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Poultry Housing Tips

The 80 - 80 Rule....and other facts about evaporative cooling

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During hot weather, did you know that whenever the air temperature is above 80°F the relative humidity is virtually always below 80%? And that when the air temperature is below 80°F,(i.e, early morning, evening, and night) that the relative humidity is always above 80%. It may seem hard to believe, but it is a fact. For example, from June through August of 1999 in Gainesville, Georgia, when the air temperature was above 80°F, 99.5 percent of the time the relative humidity was below 80%....99.9 percent of the time the relative humidity was below 85%! This is not only true in Gainesville but throughout most of the poultry-growing areas of the U.S.

This fact can be seen in the following temperature/relative humidity graphs. At night relative humidity is typically between 90 and 100%. As the air temperature begins to rise in the morning, the relative humidity falls. When the temperature creeps above 80°F, the relative humidity drops below 80%. In the evening the trend in reversed. As the temperature falls below 80° F, the relative humidity rises above 80% (this particular graph is from a broiler farm in West Georgia).

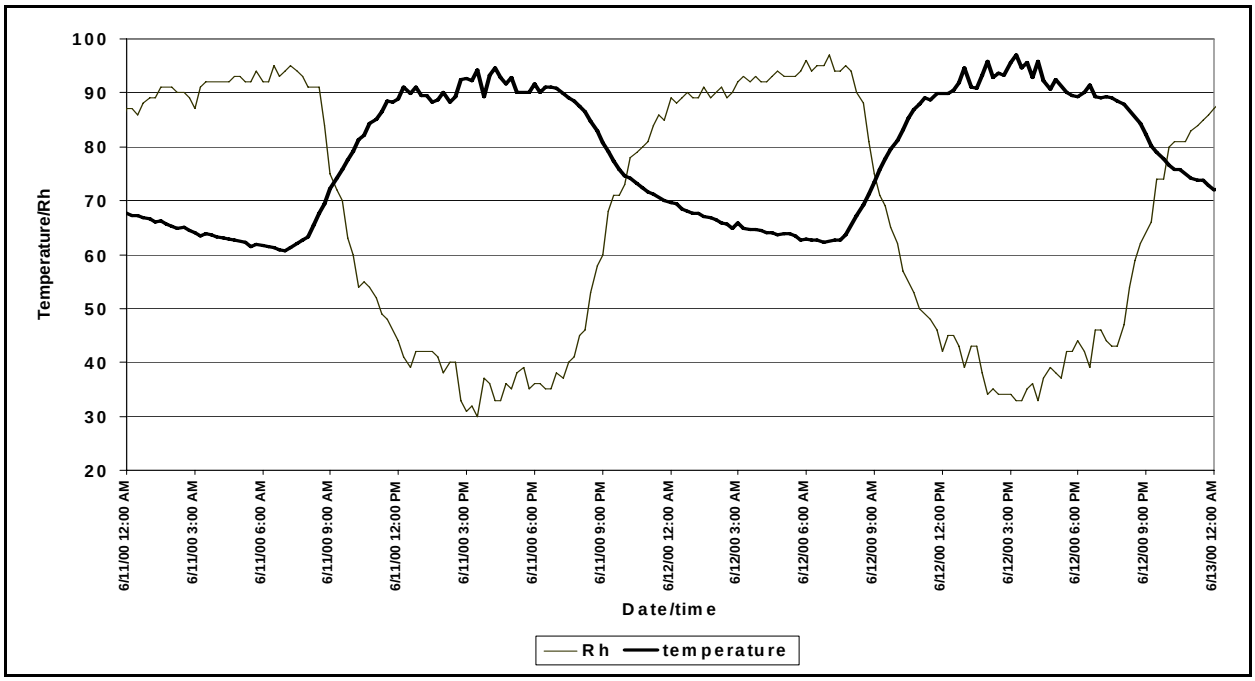

Figure 1. Relationship between air temperature and relative humidity

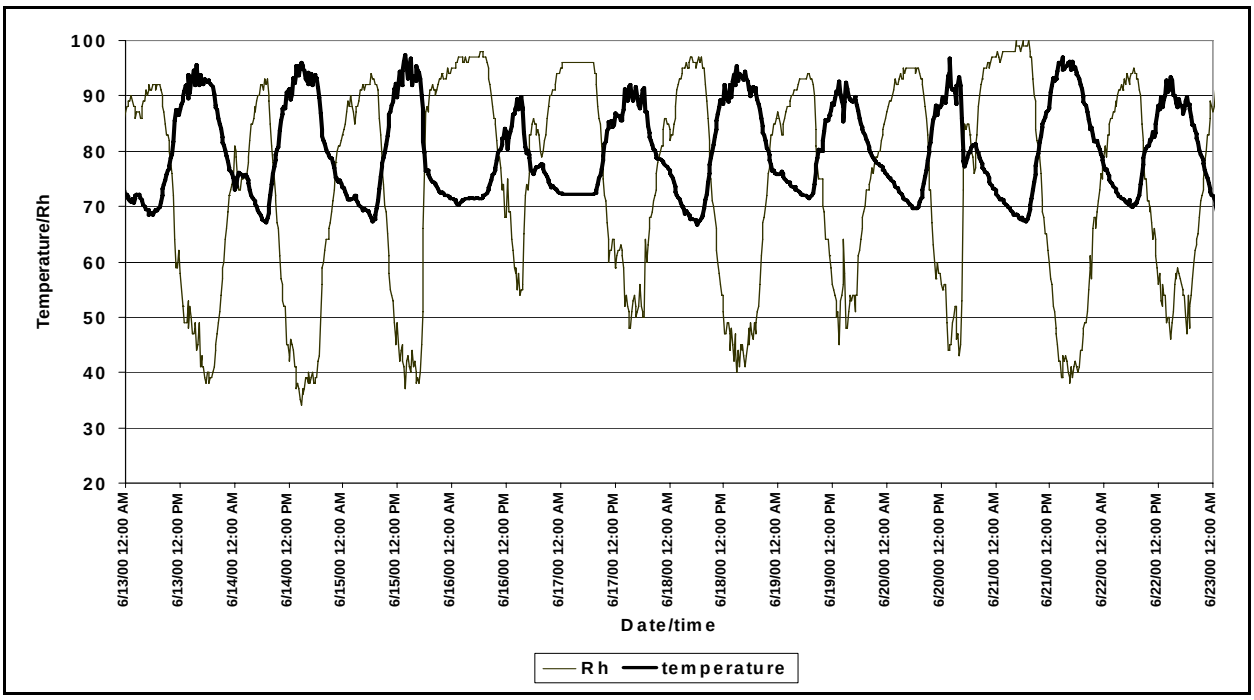

Figure 2. Ten day temperature and relative humidity graph

