The University of Georgia

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Poultry Housing Tips

Condensation Clouds

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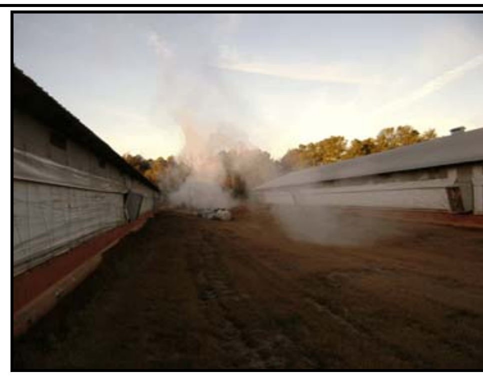

Condensation clouds are a fairly common site on poultry farms during cold weather. They allow us to see, for a brief moment, the typically invisible moisture that is in the air that surrounds us. The fact is that from a practical standpoint, there really is no such thing as "dry" air. All air contains some amount of invisible moisture. We generally describe how much moisture is in the air in terms of relative humidity. But we must keep in mind that the moisture holding ability of air is not constant, but changes with temperature. Warmer air can hold more moisture than cooler air. In fact, for every 20ºF increase in air temperature, the moisture holding ability of air roughly doubles. So, 60ºF air can hold twice the moisture as 40ºF, which can hold twice the moisture of 20ºF, and so on.

The actual amount of moisture that is contained within a 1,000 cubic feet of air at various combinations of temperature and relative humidity can be found in Table 1. From Table 1 it can clearly be seen that maximum moisture holding ability of air (Rh=100%) changes quite dramatically with temperature. For instance, 100ºF air can hold over twelve times the moisture as 30ºF air can. Since the moisture holding capacity of air changes with temperature, the amount of moisture that is in the air when the relative humidity is for instance, 50%, is not the always the same. So if outside it is 40ºF with a relative humidity of 50% and inside it is 80ºF with a relative humidity of 50%, even though the relative humidity is the same, the air inside the house actually contains over four times the amount of moisture per 1,000 cubic feet than the air outside the house.

Once you realize that the moisture holding ability of the air changes with temperature, and that humidity is a relative concept, you can begin to understand how you can remove moisture from a house even when it is cold and rainy outside. For instance, if it is 40ºF and rainy (100% Rh) many producers believe that ventilation rates should be decreased because, after all, what is the point in bringing saturated air into a house where the relative humidity may only be 60%? But, one must keep in mind that the moisture holding ability of air changes with temperature and that in fact even though the relative humidity of the outside air may be higher than that inside, the outside air can actually be drier if it is significantly cooler outside than inside. For instance, if it is 80ºF inside and the relative humidity is 60% there are 0.117 gallons of water in every 1,000 cubic feet of air. This means that there are actually three times the amount of water in every 1,000 cubic feet of air inside the house than outside when it is 40ºF and the relative humidity is 100% (0.046 gallons/1,000 ft^3 of air). So for every 1,000 cubic feet of "dry" inside air you exchange with "wet" outside air, you are actually removing 0.071 gallons (9.1 ounces) of water from the house.

	20%	30%	40%	50%	60%	70%	80%	90%	100%
10 F	0.002	0.003	0.005	0.006	0.007	0.008	0.009	0.010	0.012
20 F	0.004	0.006	0.008	0.010	0.011	0.013	0.015	0.017	0.019
30 F	0.006	0.009	0.012	0.015	0.018	0.021	0.024	0.028	0.031
40 F	0.009	0.014	0.018	0.023	0.028	0.032	0.037	0.041	0.046
50 F	0.013	0.020	0.027	0.034	0.041	0.047	0.054	0.061	0.068
60 F	0.019	0.029	0.039	0.049	0.058	0.068	0.078	0.088	0.098
70 F	0.028	0.041	0.055	0.069	0.083	0.097	0.111	0.126	0.140
80 F	0.038	0.058	0.077	0.097	0.117	0.137	0.157	0.177	0.198
90 F	0.053	0.080	0.107	0.135	0.162	0.190	0.218	0.247	0.276
100 F	0.072	0.109	0.147	0.185	0.223	0.262	0.301	0.341	0.382

Table 1. Moisture holding ability of air (gallons per 1,000 cubic feet).

So when we warm air, its moisture holding ability increases and we are better able to keep our floors dry. But, what happens when we cool air? As you might suspect, its moisture holding ability decreases. For roughly every 20ºF we cool air its moisture holding ability is cut in half. So if we take 80ºF air with a relative humidity of 60% and we cool it 20ºF, the moisture holding ability of the air would be cut in half, and the relative humidity would double to 120%. In other words 20% of the moisture that is in the air would have to come out of suspension and you are likely to see a condensation cloud form.

Whenever you cool, warm-humid air there is the possibility of a condensation cloud forming. The more moisture there is in the air, the more you cool it, the more likely a condensation cloud will form. But keep in mind when you see a condensation cloud forming inside your house, it is not a sign that you are bringing moisture into your house, but rather a condensing of the moisture that is already in the house that was invisible to the naked eye. Basically what is happening by cooling the air inside the house you are taking moisture that was already removed from the litter and putting it back into the litter and on to the birds.

How does a producer minimize condensation clouds forming inside their houses during cold weather? **First, keep humidity levels to a minimum, ideally 60% or lower.** The lower the relative humidity in a house, the less likely condensation clouds will form. For instance, if it is 80ºF and 80% Rh and the air is cooled 20ºF, basically 60% of the moisture will need to come out of suspension. But, if it is 80ºF and 40% Rh, no condensation would form if the temperature was decreased 20ºF because the Rh would only increase to 80%. **Secondly, make sure that the cold dry air you bring in mixes thoroughly with the warm humid air in the house.** The more warm air the cold incoming air mixes with, the less likely it will decrease the temperature of any given cubic foot of air to the point that the moisture in the air will drop out of suspension. If you decrease the air in the entire house a couple of degrees, condensation will not likely form. But, if you only cool the warm humid air near the side walls, condensation is more likely to occur. Think of it this way. If on a cold day you blow air slowly out of your mouth, a large condensation cloud will form. But if you blow out very quickly (producing greater mixing) a smaller cloud will form.

Mixing of the cold incoming air with the warm humid air in a house can be maximized through the proper use of air inlets. Side wall inlets must have sufficient opening and be operated at high enough static pressure that the cold incoming air makes it all the way to the center of the house before falling to the floor. Leakage must be kept to a minimum due to the fact that cold air which enters through cracks in the side walls will to drop quickly to the floor, increasing the likelihood of condensation cloud formation. Last but not least, circulation fans should be used to help promote the distribution of cold, fresh air throughout the house.

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