Quality control – how uniform is your setter temperature?

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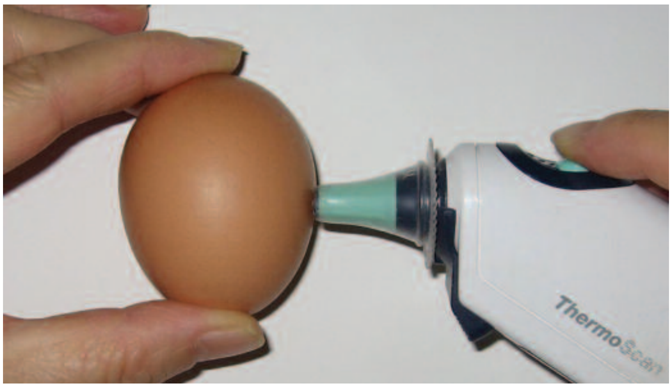

Using the Braun Thermoscan to measure eggshell temperature.

During incubation, the chicken embryo develops from the tiny germinal disc found in the fertile egg when it is laid, into a fully functional, live chick. For this to happen, the eggs need to be held in a constant, warm environment at the correct temperature.

Time is also an important factor and differences in the cumulative heat input will affect the incubation time needed for the chicks to hatch. If temperature variations develop within the setter, embryo development and hatchability can be negatively affected. The ability to monitor the uniformity of the temperature within the setter is a useful quality control tool for the hatchery.

Effect of temperature

It is well known that the optimal still air temperature for hatching chicken eggs is somewhere between 37 and 38°C. Small differences away from the optimum will not only advance (if warmer) or delay (if cooler) embryo development, but will usually have some impact on the quality of the chicks that hatch.

Chicks hatched from eggs incubated too warm will have a variety of abnormalities at the navel (black buttons) and in the down. If the temperature is very different from the optimum, then hatchability will be depressed; big depressions in hatch will occur in eggs given six hours at 43°C and a total hatch failure will occur after only a short time at 46°C. Prolonged exposure to a slight increase in temperature, for example an increase of just 1°C applied for several days, will also have a negative effect on hatch.

Incubation temperatures that are too low will have a negative effect on embryo development and hatchability as well. Eggs incubated at temperatures that are too cool will produce large, soft chicks with a late hatch and a very wide hatch window.

For roughly the first half of incubation heat has to be supplied from outside the egg, coming from electric or water heaters, or, in multi stage machines, from the older embryos.

During this period the priority is ensuring that eggs are kept warm enough. Temperature uniformity at this time can be challenged by spray cooling, or by large amounts of cold air brought into the machine for ventilation. After about 12-13 days of incubation metabolic heat production from the embryo increases and heat removal from the mass of eggs becomes essential. If there are local ventilation problems anywhere in the machine, this can lead to eggs overheating, and in practice there are more problems of over heating than under heating in this period.

Ensuring that the eggs do not become too warm at this time becomes the priority; this is reflected in setter and hatcher programmes for single stage machines where air temperature steadily drops after 13-14 days.

Egg shell temperature

As understanding has developed it has been realised that what is important is the temperature of the embryo (usually estimated in practical situations by measuring the egg shell surface) rather than the air temperature in the machine.

For egg shell temperatures relatively small local deviations from a through-incubation target of 37.8-38.3°C can have a significant impact on chick quality, hatchability and relative incubation times in the part of the incubator concerned.

The optimal air temperatures through incubation for hatch and chick quality will not only vary through the incubation process, but will also show small differences depending on the incubator type, ventilation and air flow over the eggs and humidity levels achieved.

Manufacturers of incubation equipment provide detailed temperature and humidity profiles to their customers, which take account of all these differences. These should achieve optimal egg surface temperatures for most of the eggs in the incubator.

Table 1. Mean shell temperatures from infertile eggs down one side of a multi-stage fixed rack setter. Infertile eggs were identified and marked in trays near the top, middle and bottom of each stack and their shell temperatures measured using a Braun Infra-red thermometer.

Stack No	1	2	3	4	5	6	7	8	9	10	11	12
Top	37.2	37.3	37.6	38.0	37.9	37.5	37.4	37.7	37.9	37.2	37.2	37.3
Middle	37.2	37.3	37.7	37.7	37.4	37.2	37.1	37.2	37.8	37.7	37.3	37.2
Bottom	37.3	37.3	37.4	37.6	37.6	37.3	37.2	37.5	37.6	37.6	37.2	37.1

Monitoring uniformity

It follows that hatchability and chick quality are dependent on having good control of incubation temperature. Ideally, the temperature should be uniform throughout the setter, but in actual practice there can be large variations. This can lead to a widening of the incubation period for the eggs because embryos that find themselves in the colder areas will develop more slowly and hatch later.