If you look closely at the graphs you can see another interesting trend, which is that the "crossover" of temperature and relatively humidity occurs at about 10 a.m. and 10 p.m. During hotter weather, when it gets hot earlier in the morning and it stays hot later at night this "crossover" of temperature and relative humidity may occur a little earlier in the morning and later at night. But the fact remains, when the air temperature is above 80°F, relative humidity is below 80%.

In drier climates or during drier times of the year, the crossover may occur more toward 70°F. That is to say when the air temperature rises above 70°F, the relative humidity falls below 70%. This of course is preferable because our evaporative cooling systems can be used earlier and more effectively. But the worst case scenario remains a crossover of approximately 80°F - 80 %.

These relationships between air temperature and relative humidity are important to keep in mind when operating an evaporative cooling system. When the relative humidity is above 80%, the amount of cooling produced by pads or foggers is very limited, typically less than a couple of degrees. This of course is because it is very difficult to evaporate water into the air and get cooling when the air already is 80% full of moisture. Therefore, using an evaporative cooling system before the air temperature reaches 80°F, and the relative humidity falls below 80%, will produce very little cooling and will create a number of problems. In houses with fogging nozzles, you will get wet litter. In fogging pad houses, you will get a lot of run-off. And in houses with recirculation system, the pump will tend to run too much, leading to algae growth, reduced air flow and decreased pad life.

