IMPLEMENT INCUBATION SCIENCE

People still perceive hatcheries as rather mysterious places. A chick develops hidden within its egg, and the eggs incubate hidden in huge heated, cooled and ventilated boxes – the setters. Yet artificial incubation was practiced in Egypt and China thousands of years ago. These very early hatcheries gave respectable levels of hatch – one description reports that they expected two chicks out of every three eggs set. Heated by smoky fires, there were no thermometers or thermostats other than the senses of the incubationists, who had to turn the eggs by hand twice a day.

Developments in hatchery practice during the early 20th Century were mostly engineering solutions to perform the temperature control and egg turning functions of the early incubationists. Multi-stage incubation was used so that the heat generated by the embryos could compensate for limitations in heat distribution and temperature control. Incubator temperature profiles (which strictly speaking refer only to the air temperature at the sensor) were optimised by trial and error within each hatchery.

Single stage incubation started to become popular around 30 years ago. At first, it was implemented because of the benefits to hatchery hygiene. Eggs were set in single stage machines using multi-stage programmes; hatch was poorer than it would have been in multi-stage machines. This showed clearly that there was a need to improve our understanding of the requirements of the embryo. Recent research has used increasingly sophisticated temperature monitoring technology to demonstrate what happens where embryo temperatures are not optimal, and to define conditions to give the best hatch and chick quality. During this process it has been discovered that incubation conditions – temperature, humidity, and time – can have a profound effect not only on hatchability and chick quality, but also on the growth, feed conversion and robustness of the birds throughout the broiler growth cycle.

The incubation specialist team:
Nick French, Dinah Nicholson and Eddy van Lierde.

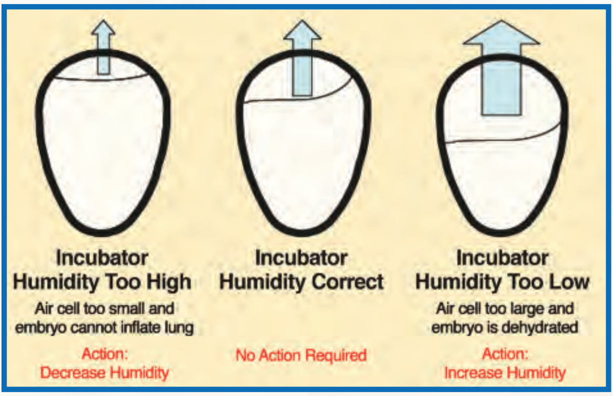
Now that much more is understood about the conditions the embryo needs to flourish, and the impact that incorrect incubation conditions can have on broiler performance, it has been possible to define a series of simple monitoring checks that the hatchery can perform as part of routine quality assurance programmes. The information generated allows the incubationist of the 21st Century to adjust incubator conditions to deliver what the embryos truly need.

This series of practical guides, called Hatchery How To, are designed to help hatchery workers carry out the important monitoring tasks in a consistent, meaningful and robust fashion. They cover egg weight loss, chick yield, embryo (egg shell) temperature, identifying infertile eggs, hatch debris breakouts and monitoring chick comfort. For each topic, its importance, the equipment needed to perform the task and the method that should be used is defined. The final section in each How To covers interpretation of the results – how they compare with target values, what deviations from the target are acceptable and finally the likely causes and solutions to deviations from target.

MEASURE EGG WATER LOSS – PART 1

Why measure egg water loss?

- Controlling incubator humidity to ensure that egg weight loss is in the optimal range will maximise hatch and chick quality.
- Routine monitoring of egg water loss is the best way to check that incubator humidity is correct – it uses the egg to tell us what is required.



- Changes in egg weight during incubation are due entirely to the loss of water from the egg. Therefore egg weight loss can be easily measured by weighing the egg.
- Incubated correctly, eggs lose on average 11-12% of their egg weight between laying and transfer at 18 days.

Note: A small amount of water (typically 0.5% per week of storage) is lost from the egg during storage. Any water loss during storage should be taken off that lost during incubation, for example if eggs are stored for a week average water loss between set and transfer at 18 days would be 10.5-11.5%.

To accurately measure egg water loss:

- Monitor egg water loss from three incubator trays from each breeder flock.
- Use a balance that can weigh a whole incubator tray of eggs to an accuracy of at least 5g.

