



HATCHERY TIPS

2025



Aviagen®

HATCHERY TIPS

CONTENTS

NOTE – Several of the tips are relevant to more than one place. These tips are identified by being listed in *italic script* for all but their first appearance.

Click here to access all the tips via the **Interactive version**

EGG STORE

How often do you check eggs coming in to your hatchery for hairline cracks?	8
Egg yolk mottling	9
Pre-warming eggs	10
Analyzing egg handling with a thermal imaging camera	11
Assessing alternative hatching egg disinfectants	12
Checking fresh eggs for unwanted embryo development	13
Check hatching egg quality with UV light	15
Controlling egg water loss during storage	16
What is the best temperature for storing eggs?	17
Checklist - Egg management and setter balance	18
Automated grading systems for hatching eggs	19
What happens to hatchability when egg stores go through a period of extreme cold?	20
Cooling eggs after short periods of incubation during egg storage (SPIDES)	21
What happens when eggs are set small end up?	22
Embryo development during storage	23
Balancing setters when mixing flocks for better heat distribution	24
Urates seen on eggshells under UV light are no cause for concern	25
Using a dehumidifier in the egg store	26

HATCHERY MONITORING TOOLS

Let your eggs guide you	28
Correct use of tinytag loggers to measure eggshell temperature	29
When did you last watch your eggs turning?	31
Using temperature & humidity data loggers	32
Are you measuring and calculating your chick yield correctly?	33
Getting the hatchery connected	34
How to calibrate and use temperature readings taken with tiny tag loggers	35
Putting incubation research into practice	37
Measuring vent temperatures accurately	39
Using your mobile as a powerful tool in your hatchery	41
The role of the incubationist in the hatchery	43
The chick yield vs. moisture loss box	44

SPIDES

<i>Cooling eggs after short periods of incubation during egg storage (SPIDES)</i>	27
If you are heat treating stored eggs to improve hatchability (SPIDES), how long should the eggs be kept warm?	46
Optimizing chick quality & hatchability in periods of long egg storage	47

SETTER ROOM

<i>Pre-warming eggs</i>	10
<i>Checklist - Egg management and setter balance</i>	18

<i>What happens when eggs are set small end up?</i>	22
---	----

<i>Balancing setters when mixing flocks for better heat distribution</i>	24
--	----

<i>Let your eggs guide you</i>	28
--------------------------------	----

<i>Correct use of tinytag loggers to measure eggshell temperature</i>	29
---	----

<i>When did you last watch your eggs turning?</i>	31
---	----

<i>Using temperature & humidity data loggers</i>	32
--	----

<i>How to calibrate and use temperature readings taken with tiny tag loggers</i>	35
--	----

<i>Keep setter floors dry</i>	50
-------------------------------	----

<i>Hot eggs damage chick quality</i>	51
--------------------------------------	----

<i>Calibrate CO₂ sensors regularly</i>	52
---	----

<i>Check hatch debris regularly to identify egg turning problems</i>	53
--	----

<i>Temperature calibration probes</i>	54
---------------------------------------	----

<i>Calibrating electronic humidity sensors</i>	55
--	----

<i>Zero calibration of pressure sensors</i>	56
---	----

<i>Sense-check your CO₂ sensor calibration</i>	57
---	----

<i>Use water loss data to assess setter function</i>	58
--	----

<i>How to calculate water loss correctly</i>	60
--	----

<i>Incubation in high humidity climates</i>	61
---	----

<i>Balancing a set in single stage setters</i>	62
--	----

<i>Checklist - Setters and Hatchers</i>	63
---	----

TRANSFER

<i>Checklist - Setters and Hatchers</i>	63
---	----

<i>How to optimize the timing of in ovo vaccination?</i>	90
--	----

Do you make regular checks for transfer damage?	66
---	----

Backfilling hatcher baskets for low fertility flocks	67
--	----

Optimizing the environment during egg transfer	68
--	----

HATCHER ROOM

Using temperature & humidity data loggers	32
---	----

How to calibrate and use temperature readings taken with tiny tag loggers	35
---	----

Putting incubation research into practice	37
---	----

Calibrate CO ₂ sensors regularly	52
---	----

Temperature calibration probes	54
--------------------------------	----

Calibrating electronic humidity sensors	55
---	----

Zero calibration of pressure sensors	56
--------------------------------------	----

