Humidity in Incubation

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No aspect of incubation causes more confusion and concern than humidity. When other factors appear correct humidity is often blamed for poor hatches but whether too high or too low may still be in doubt. It doesn't have to be so; a few simple procedures can take the mystery out of humidity and put control back in the hands of the operator.

Humidity is one of four primary variables which must be controlled during egg incubation – the others being temperature, ventilation, and movement (turning). Humidity is the most difficult of the four to monitor accurately and to control and therefore is commonly misunderstood. The operator instructions that accompany all incubators give guidelines to achieve correct humidity levels for most species under normal conditions and in the majority of cases this gives excellent results so first check that you have followed these guidelines.

However, there are times when incorrect humidity levels do cause problems and further steps are needed to check that humidity levels are correct. This article explains the effect of different humidity levels, measurement of humidity, and the best techniques for achieving correct humidity levels.

Before spending time and effort checking incubation humidity levels, it essential to ensure that temperature and egg turning are correct – refer to the unit's operating instructions. Also check that the eggs are fertile and the parent stock healthy, properly fed, and free from in-breeding.

The Effect of Humidity Upon the Incubating Egg

Egg shells are porous – they allow water to pass through, and so all eggs, whether being incubated or not, dry out slowly. The amount of water that an egg loses during incubation is important and this is determined by the humidity levels within an incubator; if the humidity level is higher then the egg will "dry out" more slowly than if the humidity is lower.

All eggs have an air space at the round end and as water is lost through the shell it is replaced by air drawn through the shell into the air space which gradually increases in size. This air space plays a crucial part in hatching. It is the first air that the fully developed chick breathes and the space allows the developed chick some movement inside the shell to allow it to maneuver into hatching position.

If the incubation humidity has been too high the egg will have lost too little moisture and the chick will be rather large. In this case the air space will be too small, the chick's respiration will be affected and the young bird will have difficulty breaking out of the shell because of the lack of space.

Commonly, with excess incubation humidity, chicks will die just before or after having broken through the shell in one place ("pipped") either through weakness because of the lack of air to breathe in the shell or because of lack of space to turn and cut around the shell with their bill. Often, because of pressure within the egg, the bill protrudes too far out of the initial hole preventing the normal anti-clockwise progress of the bill chipping the shell from inside. The bill becomes gummed up with drying mucus.

Low incubation humidity levels lead to small chicks with large air spaces by the time the hatch is due. These chicks will tend to be weak and may also die just before, during, or just after hatching. It should be noted in general that a slightly lower humidity level than optimum is likely to be less disastrous than a slightly higher than ideal level.

It is important also to understand that humidity does not directly affect embryo development unless the egg is seriously dehydrated. Only temperature and egg turning affect growth of the embryo directly. Humidity is important only to achieve the right balance between excessive dehydration and space within the egg as it reaches full term. Thus a temporary error in humidity can be corrected later provided the error is observed and the right action taken. Death of an embryo at early or mid-term stages of incubation is not usually attributable to incorrect humidity.

Measurement of Humidity

Many materials are capable of absorbing water or water vapor and air is one of them. Water vapor is a gas like any other gas, and air is a mixture of gases, one of which is usually water vapor. The difference is that the amount of water vapor varies widely whereas the other gases which make up our atmosphere remain fairly constant. The range of vapor may be from none to a certain maximum which the air can absorb. This maximum increases with temperature and is known as saturation level.

There are two commonly used ways to define humidity and the differences need to be clearly understood. These are:

Relative Humidity (RH) Expressed as a Percentage

This is a measure of the amount of vapor in air compared with the maximum that could be absorbed at that particular temperature. This is why relative humidity (RH) is quoted as a percentage. For example, an incubation RH level of 50% might be quoted. This means that at incubation temperature the air in the incubator contains half of its maximum possible water vapor capacity. Because maximum possible water content increases at higher temperature, if the temperature was increased but no additional water added then the % RH level would drop. The air would become dryer.

A good way of imagining this effect is to think of a bath sponge. When the sponge is squeezed to half its normal size, clearly it can hold less water. Imagine a half-squeezed sponge soaked in water until no more can be absorbed (saturated). This is analogous to cold air at 100% RH – no more water can be absorbed. If the sponge is allowed to expand completely then, although the amount of water has not changed, the sponge is relatively dryer than before because it has greater capacity to absorb water. This is analogous to warmer air containing the same amount of water vapor which will now have a much lower RH level.

Conversely, when air cools, the capacity of the air to hold water vapor reduces and % RH levels will rise. If the air temperature drops below the saturation point (100%RH) the water vapor condenses. An example of this is dew forming on a cold night after a warmer day.

Wet Bulb Temperature

This is the temperature (in degrees C or F) of a thermometer with a moist cotton wick around its bulb. Evaporation of water from the wick cools the bulb by an amount related to the relative humidity. This cooling effect is the same as the chill we feel when we step out of a shower. It is the difference between Wet Bulb temperature and air temperature that is important, so air temperature or Dry Bulb temperature must also be known to define the RH. In incubators the Dry Bulb temperature is constant (we hope!) so WB is often quoted on its own.