Step 1:
Fill setter tray with the fresh eggs – exclude any cracked or poor shell quality eggs.

Step 2:
Weigh full setter tray – record weight and number of eggs on tray.

Step 3:
Label the tray so that it can be relocated at transfer.

Note: *Trays should be located in the incubator so that one is positioned near the top, one near the middle and one near the bottom of the incubator rack.*

Step 4:
If eggs are fertility tested prior to transfer, do not remove any clear or non-viable eggs.

Step 5:
At 18-day transfer, reweigh the tray of eggs – record weight. Reject any tray weights if there are cracked eggs on the tray.

Step 6:
Weigh empty setter tray – record weight

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MEASURE EGG WATER LOSS – PART 2

Calculation of egg water loss

$$\text{\% water loss} = \frac{\text{full tray weight at set} - \text{full tray weight at transfer}}{\text{full tray weight at set} - \text{Empty tray weight}} \times 100$$

For example: Empty tray = 1205g; Full tray at set = 8201g; Full tray at transfer = 7382g

$$\text{\% water loss} = \frac{8201 - 7382}{8201 - 1205} \times 100$$

$$\text{\% water loss} = \frac{819}{6996} \times 100$$

$$\text{\% water loss} = 11.7\%$$

Note: If eggs are not transferred and weighed at 18 days, calculated water loss should be corrected to 18 days to allow accurate and appropriate quality control. This is done by dividing by the actual number of days at transfer and then multiplying by 18. If eggs are transferred at 17 days then water loss corrected to 18 days would be: (11.7% ÷ 17) x 18 = 12.4%

Example of water loss recording sheet.
This sheet also records chick yield information as the two quality control processes can be easily combined.

Egg weights and chick weights

Company: ACME Farming

Farm: Windyhill Farm Age: 26 Weeks

Setter No.: 1, 2, and 3

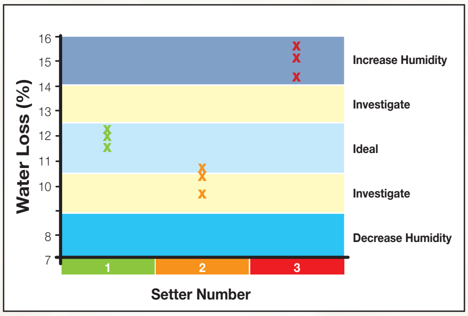
Set: 26/10/2010 Hatched: 16/11/2010

Broken Out: 16/11/2010

Hatcher No: 1

Interpreting results

The graph below shows the water loss results from three different incubators:



Incubator 1 has water loss within the acceptable range.
Action: No action required.

Incubator 2 has slightly low water loss but close to the acceptable range.
Action: Check the water loss from this incubator again, make sure humidifiers are working correctly and if it is still low, decrease incubator humidity.
Note: this water loss would be normal for long stored eggs.

Incubator 3 has very high water loss.
Action: Make sure there were no cracked eggs on these trays (these will lead to an artificially high estimate of water loss), make sure humidifiers are working correctly and increase incubator humidity.
Note: if cracked eggs are found to be present the data for that tray should be ignored and a repeat measurement taken.

To alter egg weight loss by 1%, humidity should be changed by about 5%RH or 2˚F (1˚C) wet bulb.

Tray No.	1	2	3	4	5	6	7	8	9
No. of eggs	132	132	132	132	132	132	132	132	132
Weight of empty tray	1205	1210	1205	1208	1206	1208	1212	1201	1205
Weight of full tray	8201	8364	8175	8191	8242	8336	8089	8263	8307
Transfer weight	7382	7499	7324	7451	7510	7637	7113	7183	7206
No. of chicks hatched	120	116	123	122	115	118	109	104	106
Total chick weight	4268	4238	4384	4395	4193	4371	3748	3667	3724
Culls and deads	1	0	1	1	2	1	2	3	2
Unhatched eggs	11	16	8	9	15	13	21	25	24
Egg weight loss (%)	11.7	12.1	12.2	10.6	10.4	9.8	14.2	15.3	15.5
Mean egg weight (g)	53.0	54.2	52.8	52.9	53.3	54.0	52.1	53.5	53.8
Mean chick weight (g)	35.6	36.5	35.6	36.0	36.5	37.0	34.4	35.3	35.1
Chick yield (%)	67.1	67.4	67.5	68.1	68.4	68.6	66.0	65.9	65.3

MEASURING CHICK YIELD – PART 1

Why measure chick yield?

