The University of Georgia
Cooperative Extension Service
College of Agricultural and Environmental Science/Athens, Georgia 30602-4356

Poultry Housing Tips

Does Chilling the Water Circulating Over A Pad System Increase Cooling?

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Figure 1. Ice for pad systems?

In short, "no". The truth is that the cooling produced by an evaporative cooling system is due almost totally to the evaporation of water into the air and has very little to do with the actual temperature of the water being evaporated. Hot water, cold water, lukewarm water, simply doesn't matter. The laws of physics say it takes 8,340 Btu's to evaporate one gallon of water. So, when we evaporate a gallon of water into the air coming into a poultry house using either pads or fogging nozzles, 8,340 Btu's of energy in the form of heat is removed from the air which results in a decrease in air temperature. How much cooling will the evaporation of one gallon of water produce? It depends on the volume of air the gallon of water is being evaporated into; more air less cooling, less air more cooling. But, for example, if we evaporated one gallon of water into 100,000 cubic feet of air each minute, we would reduce the temperature of the air by approximately five degrees.

What role does water temperature play in cooling? Again, the laws of physics say 8.34 Btu's of energy are required to raise the temperature of one gallon of water one degree. So, if in the example above instead of evaporating, lets say, 70°F water, we evaporated 60°F water, the cooler water would increase the amount of heat removed from the air by 83.4 Btu's (10°F X 8.34 Btu's). What does this all add up to? If it was 90°F outside and we evaporated one gallon of water into 100,000 cfm we would drop the incoming air temperature to 85°F. If the water was 10°F cooler, the incoming air temperature would drop an additional 0.05°F to 84.95°F.

Here is an illustration of how much more effective it is to cool the air through evaporating of water than by using cold water. On a day when it is 90°F and 50% Rh a properly designed and maintained six inch pad system will produce approximately 11°F of cooling. If the house had 200,000 cfm of exhaust fan capacity, approximately five gallons of water would evaporate from the pads each minute. Now imagine instead of using evaporative cooling pads we ran the incoming air through a large radiator filled with cool water so the only cooling that took place was due to the heat removed from the air by the fact that the water is colder than the air (no evaporation). Let's say that the water went into the radiator at a temperature of 60°F and exited at a temperature 70°F and the air exited into the house at 79°F (the same as the pad system). To produce the same 11°F of cooling approximately 500 gallons of 60°F water would have to flow through the system each minute!

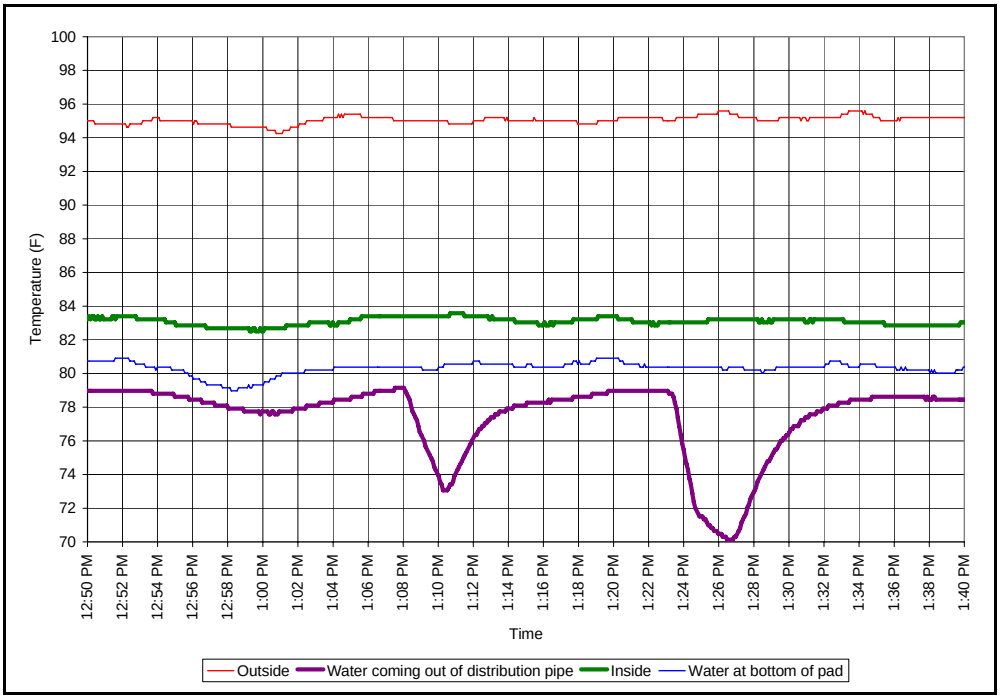

Figure 2. The effects of adding ice to a six-inch-pad system on a hot day.