Sense-check your CO ₂ sensor calibration	57
---	----

Incubation in high humidity climates	61
--------------------------------------	----

Checklist - Setters and Hatchers	63
----------------------------------	----

Did you know that if chicks are held too long at high temperatures, it can affect their growth?	70
---	----

Correct positioning of hatcher buggies	71
--	----

What is your meconium score?	72
------------------------------	----

Hitting the chick yield target	73
--------------------------------	----

Logging temperature in the hatcher basket	74
---	----

Preventing chick fluff build-up on hatcher cooling coils	75
--	----

Assessing chick maturity at take-off	76
--------------------------------------	----

Humidity changes in the hatcher indicate hatch time and spread	78
--	----

CHICK PROCESSING AND STORAGE

Are you measuring and calculating your chick yield correctly?	33
---	----

Measuring vent temperatures accurately	39
--	----

Did you know that if chicks are held too long at high temperatures, it can affect their growth?	70
---	----

What is your meconium score?	72
------------------------------	----

Hitting the chick yield target	73
--------------------------------	----

Chick box layout for laminar ventilated chick holding rooms	80
---	----

Managing chick holding room temperatures	81
--	----

Keeping chicks comfortable	82
----------------------------	----

Checklist - Chick processing and holding	83
--	----

Chick weight loss post pull - what is normal?	84
---	----

Is measuring vent temperature accurate?	85
---	----

Optimizing chick holding: shedding light on the blues	87
---	----

VACCINATION

How to optimize the timing of in ovo vaccination?	90
---	----

Keep vaccine preparation rooms biosecure	91
--	----

MAINTENANCE

How to calibrate and use temperature readings taken with tiny tag loggers	35
---	----

Calibrate CO ₂ sensors regularly	52
---	----

Calibrating electronic humidity sensors	55
---	----

Zero calibration of pressure sensors **56**

Have you got a hatchery
maintenance plan in place? **94**

Do we supply enough
air to our incubators? **95**

Checklist - Ventilation **96**

Maintain the fans in your
setters and hatcher **98**

Be careful when you change
To different fans in an incubator **99**

BIOSECURITY

*Assessing alternative hatching
egg disinfectants* **12**

*Keep vaccine preparation
rooms biosecure* **91**

Is your smartphone safe to take
into the hatchery? **102**

CHICK TRANSPORT

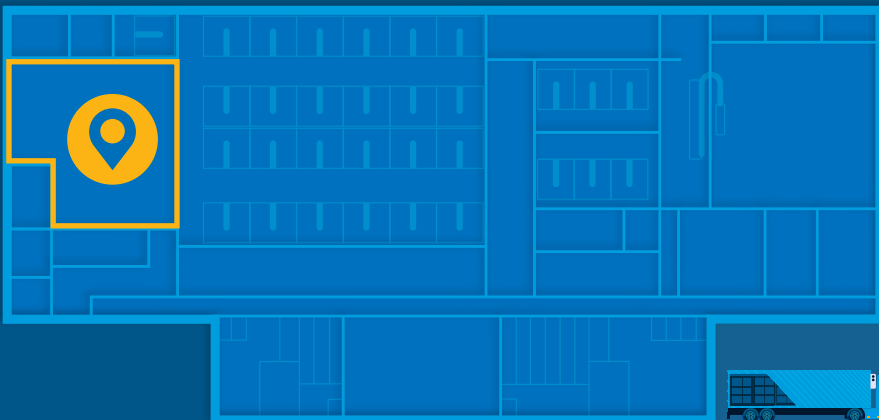
Chick transport conditions **106**

USEFUL APPS

*Using your mobile as a powerful
tool in your hatchery* **41**

The chick yield vs. moisture loss box **44**

Making the most of your hatchery data.
Using pivot tables to boost hatchery
management **108**



EGG STORE

How often do you check eggs coming in to your hatchery for hairline cracks?	8
Egg yolk mottling	9
Pre-warming eggs	10
Analyzing egg handling with a thermal imaging camera	11
Assessing alternative hatching egg disinfectants	12
Checking fresh eggs for unwanted embryo development	13
Check hatching egg quality with UV light	15
Controlling egg water loss during storage	16
What is the best temperature for storing eggs?	17
Checklist - Egg management and setter balance	18
What happens to hatchability when egg stores go through a period of extreme cold?	20
Cooling eggs after short periods of incubation during egg storage (SPIDES)	21
What happens when eggs are set small end up?	22
Embryo development during storage	23
Balancing setters when mixing flocks for better heat distribution	24
Urates seen on eggshells under UV light are no cause for concern	25
Using a dehumidifier in the egg store	26

How often do you check eggs coming in to your hatchery for hairline cracks?