• Chick yield (the weight of the chick at hatch as a percentage of egg setting weight) is a simple method of checking whether hatch timing and incubation parameters are correct.

• Chicks with a low yield have either been:
1. hatched for a long time before they were removed from the hatcher or,
2. incubated at a high temperature or a low humidity.
These chicks are at risk of being dehydrated and perform poorly on the farm.

• Chicks with a high yield have either:
1. only just finished hatching when they were removed from the hatcher or,
2. have been incubated at a low temperature or a high humidity.
If placed on the farm quickly these chicks will not be ready to eat and drink and will tend to be lazy.

Optimum chick yield

>68%
High

67-68%
Ideal

<67%
Low

>68% High: This chick will be lazy and not ready to feed and drink when placed on farm.

67-68% Ideal: This chick will be active and ready to feed and drink when placed on farm

<67% Low: This chick will be dehydrated and have little yolk reserve. Often very active and noisy.

Note: If chicks are to be placed onto the farm the day after hatch 1% should be added to the above ranges, i.e. optimum chick yield would be 68-69%.

If eggs are stored 0.5% should be added for each week of storage i.e. for eggs stored for two weeks optimum chick yield would be 68-69%.

The procedure for measuring chick yield

• To accurately measure chick yield and check the hatch timing of a flock:
- monitor the chick yield from three incubator trays
- use a balance that can weigh a whole incubator tray of eggs or a box of chicks to an accuracy of at least 5g.

Note: This procedure can be easily combined with the monitoring of egg water loss

Step 1:
Weigh empty setter tray – record weight.
Note: This can be done at setting or transfer.

Step 2:
Fill setter tray with fresh eggs. Exclude any cracked or poor shell quality eggs.

Step 3:
Weigh full setter tray – record weight and number of eggs on tray.

Step 4:
Label the tray so that it can be relocated at transfer.
Note: Trays should be located in the incubator so that one is positioned near the top, one near the middle and one near the bottom of the incubator rack.

Step 5:
At transfer ensure the hatcher tray is labelled so that it can be associated with the correct egg tray.

Step 6:
At hatch take-off, zero the balance with the empty chick box.
Note: If the chicks are to be vent sexed then the chicks need to be weighed before sexing.

Step 7:
Count all the good chicks from the hatcher basket into the box – record number.

Step 8:
Weigh the full chick box – record weight.

MEASURING CHICK YIELD – PART 2

Calculation of chick yield

$$\% \text{ chick yield} = \frac{\text{Average chick weight}}{\text{Average fresh egg weight}} \times 100$$

- Empty tray = 1205g
- Full tray @ set = 8201g
- Number of eggs = 132
- Number of chicks = 120

Example of chick yield recording sheet

$$\% \text{ chick yield} = \frac{4268 \div 120}{(8201 - 1206) \div 132} \times 100$$

$$\% \text{ chick yield} = \frac{35.6}{53.0} \times 100$$

% chick yield = 67.1%

This sheet also records egg water loss information as the two quality control processes can be combined.

Egg weights and chick weights

Company: ACME Farming

Farm: Windyhill Farm Age: 26 Weeks

Setter No.: 1, 2, and 3

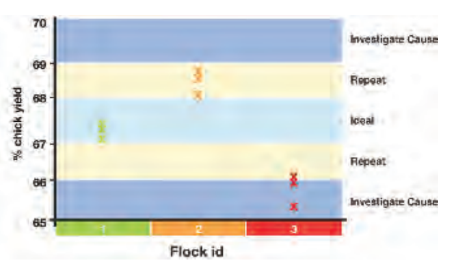
Set: 26/10/2010 Hatched: 16/11/2010

Broken Out: 16/11/2010

Hatcher No: 1

Interpreting results

The graph below shows the chick yield results from three different flocks:



Flock 1 has chick yields within the acceptable range. **Action:** No action required.

Flock 2 has slightly high chick yield but close to the acceptable range. **Action:** Check the chick yield from this flock again and if it is still high, use table below to investigate the cause of the high chick yield.
Note: This high chick yield would be acceptable if the chicks do not arrive on the farm on the same day as hatch.

Flock 3 has low chick yield and these chicks will be at risk of dehydration. **Action:** use the table below to determine the cause of the low chick yield.

