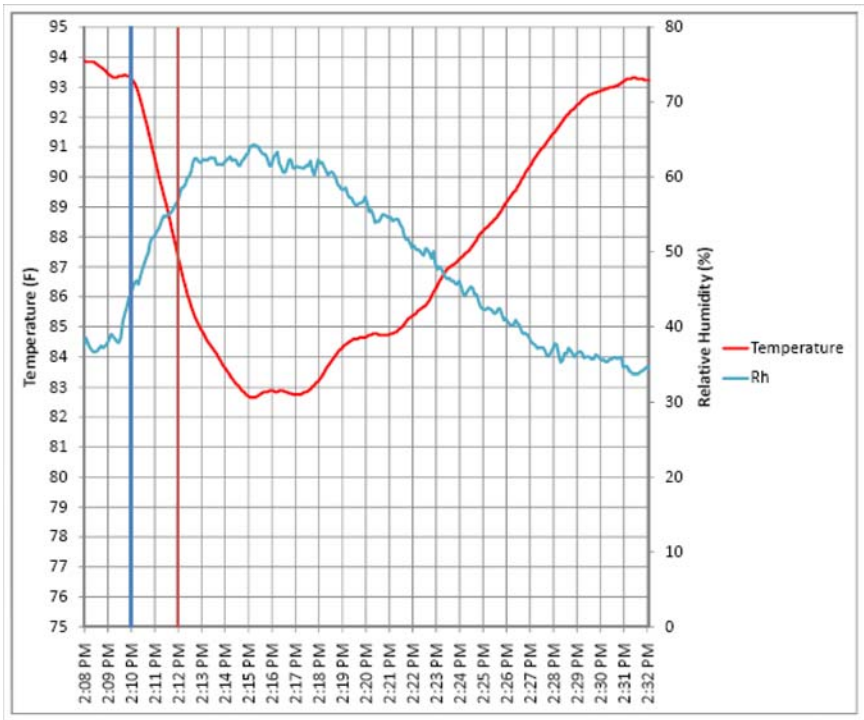

Figure 4. Water added to pads for two minutes.

Figure 4 illustrates what happens when water is circulated over a pad system for only a short period of time as is the case when circulation pumps are controlled using a ten-minute interval timer. The circulation pumps were turned on at 2:10 p.m. then turned off at 2:12 p.m. Even though the circulation pumps were turned off, the incoming air temperature continued to drop for another three minutes. This is due to the fact that water on the pads when the pump was turned off continues to "wick" through the entire depth of the pad, thus increasing wetted pad area and therefore cooling. This observation gives the illusion that the water flowing over the pad is decreasing cooling because once it is shut off the cooling increases. The fact is though, that since the pads were not thoroughly wetted during the two minutes the circulation pumps were operating, the cooling achieved was actually reduced (as well as humidity) compared to when the pads were fully wetted as illustrated in Figure 1. Figure 5 is a second illustration of the same phenomenon. Cooling continues to occur after the water circulation pumps are turned off, but the total amount of cooling is reduced. Both figures also illustrate the fact that reduced cooling also resulted in a lower relative humidity. More cooling, more humidity. Less cooling, less humidity. You simply cannot get more cooling and less humidity using an evaporative cooling system because it is the increase in relative humidity (moisture evaporated into the air) that is producing the cooling.

Operating a pad off an interval timer may not necessarily lead to a significant reduction in cooling. When a pad is operated for long period of time using a 10 minute interval timer, it may not actually have time to fully dry before the next on cycle begins (in most climates it takes 20 to 30 minutes for a wet pad to fully dry). So even if a pad is only partially wetted during the first on cycle, by the second or third cycle it often becomes fairly wetted. This is provided that the circulation pump "on time" is at least two minutes and is properly sized. The net result is often that placing the circulation pumps on an interval timer doesn't always significantly decrease pad cooling. But, in no way does it increase the cooling produced by the pads. What is more likely to happen if the on time is too short, the circulation pump is too small, or if it is fairly hot and dry, placing the circulation pumps on a timer will tend to decrease cooling. Furthermore, not circulating water over the pad continuously increases dirt and mineral buildup on the pads, which in the long run will not only reduce the tunnel fans' ability to pull air into the house, but decrease pad life as well.