Identifying all the eggs that have cracked shells on arrival at the hatchery is not easy, but removing and discarding them will increase your hatchability and improve chick quality.

As the use of automated egg handling on the farms increases, hairline cracks, in particular, are becoming much more common.

'Hairline' cracks can be difficult to spot. They occur when the force of an impact is just sufficient to crack the crystalline shell, but there is no obvious surface damage or disruption to the underlying shell membranes. Hairline cracks may only become obvious after a few days in the egg store when moisture from the egg contents has had time to penetrate into the crack and produce a faint gray line at the shell surface (**Figure 1**).

A good way to detect hairline cracks is to candle the eggs because the moisture that has entered the crack becomes illuminated brightly (**Figure 2**).

Eggs with hairline cracks can cause just as many problems as eggs with more severe shell damage.

Research has shown that the hatchability of eggs with hairline cracks can be reduced by almost 25%. In addition, there is an increased level of contamination in eggs with hairline cracks which seems to be carried over to the chicks. The mortality of chicks hatched from cracked eggs to two weeks of age was almost four times that in the control group.

When the effect of hairline crack length on hatchability, egg weight loss, embryo losses, chick quality and contamination rates have been studied it is clear that substantial detrimental effects still occur in eggs with only short hairline cracks, such as that in **Figure 3**.

So, the message is clear. Cracked eggs and those with hairline cracks are bad news for the hatchery. Not only do they reduce hatchability through increased water loss from the egg, but they are more likely to become contaminated. This contamination is carried over onto the farm by the chicks.



Figure 1



Figure 2



Figure 3

Egg yolk mottling

Levels of mottling in egg yolks seem to be quite high at the moment.

Mottling is something that is often identified when there are reports of high levels of very early dead embryos, or particularly poor hatch after egg storage longer than 4-5 days.

Opening candled clear eggs shows that there is very little embryo development. But unlike infertile eggs, often the yolk membrane has broken and the yolk is mingled with the albumen. Examining fresh eggs usually shows that fertility is normal for the flock age, but that the yolk surface looks different – there are areas of the yolk that look translucent in mild cases (**Figure 1**) but a tan color in more severe ones (**Figure 2**). This is due to changes in the membrane around the yolk which allow water to collect between the layers. This makes the yolk more fragile, and less able to support normal embryo development.

It is normal to see some mottling, which will get worse as eggs age. It will not necessarily be easy to see in fresh eggs on the breeder farm. However, if the incidence of candled clear eggs is higher than expected and fertility is normal, it is worth checking eggs carefully for mottling.

Mottling can be caused by a variety of factors affecting the breeder hens. One of the best known is contamination of the feed with Nicarbazine (or an anticoccidial containing Nicarbazine). Wormers such as Piperazine can cause mottling, as can gossypol from cottonseed meal (above 0.005%) or tannins from sorghum (above 1%).

Yolk mottling also tends to be high in years where fungal diseases in wheat and maize cause a high or erratic mycotoxin burden in finished feed.

Management factors which put the birds under stress can also cause them to lay eggs with mottled yolks. Over mating is a surprisingly common cause – which tends to escalate if the candled clears are perceived to be due to poor fertility, triggering early or over generous spiking. The bird handling necessary for taking blood or swab samples can also cause a rise in mottling.

Sometimes the cause of mottling is not immediately obvious. In this case, a review of the feed formulation and raw materials in the feed mill will be helpful, along with a review of the birds' behavior. This should include periods of observation in the house, watching the birds feeding, selecting nests to lay in and during peak mating times.



Figure 1



Figure 2



Pre-warming eggs

ARTICLE
UNDER
REVIEW

Analyzing egg handling with a thermal imaging camera

Thermal imaging cameras used to be large, heavy and very expensive. In the last few years smaller, much more affordable versions have become available, often as attachments for a mobile phone.