Tray No.	1	2	3	4	5	6	7	8	9
No. of eggs	132	132	132	132	132	132	132	132	132
Weight of empty tray	1205	1210	1205	1208	1206	1208	1212	1201	1205
Weight of full tray	8201	8364	8175	8191	8242	8336	8088	8263	8307
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Mean Chick Weight (g)	35.6	36.5	35.6	36.0	36.5	37.0	34.4	35.3	35.1
Chick Yield (%)	67.1	67.4	67.5	68.1	68.4	68.6	66.0	65.9	65.3

Factors affecting chick yield

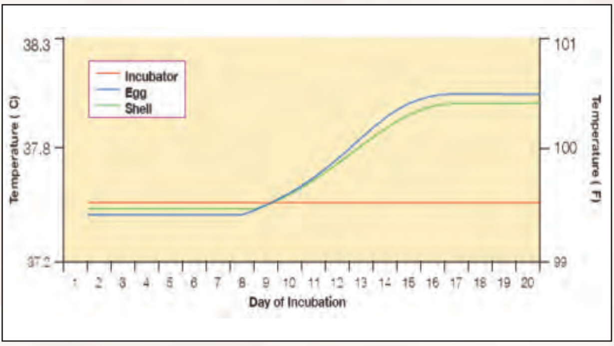
Low chick yield	High chick yield
1. Incubating the eggs too long.	1. Incubation time too short. This may be as a consequence of long egg storage, or eggs from very young or old breeders.
2. High incubation temperature.	2. Low incubation temperature.
3. Low incubator humidity.	3. High incubator humidity.

MEASURING EGGSHELL TEMPERATURE – PART 1

Why measure eggshell temperature?

- Correct setter temperature is critical for hatching good quality chicks.
- Setter temperature is what is experienced by the embryo inside the egg. It is not the air temperature of the setter.
- Eggshell surface temperature is closely related to internal egg temperature (see graph below). It is therefore a useful tool for determining whether or not setter temperature is correct.
- Shell temperature can be easily measured using a medical infrared thermometer.
- Optimum shell temperature for maximum hatch and chick quality is 37.8-38.3˚C (100-101˚F) throughout the whole setting period.
- Knowledge of eggshell temperatures allows setter temperatures to be adjusted to optimise conditions for differences in embryo heat production and machine design.
- Measurement of eggshell temperature should be used to establish the correct machine temperature setting for the type of egg that is being incubated and for the design of setter.
- It should not be used for calibrating setters or checking machine temperature uniformity.

Measured internal egg and eggshell temperature during the incubation period when incubated at a constant temperature – based on Tazawa & Nakagawa (1985) and French (1997).



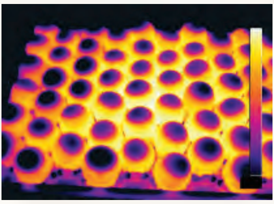
The procedure for measuring eggshell temperature

- The only equipment required for measuring eggshell temperature is a medical infrared ear thermometer.
- It is recommended to use a Braun ThermoScan ExacTemp (Model IRT 4520, type 6022).
- Correct region for measuring shell temperature is shown right.

MEASURING EGGSHELL TEMPERATURE – PART 2

Where and when to check for eggshell temperature

- The objective is to sample eggs within the machine from locations on the left and right, front and back and top, middle and bottom of the setter. The exact locations will vary with machine design but attempt to cover all areas of the setter.
- Do not choose trays at the very top or bottom of the trolley or rack.
- Choose eggs in the centre of the incubator tray to monitor; those at the edges of the tray will be cooler.
- To get a complete profile of the setter, eggs will need to be monitored at each stage of incubation.



Thermal image of eggs on a setter tray. Note that the temperature of the air cells and eggs at the edge of the tray is cooler than the temperature at the equator of eggs in the centre of the tray.

Step 1:
Check that the measuring tip of the thermometer is clean and that it has a new plastic cover on. (Some older thermometer types may need to be kept at incubation temperature for 30 minutes prior to use to prevent an error message).

Step 2:
Plan where to sample eggshell temperatures before opening the setter door, so that it will be possible to work quickly once inside. Ensure each area of the setter is monitored.