Direct measurement of RH is not easy. Cheap hygrometers are available but you get what you pay for; we have seen cheap instruments reading 30% different from out of the same new pack. More expensive direct reading digital instruments have improved in recent years and are not so prone to calibration drift but still need to be recalibrating occasionally. A very reliable method of measuring RH without spending a lot of money, is to measure wet and dry bulb temperatures and convert the information to %RH by using a simple chart.

Thermometers for measuring Wet and Dry bulb temperatures are usually identical; the wet bulb instrument just has a wick around the bulb. There are two special cases where Wet and Dry bulb readings are the same; when the air is saturated (100%RH), and when the wet wick has dried out.

A further complication is that it is difficult to measure humidity in "still air" incubators. Wet bulb thermometers do not work well in near static air conditions. The other problem is that the temperature will vary by several degrees from the top of a still air incubator to the bottom and so RH readings will vary with height too. Fortunately the humidity level in still air incubators is probably less critical than in fan assisted (forced draught) machines.

Achieving Correct Humidity Levels

There is a fairly easy and reliable way of measuring RH indirectly and, more importantly, directly measuring the effect that RH level has on the egg. This is by weighing the eggs to monitor their water loss over the incubation period. Most species of birds need to lose between 13 and 18% of their weight from the time of setting the eggs in an incubator to hatching. Data is available on many species but as a rough guide, domestic hens, waterfowl, and game birds should lose 13 or 14%, parrot species and many other altricial species around 14 to 18%. By measuring the weight of the eggs at intervals during incubation and comparing this to the expected weight needed to achieve the ideal weight loss by hatching time, it is possible to see when the rate of water loss is too great due to humidity being too low or vice versa. Eggs can be weighed individually or in convenient groups (trays?) and averaged.

In practice, this means drawing a graph (see chart) with incubation time in days along the x-axis and weight up the y-axis. The average weight of eggs when set (day 0) can be entered and the ideal hatching weight (average day 0 weight less, say 14%) can be plotted on the day the hatch is due. These two points are joined to give the ideal weight loss line. Average weights can then be taken every three or four days and plotted on the graph. If the actual average weights are lower than the ideal, then humidity levels need to be increased and vice versa. Thus any deviation from the ideal weight loss line can be corrected as incubation progresses. The important point is to reach the ideal weight loss by hatching day; some deviation form the ideal weight loss line earlier in incubation will not cause damage.

Altering Incubation Humidity Levels

All incubators should have the facility to evaporate water inside the egg chamber and thereby adjust humidity levels. Two controllable factors influence humidity levels: water surface area and the amount of fresh air the incubator draws in. Most incubators have two or more water pans to give some flexibility over evaporation rates. Remember that it is the total surface area of water that matters not the depth. So to increase humidity levels fill more pans and reduce ventilation by either adjusting the control or blocking up to half of the ventilation holes. Some ventilation must be maintained to allow the chicks to breath. Refer to the operator instructions for your model. In exceptional circumstances it may be necessary to further increase the surface area of evaporation by using evaporating pads or blotting paper to soak water from the vessels in the incubator. Do not spray the eggs with water – the increase in humidity is very short lived and bacteria may be spread.

A third factor does affect incubation humidity levels and this is the ambient (or environmental) humidity level outside the incubator. Clearly, if the air being drawn into the incubator contains very little water then incubation humidity levels will be lower (all else being equal) than if outside air is very humid.

As explained above, cold air cannot contain much water vapor so when cold winter air is warmed, the RH level will be very low (remember the sponge!). This happens in heated houses in winter and in incubators. The result is that, in general, humidity levels will tend to be lower in your incubator in winter than in summer and so water evaporation and ventilation levels should be adjusted with this in mind.

Because eggs are more likely to be damaged by excess incubation humidity, one common mistake is to use the same regime of water and ventilation in the summer that was successful in the winter. In warm summers it may be that no water is needed in the incubator until hatching time because the combination of warm, damp ambient air plus the water given off by the eggs themselves gives sufficient RH levels.

There is no evidence of any change in ambient humidity levels associated with global temperature change as a result of the Greenhouse Effect. Small climatic temperature changes are insignificant when compared to seasonal variations and so although it may be fashionable, there is no justification in blaming a poor hatch on global warming.

Humidity and Hatching

The humidity levels required as the chick emerges are different from those earlier in incubation. For the last day or so of incubation, humidity levels need to be much higher than earlier on. By "pipping" stage the projected weight loss of the eggs should have been achieved. High humidity levels are now required to prevent the down of the chick and shell membranes drying too fast as air gets to them and becoming stuck and difficult to separate. In natural incubation, membranes do not dry as quickly because the parent bird covers the eggs and reduces evaporation but in an incubator, drying membranes can be a problem. The actual level of humidity is not too critical for hatching but usually needs to be at least 60% RH. Humidity levels drop rapidly when the incubator is opened and take much longer than temperature levels to re-establish. To keep humidity high, try to avoid the temptation of opening the incubator often when chicks are emerging.