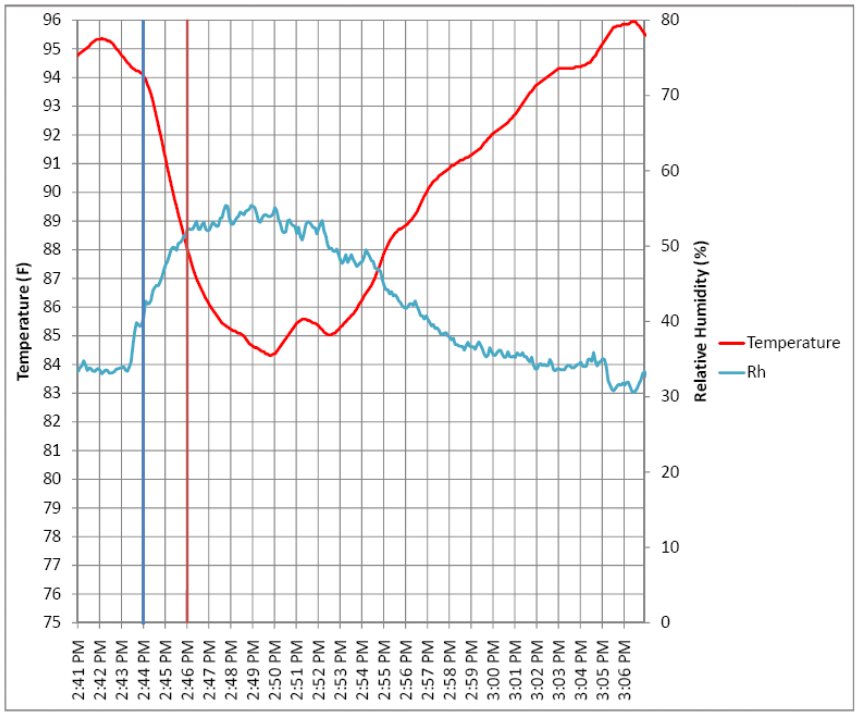

Figure 5. Pad system circulation pumps operating for two minutes.

There is a common belief that the pads produce maximum cooling just before they begin to dry out and not when there is water flowing over the pads. In part this misconception stems from the fact that an evaporative cooling pad dries slowly from the outside surface inward. So even though the surface of a pad may be just beginning to show signs of drying, 95% or more of the pad is still wet and essentially producing the same amount of cooling as when water is flowing over the surface of the pad. Add to this the fact that the temperature continues to fall after circulation pumps are shut off, then indeed the pad is producing maximum cooling just before it "appears" to dry out (Figure 5, 2:50 p.m.). BUT, this is the maximum cooling the pad will produce when operating on an interval timer cycle. When the circulation pumps are operating continuously, and the pads become fully wetted, it is likely that the "maximum" cooling experienced will typically be greater (Figure 1, 1:40 p.m).

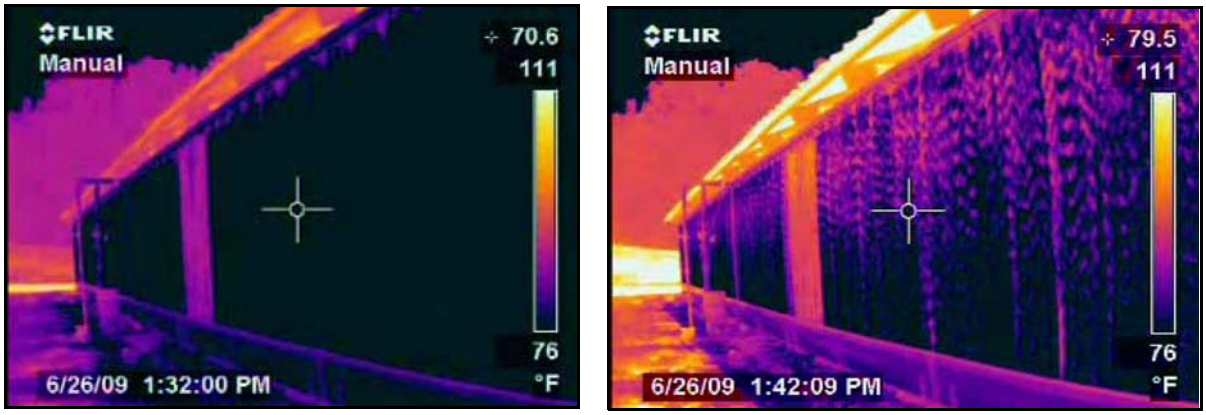

Figure 6. Thermal images of an evaporative cooling pad system.

Figure 6 is two thermal images taken during the time period shown in Figure 1. At 1:32 p.m. the water circulation pump is operating and the pad surface temperature is 70.6°F (wet bulb temperature). At 1:42 p.m., four minutes after the water circulation pumps were turned off, the pad surface is starting to show signs of drying (right thermal image, Figure 6). Though the pad surface temperature has increased to nearly 80°F, the temperature of the incoming air did not change from what it was at 1:32 p.m. when water was circulating over the pads (Figure 1). So even though the pad surface is showing initial signs of drying, the cooling produced by the pad is not reduced due to the fact that a vast majority of the pad is still wet and producing cooling.

The fact of the matter is that placing pads on a ten-minute interval timer has little benefit when it comes to keeping birds cool during hot weather. If the timer cycle is very short and the pad remains wet for the entire cycle, the pad will essentially produce the same level of cooling and humidity and evaporate the same amount of water as had the circulation pumps run continuously. The downside is that the lack of water flow over the surface of the pads will lead to dirt and mineral build up, which can lead to reduced pad life and reduced air flow into the house. It is important to realize that each time the pads dry or even start to dry all of the contaminates in the water become concentrated. When they are concentrated they are more corrosive and destroy the pad "a little bit". So every cycle reduces pad life. This is the reason why pad manufacturers do not warrant operating pad systems on interval timers. Long timer cycles where the pads fully or partially dry will result in higher house air temperatures. Bottom line, if you want maximum pad life and temperature reduction, evaporative cooling pads should be operated continuously, provided the outside temperature is high enough to warrant their use (*Poultry Housing Tips*. August, 2000).

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