This has opened up new possibilities for investigating egg handling and holding conditions. Allowing hatching eggs to cool down promptly and evenly, and to stay cool, is very important if the eggs are to hatch well. Starting when eggs are collected from the nests, we need to make sure that embryo development is completely paused. Do we really know if all our fertile eggs are kept under ideal conditions? There may be thermometers or temperature sensors in a farm egg room or hatchery egg room that indicate temperatures in a limited number of locations, but we don't get a full picture of the thermal environment to which the eggs are exposed. Nor can we see how the cooling eggs interact with the environment.

Thermal imaging has proved to be a valuable tool for investigating not only the environment where the eggs are stored but also egg temperature in different locations within the trolley, egg boxes or pallet.

All objects emit infrared radiation (heat) that is invisible to the human eye, but can be captured by the thermal imaging camera. The camera software then converts the temperature into colors depending on the surface temperature. The final result is a picture where each color represents a specific temperature. Thermal imaging can be used to audit eggs handling practice and conditions in farms and hatchery egg stores.

Figure 1 shows uneven temperatures in between the eggs in a farm storage room.

The dark blue spots show the coldest eggs, while the orange eggs are still warm. In this case we can see that very warm eggs are brought inside the room and are being stacked on the top of eggs that are already cold, which can be a problem – each additional layer of warm eggs will re-heat the eggs that have already cooled down. Just looking at the egg room (**Figure 2**) and the read out of the room thermometer, we would not be aware that the situation is occurring and the problem would only be detected when pre-incubation is seen when opening fresh eggs.

Thermal imaging can also be useful to show if the eggs are being boxed while they are still warm, which can also cause pre-incubation in the farm or during transport. Eggs should always be allowed to cool down before being boxed into cardboard boxes. Cardboard is an effective thermal insulator and will slow cooling of the eggs if they are put into the boxes still warm. **Figure 3** shows eggs that weren't allowed to cool down before being boxed. They arrived in the hatchery still warm. In the hatchery, the thermal imaging camera can be used to check that a delivery of eggs is at the correct temperature, and that all the eggs in the delivery are of a uniform temperature. Getting this stage right gives a better hatchability, because all the embryos will be properly cooled at the same time. It will also minimize the hatch spread within a batch of eggs.

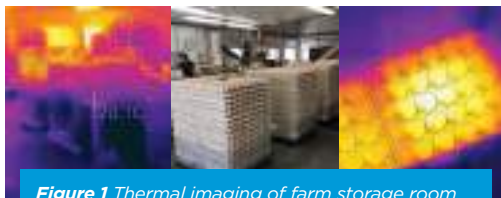


Figure 1 Thermal imaging of farm storage room.

Figure 2 Normal imaging of farm storage room.

Figure 3 Eggs still warm when arrived in the hatchery egg room after transport.

Assessing alternative hatching egg disinfectants

Hatching eggs need to have the shell surface disinfected at some point between the farm and the hatchery.

This is good practice and often a legal requirement. Traditionally this was done using formaldehyde gas, but there are increasingly stringent regulations making its use on farms and in the hatchery more difficult.

Formaldehyde is a difficult disinfectant to replace. It is very effective against a wide range of micro-organisms; it forms a dry gas so does not wet the egg surface; and it is harmless to the paused embryo in the fertile hatching egg. It is also cheap. However, a variety of alternative disinfectants are being suggested.

Any alternative product needs to give a satisfactory kill rate of the micro-organisms on the shell surface, ideally without wetting the egg shell. It needs to be gentle enough not to damage the cuticle covering the egg shell – with no cuticle left the eggs are more open to internal contamination after treatment – and it needs to be safe for the embryo inside the egg.

When offered an alternative hatching egg treatment, always ask questions. What is the active ingredient? How is the treatment delivered? Does it need to be dissolved in water? What percentage of the micro-organisms on the egg shell will it kill? Most suppliers will be able to answer all these questions, but may have more trouble with the most important one. “This product kills bacteria on the egg shell – can you prove to me that it won’t kill the embryo inside the egg shell?”

To be confident that the chemical, or the method of application, will support good hatchability, you need to see trial results (or run your own).