Step 3:
If it is not possible to work inside the setter safely while it is operating, turn it off and measure as many eggs as possible in 10 minutes. If it is not possible to measure eggs at all locations within 10 minutes, close and restart the setter and return after 30 minutes to complete the measurements.

Step 4:
Measure shell temperature at the equator of the egg, not at the top or bottom. Make sure the tip of the thermometer is flat against the eggshell surface.

Step 5:
Sample three eggs from the centre of each setter tray. For eggs in the second half of incubation, reject any measurement that is significantly cooler (>0.4°C/0.7°F) than the other eggs on the tray as it is likely there is no embryo in the egg.

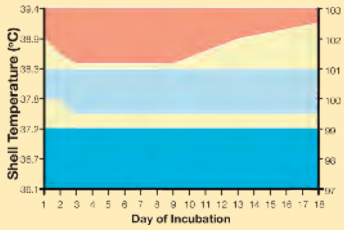
Step 6:
Record results. Determine average eggshell temperature and spread of eggshell temperatures.

Step 7:
Compare results against an egg shell temperature graph to determine if incubation temperature is correct. This will be covered in more detail in the next issue of International Hatchery Practice.

MEASURING EGGSHELL TEMPERATURE – PART 3

Interpreting eggshell temperature

Egg shell temperatures should be recorded on a graph like the one show below.



• The objective is for most of the eggs to be within the ideal temperature range (37.8-38.3˚C/100-101˚F) throughout the incubation period.

• In single-stage systems this is achieved by adjusting the temperature programme at each age of incubation.

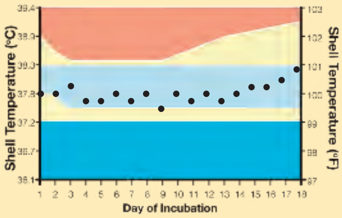
• In multi-stage systems where only one temperature setting can be used, there may have to be a compromise between the requirements for the start and the end of incubation. It is probable that at the start of incubation it will be necessary to have eggs cooler than ideal in order to ensure that eggs do not become too hot at the end of incubation.

• High incubation temperature is normally more damaging than low incubation temperature.

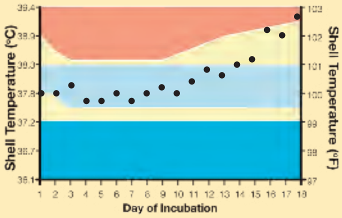
• If there is a wide spread of eggshell temperatures across one machine it may indicate that it needs maintenance.

Single-stage machines

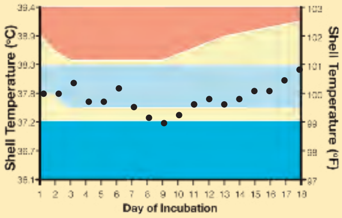
Note: Prior to any alteration of setter operating temperatures, ensure that there are no maintenance problems with the machine.



Temperatures within ideal range: no adjustments required.



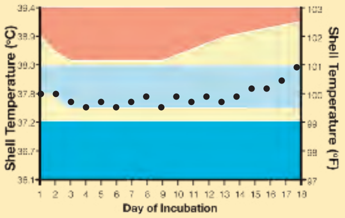
Temperatures from day 14 onwards too high: lower incubator temperature to bring day 14-18 temperatures into ideal range.



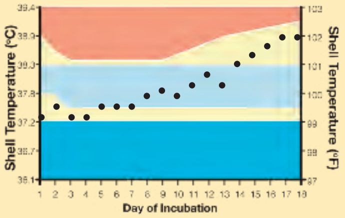
Temperatures from day 8-10 too low: increase incubator temperature to bring day 8-10 temperatures into ideal range.

Multi-stage machines

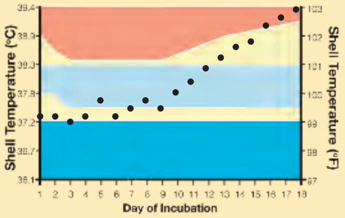
Note: Prior to any alteration of setter operating temperatures, ensure that there are no maintenance problems with the machine and multi-stage loading of the setter is correct.



Temperatures within ideal range: no adjustments required.



Temperatures at the start of incubation in low risk area and at the end of incubation within the high risk area: no adjustment.



Temperatures from day 16 onward in danger range: lower incubator temperature to bring day 16 onward temperatures into risk range.

Danger | Risk | Ideal | Delayed hatch