HUMIDITY IN INCUBATION

Humidity is one of four primary variables which must be controlled during egg incubation - the others being temperature, ventilation and movement (or turning). Humidity is the most difficult of the four to measure accurately and control and therefore is commonly misunderstood. Recent advances in solid-state humidity sensor technology mean that more modern small incubators will have digital humidity displays and active controls (Brinsea Advance and EX models) which help to achieve correct humidity. The operator instructions that accompany all incubators give guidelines to achieve correct humidity levels for most species under normal conditions and in most cases this gives excellent results so please 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. Whilst bird breeders have established norms for which humidity levels suit particular species there will still be some eggs that fall outside these. This information sheet explains the effect of different humidity levels, measurement of humidity and the best techniques for achieving correct humidity levels for your eggs.

Before spending time and effort checking incubation humidity levels it is 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.

Measurement of Humidity

Humidity is the level of water vapour in air and can vary from zero (at least in theory) to saturation, which is the maximum that air can absorb. This maximum increases with increasing temperature. This means warm air can absorb more water vapour than colder air. Humidity is usually expressed in percentage Relative Humidity (%RH). This is a measure of the amount of vapour 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 vapour 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.

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 vapour, which will now have a much lower RH level. Conversely when air cools the capacity of the air to hold water vapour reduces and % RH levels will rise. If the air temperature drops below the saturation point (100%RH) the water vapour condenses. This is why dew forms on a cold night after a warmer day.

Humidity measurement devices

1 **Digital Hygrometers:** Not normally accurate enough for incubators. 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!

2 **Hand-held Digital Hygrometers:** Direct reading digital instruments are better but may need re-calibrating regularly. Check the stated accuracy and ensure it is +/- 5% or less.

3 **Built-in Digital Hygrometers:** These direct reading digital hygrometers are now built into more sophisticated small incubators (like Brinsea's Advance models). These are much more convenient than a separate hygrometer and, in the case of Brinsea Advance models, can be easily linked to the external water pump for fully automatic humidity control

4 **Wet Bulb Thermometers**: Wet bulb thermometers are a cheap and accurate method of measuring RH but can be fiddly and unreliable and rely on converting wet and dry bulb temperatures to %RH by using a simple chart.

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 fan assisted (or forced draught) machines.

The effect of humidity upon the incubating egg

Eggshells 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 – the greater the water loss through the shell, the larger the airspace. This air space plays a crucial part in incubation. Within 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 manoeuvre 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 excessive incubation humidity the chicks will die 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.

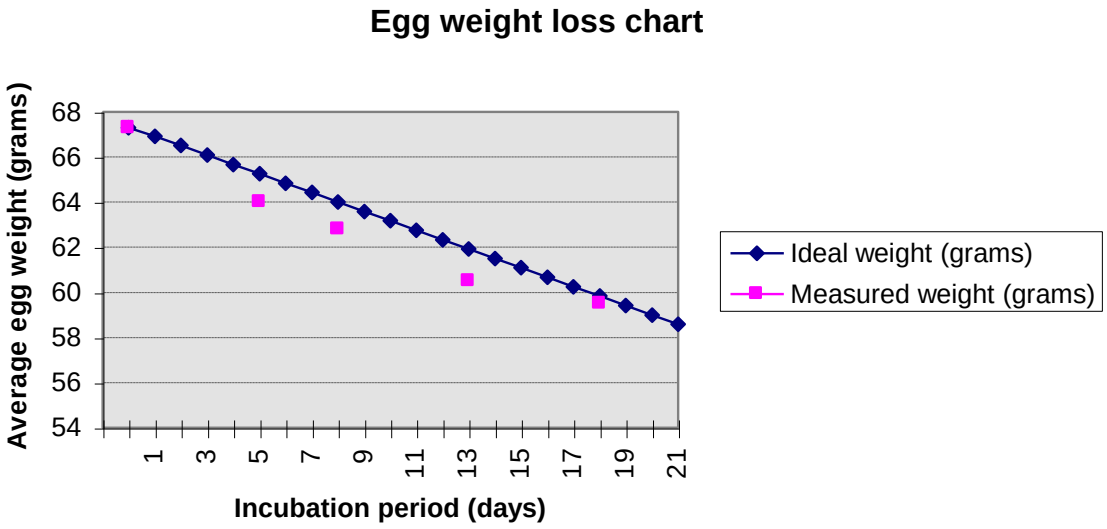
Low incubation humidity levels lead to small chicks with large air spaces by the time the hatch is due. These chicks will tend to be weak and may also die just before, during or just after hatching.
The effect of humidity on the incubating egg is only at the hatching stage and so variations day to day don't matter provided the average is right.

In general a slightly lower average humidity level than optimum is likely to be less disastrous than a slightly higher than ideal level.

Achieving correct humidity levels

There is a fairly easy and reliable way of measuring RH indirectly and 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 bird (with the exception of the ostrich family) need to lose between 13% and 15% of their weight from the time of setting the eggs in an incubator to hatching. By measuring the weights of the eggs at intervals during incubation, taking the average weights and comparing these to the expected weights needed to achieve the ideal weight loss by hatching, it is possible to see when the rate of water loss is too great due to humidity being too low and vice versa.

In practice this means drawing a graph (see below) 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 14%) can be plotted on the day the hatch is due. These two points are then 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 from the ideal weight loss line earlier in incubation will have little adverse effect.



The graph shows the average actual weights of incubating eggs against the ideal weight loss line - Note that the greater than ideal weight loss in the earlier stages of incubation has been corrected by hatching day.

The combination of monitoring egg weight loss and precise control of humidity with the Automatic Humidity Management Module (see below) is the ultimate solution of ensuring correct incubation humidity.

Altering incubation humidity levels

All incubators should have the facility to evaporate water inside the egg chamber and thereby influence humidity levels. Always refer to the manufacturers instructions. The important point is that two controllable factors influence humidity levels: water surface area and the amount of fresh air the incubator draws in. All Brinsea incubators have two water vessels 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 the second vessel (or if both are dry, fill one) 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. 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 vapour so when cold winter air is warmed temperature 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 particularly sensitive to excess incubation humidity the most common mistake associated with incubation 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 possible to add no additional water to 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.

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 this stage the weight loss of the egg should be 13-15% and water loss for the last 24-48 hours will not significantly affect this. The high humidity levels are required to prevent the membranes of egg drying too fast as the chick hatches and becoming tough and difficult to tear. In natural incubation the membranes cannot dry quickly because the parent bird is sitting on the egg but in an incubator drying membranes can be a problem. The actual level of humidity is not too critical for hatching but

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. Try to avoid the temptation of opening the incubator too often when chicks are emerging to maintain high RH levels.

Summary

- Follow the incubator manufacturer's instructions for your machine.
- As a general rule most species need an average humidity of 45% - 50% during incubation and 60% or higher for hatching but if you suspect that poor hatch results are due to incorrect humidity measure weight loss and be guided by the graph.
- Average incubation humidity is important, so short term changes don't matter.
- Don't rely on readings from cheap hygrometers.
- Don't try to measure humidity in still-air (without a fan) incubators
- Use an incubator with automatic humidity control for best control.
- Low incubation humidity tends to be less dangerous than high humidity.
- Weight loss measurement is the best way to ensure humidity is right for your eggs.

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