When you start to think about existing differences between flocks, between egg collections through the day, egg storage conditions and even individual incubators, it is obvious that the trials will need to be carefully designed, will need to take account of a lot of variables and should use a lot of eggs. As a starting point, trials should include eggs from young, prime and old flocks – old flocks are probably the most vulnerable to mistreatment of any kind. Trials should be repeated, and they should be designed to equalize the hatch potential of the eggs going into each treatment. Always have a control treatment, where eggs are given your current standard treatment. To set up this sort of trial you could:

- **Put alternate setter trays from every collection into treatments A or B as they are packed.**
- **Or compare eggs packed Monday, Wednesday and Friday with those packed Tuesday, Thursday and Saturday.**
- **Or even compare whole houses, but switch the treatments at intervals so each house is its own control.**

Aim to use at least 2,000 eggs per treatment per run, and to repeat each comparison at least 10 times over a range of flock ages. Without this sort of careful comparison, you will never really know whether the treatment is giving you results that you expect, has made things worse or (very rarely) given better hatch or chick quality.



Figure 1 A fumigation cabinet.

Checking fresh eggs for unwanted embryo development

The best way to look after hatching eggs is to collect them from the nests as often as possible (ideally 4-5 times per day), disinfect the shell surfaces, let them cool evenly and slowly and then hold them at around 15°C until they are placed in the setter.

It is especially important to keep the eggs below physiological zero – the temperature above which embryo development is possible.

When eggs cool unevenly, some of them will develop a lot further than others.

After 18 days of incubation this range will be enough to widen the hatch window significantly, with the quality of the earliest hatching chicks suffering accordingly. Eggs held at temperatures which fluctuate around 20-24°C will show distinct signs of embryo development which if allowed persist for too long will give higher levels of early embryo mortality.

There are several ways to check egg-holding temperatures using simple technology. A max-min thermometer, read once a day and the results plotted manually on a daily graph will tell you if the storage room is suitably insulated, cooled and heated for the local climate.

Data loggers such as Tinytags can measure egg shell temperature at any point in the egg mass, highlighting temperature fluctuations over time.

Several loggers, suitably located, will show if the room conditions are uneven. A cheap thermal imaging add-on for a smart phone will show hot and cold spots within the egg store.

At a biological level, it can be helpful to look at the embryos directly, using hatching eggs from the flock of interest. (Don't use floor or cull eggs – they will have been held under different conditions to the hatching eggs).

This can be done as a one-off, or more usefully as part of a regular sampling program. The work must be done in an area with good bright light. Label each egg to show date, flock and location it was taken from. Use forceps to make a small opening at the very top of the large end of the egg.

Remove the shell and membranes around the hole, to expose the germinal disc without damaging it (the yolk will always float so that the germinal disc is at the top, so will be easy to find.)

Check that the egg was fertile (Hatchery How to 4) and sort the fertile embryos into order of size.



Figure 1 Appearance of a normal embryo when the egg is laid and cooled promptly.

Checking fresh eggs for unwanted embryo development *Continued*

Embryo development takes place for 24 hours after fertilization as the egg forms around the ovum. When the egg is laid there will be 30-60,000 cells in the blastoderm, which will have reached Stage X of development.

Unmagnified, the embryo will look like a ring doughnut, with a transparent area in the middle of the ring – the area pellucida.

Once the egg is laid, provided that holding conditions are correct, there should be no more development.

However, if the rate of cooling is uneven, or the eggs are held in fluctuating temperatures then some or all of the embryos will continue to develop past Stage X.

Some of these embryos had developed past the stage that they would survive the holding period, and even those which would be able to start developing again will develop to produce a very wide, hatch window.

To stop this pattern being a regular part of embryo development in your hatchery, check sample eggs from positions you have concerns about and correct the problem as soon as possible.



Figure 2 Eggs opened in the hatchery after uneven cooling, showing very variable embryonic growth.

Check hatching egg quality with UV light

ARTICLE
UNDER
REVIEW

Controlling egg water loss during storage

The influence of air temperature and relative humidity

To enable their function as incubation vessels, all eggs are enclosed in a porous outer container – the egg shell. The shell must allow gases through so that the developing respiring embryo is able to get rid of carbon dioxide and take in oxygen.