So, how do you keep your birds at 70°F when you cannot use your evaporative cooling system until it is about 80°F outside??? The fact is if you have proper wind speed, no evaporative cooling is required until the air temperature exceeds 80°F. With an air speed of 500 ft/min, which many houses have today, there is about a 10°F wind-chill effect. Therefore, though the thermometer says it 80°F, the birds eat and grow like it is 70°F. Once the air temperature exceeds 80°F, the evaporative cooling system can be used to bring the temperature of the air in the house down to the high seventies - low eighties and therefore, the effective temperature can be kept at about 70°F.

Since the "crossover" between temperature and relative humidity typically occurs at about 10 a.m. and 10 p.m., there

is a general rule of thumb that evaporative cooling should not be used before 10 a.m. and after 10 p.m.. This is a very a good rule to follow. The only exception is during extreme weather when the air temperature can still be in the high eighties until nearly midnight. In this case it is perfectly okay to use your evaporative cooling system. If it is this hot, the relative humidity of the air will be below 80% and evaporative cooling can be used to reduce house air temperature.

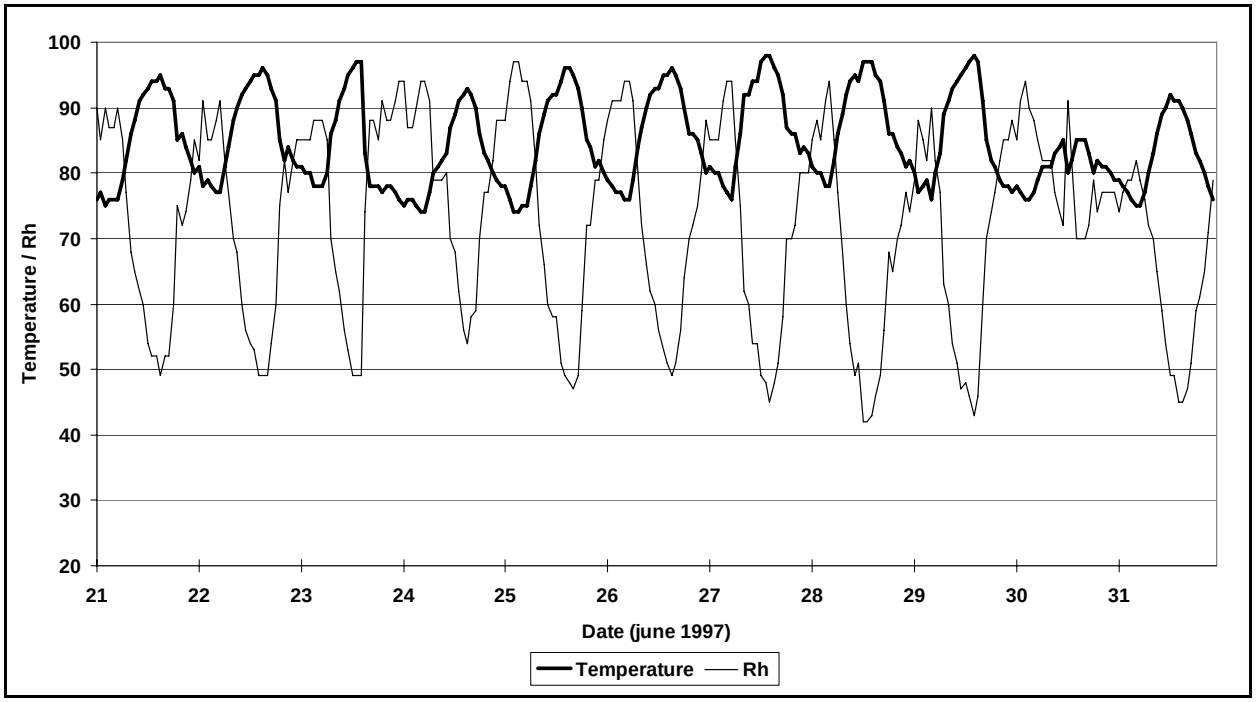

Figure 3. Temperature Vs. Rh for Shreveport, Louisiana

Another interesting fact to be aware of is that for every one degree of cooling received from an evaporative cooling system, the relative humidity of the air will increase about three percent. This is true whether a house is using fogging nozzles, fogging pads, or a pad with a recirculation system. Cooling is produced through the evaporation of water from the pads/foggers into the air, and therefore, the level of moisture in the air MUST increase as "evaporative" cooling is produced. The greater the cooling produced by pads or foggers, the greater the amount moisture added to the air. As you might expect, more cooling means more humidity. A six inch pad system that produces 20°F will increase the relative humidity of the air in the house much more than a fogging system that produces only 10°F of cooling.

The entire process can be seen in the following temperature/rh graph from a house in broiler house in West Georgia (Figure 4). At night the outside temperature was between 65°F and 70°F and the outside relative humidity was between 95 and 100%. As the air temperature rose in the morning the relative humidity began to fall. The relative humidity and temperature crossed over at approximately 80°F and 80% humidity. The fogging pad was set to come on at approximately 80°F. When the fogging pad first came on very little cooling was produced because the relative humidity was still fairly high. As the outside temperature rose and relative humidity fell, the cooling produced by the pad increased. This meant that in the morning the pad reduced the incoming air temperature by just a few degrees. But, by the afternoon when the outside air temperature was in the mid nineties and the relative humidity fell into the forties, the fogging pads reduced the incoming air temperature by more than ten degrees. Because cooling increased as outside temperature increased, the net result was that a relatively constant house temperature was maintained.