Here is another way to look at it that may help you to see why water temperature is just not that important when it comes to cooling produced by an evaporative cooling system. 200,000 cubic feet of air (90°F, 50% Rh) weighs approximately 15,000 lbs. There is approximately 100 gallons per minute moving over the pads in a house that has 200,000 cfm of exhaust fan capacity. Since water weighs 8.34 lbs per gallon this means that there is 834 lbs of water circulating over the pad systems each minute trying to cool 15,000 lbs of hot air. Pound per pound we have 18 times as much air moving through the pad system as we do water flowing over it. There simply aren't enough pounds of cool water circulating over the pad system to make a significant difference in cooling produced by the pad system.

The fact that water temperature has so little to do with the cooling produced by a pad system is fairly easy to demonstrate. We showed this recently with a six inch pad system on a hot day and approximately 32 bags of ice (Figure 1). With an evaporative cooling pad system and all the tunnel fans operating we dumped 12 bags of ice into the pad system sump (Figure 2, 1:08 p.m.). We had to do this quickly because the ice melted very quickly. In fact, within just a few minutes there was no evidence that we added any ice to the system (1:14 p.m.). The water temperature going to the pads decreased, but not as much as you may think due to the large volume of water that is continuously being circulated through the system (Figure 2, 1:10 p.m.). Any cooling of the air the cooler water does produce (which is basically too small to measure) will tend to be limited to the top of the pad. Now some may ask but what if you added more ice? Ok, if you are still not convinced, we added another 20 bags (1:23 p.m.). This of course led to a greater drop in the temperature of the water delivered to the top of the pad but again did not produce a noticeable increase in cooling (1:27 p.m.).

To actually measure a significant difference in cooling we would have to deliver 60°F water to the top of the pad on a continuous basis. Now, keep in mind that the pad systems' pumps on the typical house just circulate approximately 100 gals/min (50 gal/min per side) to insure the entire pad surface is wet. But, if we put 60°F water on the top of the pad by the time it got to the bottom it would be warmed by the incoming hot air so we would need to get rid of it. So we would need to pump, not just circulate, 100 gals/min of fresh 60°F water to produce a measurable amount of cooling. How much could we increase the cooling produced by the pad system? Evaporating five gals/minute into 200,000 cfm would produce approximately 41,700 Btu's of cooling each minute (11°F cooling). Pumping 60°F water over the pad would produce an additional 8,340 Btu's of cooling per minute, which would increase the cooling produced by the pad system from a 11°F to approximately 13.3°F. If you wanted to add ice to the pad system instead of continually pumping 100 gals/min of fresh 60°F water to the pad systems, it would take approximately 43 lbs of ice (approximately 6 bags) per minute!

Trying to increase the amount of cooling produced by a well designed and maintained evaporative cooling system is really a waste of time and effort. The fact of the matter is that the amount of cooling produced by a pad system is primarily determined by outside weather conditions. For instance, on a 90°F when the humidity is 60% a six inch pad system will produce approximately 9°F of cooling. If the humidity happens to be 20% lower, the cooling produced would increase to 14°F. So don't worry about the temperature of the water in your evaporative cooling system, just make sure your pad is being properly wetted by your distribution system (no dry spots), your houses are tight (so all the air brought into the house is entering through the pads) and hope for dry weather.

Michael Czarick
Extension Engineer
(706) 542-9041 542-1886 (FAX)
mczarick@engr.uga.edu
www.poultryventilation.com

Gary VanWicklen
Extension Poultry Production Engineer
The University of Delaware
302 856-7303
gvw@udel.edu

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