Embryos in the warmer areas will develop faster, hatch earlier and spend too long dehydrating and deteriorating in the hatcher. If the temperature is too high it may depress hatchability and chick quality or even kill the embryo.

A simple technique is described below which has proved useful in assessing the uniformity of temperature throughout the setter.

The first step is to candle eggs inside the setter in order to identify infertile eggs. Infertile eggs are ideal for this method, because they give a good indication of the long-term average temperature in the location, without being affected by internal heat production by the embryo.

These are then marked clearly so they can be located again during the temperature monitoring phase. Several eggs per location should be marked in as many locations as possible throughout the whole setter, avoiding eggs at the edge of a tray.

The shell temperature of the infertile eggs is then measured using a Braun Infra-red thermometer.

As an example, in a fixed rack multi-stage setter, infertile eggs should be identified in trays near the top, middle and bottom of each

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stack. The mean shell temperature from each of these locations is then entered in an Excel spreadsheet as shown in Table 1.

If the table is highlighted and the 'Surface' Chart Type chosen from within the Chart Wizard of Excel it will immediately produce an impression of the temperature profile.

If the temperature range is set wide (0.5°C) then the profile shown in Fig. 1 would be produced.

However, by clicking on the legend box of the graph produced in Excel and choosing the 'Scale' tab it is possible to alter the temperature range covered by each zone. Fig. 2 resulted from choosing 0.2 as the major unit.

Using narrower temperature zones can help highlight problem areas. For example, the plot in Fig. 2 clearly reveals a cold spot at the bottom of the rack near the door of the setter (Rack 12).

Clearly, in this example, the stacks at each end of the setter are the coolest and stacks 4 and 9 are the warmest.

With a detailed plot of the temperature variability across the incubator, it is possible to identify long-standing faults in the machine, and start to identify and eliminate the main causes.

In the example given here, two faults were found. Worn door seals were allowing cold air to enter the machine just by the door, and also a fault in the humidifier spray, which was allowing water to spray directly onto the eggs, thus cooling them.

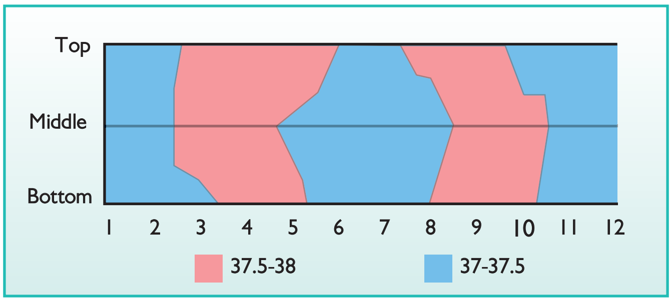
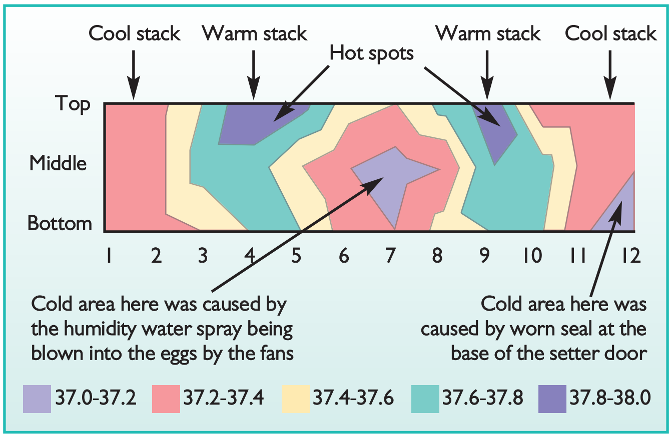


Fig. 1. Simple 'surface' plot with zones covering a 0.5°C spread.

Although the temperature drop in both cases was quite small, it could very well have worsened over time as the problem became more acute. In both cases, the problem is a common one, and is quite easily solved.

Fig. 2. Temperature zones now cover a spread of only 0.2°C. This reveals some problems in the setter.



Other possible causes of temperature variability would include incorrect fan speeds (especially if only some of the fans are affected), variable voltage through heater bars, cooling water temperature too cold and large gaps with no eggs due to an uneven setting pattern or misunderstanding of the optimal pattern for the machine being used.

Incorrect or variable turning angles can also affect local temperatures, through their effect on the air flow over the eggs.

Conclusions

The ability to monitor temperatures throughout the setter is a good quality control tool for the hatchery.

Temperature variability within an incubator can affect hatchability, the hatch window and chick quality. Regular monitoring can identify the risk areas which need early attention and help to give good consistency and quality in all machines.

The methodology described above provides a means of determining where in the setter temperature variations exist. The causes can then be identified and eliminated. ■