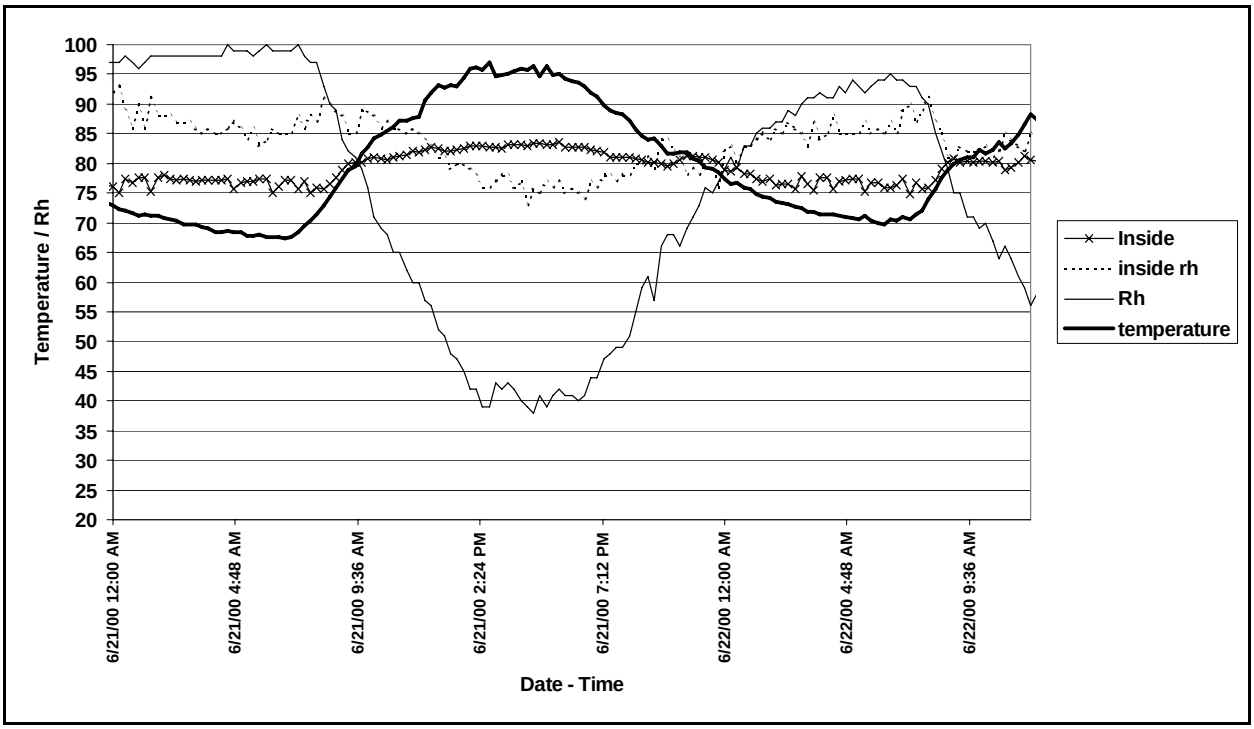

Figure 4. Outside and inside temperature and relative humidity

The fact that one degree of cooling increases the relative humidity of the air in the house by approximately three percent can be seen clearly in the previous graph. In the morning when only a couple of degrees of cooling were produced, the relative humidity inside the house was only slightly higher than that outside the house. But, by mid day when outside temperature was 92°F, the pads reduced the incoming air temperature by ten degrees to 82°F. The outside humidity at the time was approximately 45%. Since the incoming air temperature was reduced by 10°F, it would be expected that the inside rh would be approximately 30% higher than it was outside (Three percent humidity per degree of cooling X 10°F = 30 %), and it was (45% + 30%=75%). With a properly designed and operated evaporative cooling pad, you will find that the temperature as well as relative humidity in the house will remain relatively constant throughout the day.

As a general rule, the relative humidity in a house which uses a two inch fogging pad for cooling will typically be in the seventies or low eighties. In houses which use four and six-inch pads which produce more cooling, the humidity will typically in the mid to high eighties. More cooling means more humidity. It is important to realize, if you try to limit the humidity produced by the evaporative cooling pads through the use of humidistats or timers, you will limit cooling. Less humidity equals less cooling.

Should you worry about an inside relative humidity of 75 or 85% during hot weather if your air temperature in the broiler house is in the eighties? It depends on how much air speed you have. A bird has two ways to cool itself: panting and air movement. When there is little air movement, less than 300 ft/min, the bird depends heavily upon panting to cool itself. Since panting cools the bird through the evaporation of water off of its respiratory system, when the humidity is high, the effectiveness of panting is reduced. So, when there is a low amount of air movement, high humidity can pose serious problems. But, when there is a high wind speed in a house, the movement of air over the bird's body becomes the primary method of heat removal, making the bird less dependent on panting. When a bird is less dependent on panting to cool itself, high relative humidity is not as much of a problem.

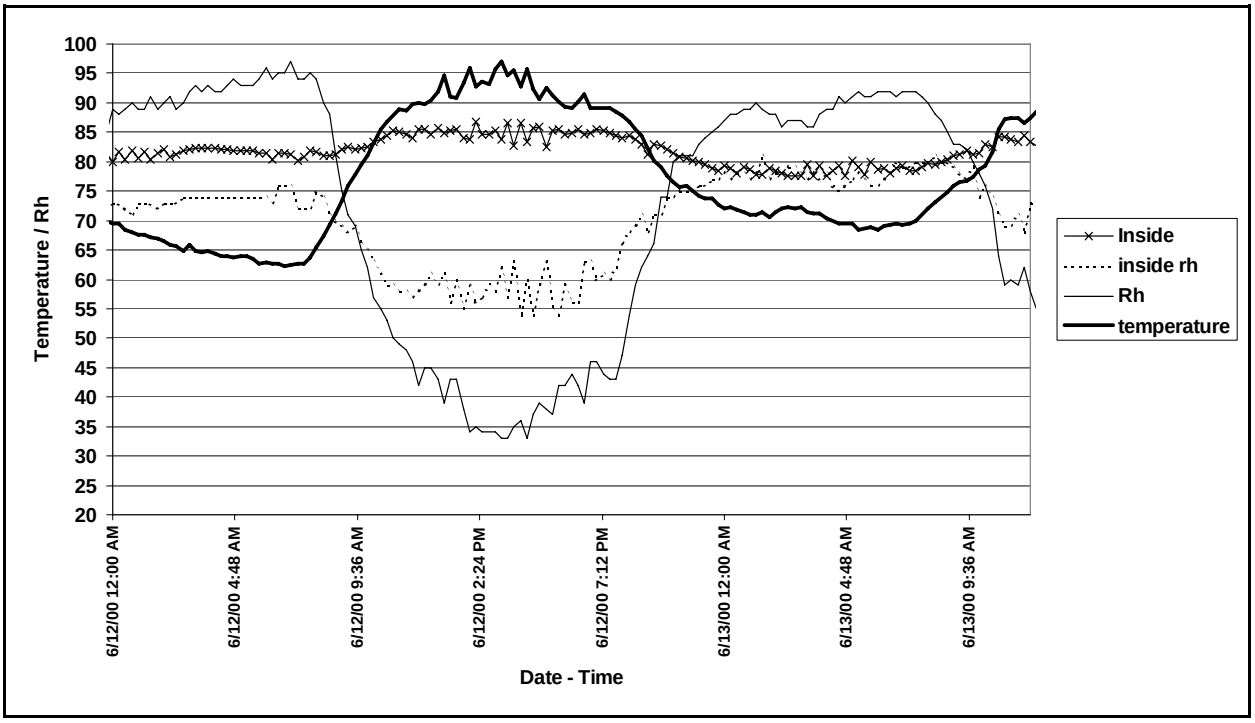

Figure 5. Inside and outside temperature and relative humidity

If you have a tunnel-ventilated house with pads, you have likely noticed that the fan end of the house is warmer than the tunnel inlet end. This is because as the air moves from the pads to the fan end of the house, the air temperature will increase due to the heat picked up from the birds. And just like when outside temperature rises and humidity falls, the relative humidity of the air in the house will decrease as it moves toward the fans and picks up heat. During extreme weather you may find that the temperature in the middle and fan end of the house may rise to the high eighties. When the temperature is this high, the relative humidity of the air will be relatively low, i.e., 60%. At this time, using interior fogging nozzles is can be effective (Figure 5). If interior nozzles are used when the house temperature is in the mid to low eighties the humidity will still be in the seventies which is too high to insure that the interior fogging nozzles will not cause excessive house wetting. After all, it is one thing to turn on a foggng pad when the humidity is in the seventies and get a little run-off; it's another to use foggers in the house and have "run-off" in the house.

It is often tempting when you have market-age birds to run interior fogging nozzles in pad houses when the house air temperature is in the low eighties because the birds may be panting. Growers should avoid this temptation because more problems can be created than solved. Keep in mind that getting a chicken wet does not produce nearly as much as a cooling effect as when we get wet. When we get wet, water evaporates directly off of our skin which removes heat directly from our bodies. But, when a chicken gets wet, its feathers usually keep its skin stays dry and therefore very little cooling takes place. It is like you wearing a heavy winter coat in a house with fogging nozzles. The water does not come in contact with your skin so cooling is fairly limited.

It is important to note that running interior nozzles in pad houses when conditions for cooling are marginal can actually increase heat stress. Excessive house moisture placed in the house during the day can make conditions worse at night due to increased humidity. Instead of the humidity running in the low nineties at night, the excessive moisture put into the house by the fogging nozzles during the day may increase the humidity to the mid to high nineties. Running interior fogging nozzles in marginal conditions can lead to litter wetting which can result in increased heat and ammonia production. The excessive use of interior fogging nozzles can also dampen fan shutters increasing dust collection on shutters which may reduce air flow by as much as 30%. A 30% reduction in wind speed

can reduce the wind-chill effect by 50%. Last but not least, excessive house moisture can lead to decreased equipment life.

In conclusion, if you keep in mind the following rules of thumbs about evaporative cooling, you should be able to keep your heat stress related problems to a minimum:

1) When outside air temperature is above 80°F, relative humidity is almost always below 80%.
2) Using evaporative cooling when the humidity is above 80% is of essentially no benefit.
3) A relative humidity of 80% is not a problem if you have proper wind speed.

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