Water also passes through the pores in the egg shell, even when embryo development is paused during egg storage. Egg water loss during storage can be assessed by measuring the egg weight at the start and end and calculating the weight loss. Eggs kept in reasonable conditions will commonly lose about 0.5% of their initial weight after a week in storage, which does not seem to harm hatch or chick quality. Although the number and diameter of pores in an individual egg are fixed, it is possible to affect the rate of water loss by adjusting the conditions in which the eggs are held.

This is because the rate of water loss will be governed by the difference in water vapor pressure inside and immediately outside the egg – the water pressure deficit. Relative humidity inside the egg will remain at 100% at all times, because the egg has a high water content. External conditions will not affect humidity inside the egg. However, the water vapor pressure differential can be changed, because the water vapor pressure of the air in the egg store alters as a function of temperature and relative humidity.

Humid air will have most of the available space already occupied by water molecules, and the vapor pressure will be high.

If the air is cooled then it can hold less moisture, so the humidity and water vapor pressure both rise.

Eventually the dew point is reached and water vapor will condense out of the air.

We tend to try to control water loss of stored eggs by keeping humidity and water vapor pressure in the egg store up.

However, this can encourage bacterial or fungal contamination of the eggs, either through using contaminated water to fog or wet the egg store, or through condensation on the egg surface.

An alternative way to reduce the water pressure deficit is to lower the air temperature in the store. Table 1 shows that the impact on the water vapor deficit is the same when humidity is raised by 5%, or temperature reduced by 3 °C.

	Common conditions	Increase relative humidity	Decrease temperature
Inside	18 °C, 100% = 20.6 mbar	18 °C, 100% = 20.6 mbar	15 °C, 100% = 17.0 mbar
Egg storage room	18 °C, 70% = 14.4 mbar	18 °C, 75% = 15.5 mbar	15 °C, 70% = 11.9 mbar
Water vapor deficit	+6.2mbar	+5.1 mbar	+5.1 mbar

Table 1 The impact on the water vapor deficit when humidity is raised by 5%, or temperature reduced by 3 °C.

Based on calculated values of water vapor deficit, the figures demonstrate that reducing the egg store temperature from 18 °C to 15 °C (64.4-59 °F) will be as effective as increasing its relative humidity by 5%. In conclusion, a lower storage temperature could help to keep weight loss during egg storage under control without increasing the risk of contamination.

What is the best temperature for storing eggs?

Most hatchery planners aim to keep egg age under 7 days at set. However, even in broiler hatcheries this is not always easy, or even possible.

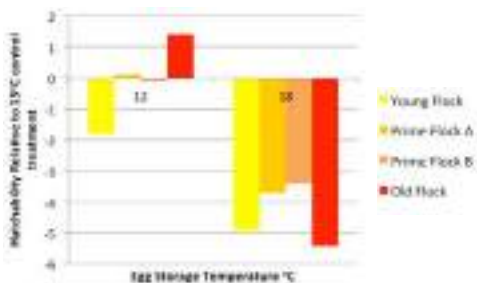
You may need to build up numbers so that a single broiler unit can be filled using eggs from only one breeder flock, order sizes may not be exactly even day to day or there may be a general slowdown in the market for seasonal or other reasons. Most advice on egg storage conditions suggests that the temperature should be adjusted dynamically depending on the average egg age. However, in practice the advice is seen as too complicated and is rarely followed. Consequently, in many operations egg storage temperature stays firmly at 17-18°C, no matter what the egg age.

In fact, the best advice is that egg store temperature should always be adjusted downwards to be optimal for the oldest eggs. Fresh eggs hatch just as well stored at colder temperatures, but older eggs suffer badly if the egg store is held too warm. The only thing you need to watch out for is the possibility of condensation when moving eggs from the cold egg store into the setter rooms.

Keeping eggs which need to be stored for longer at a lower temperature slows down the physical deterioration to the albumen and yolk membranes which are needed to support the best hatchability. The embryo will also be affected by both storage time and storage temperature, and colder storage slows down the rate of deterioration in the embryo as well. A recent collaborative study between Aviagen and Ankara University investigated the effect of storage temperature on hatchability in eggs stored for 14 days, as part of a larger investigation into how SPIDES treatments interacted with storage temperatures.

In the study, covering young, prime and old grandparent flocks, hatchability was much better when 14-day-old eggs were stored at 15°C rather than 18°C. More unexpectedly, eggs stored at 12°C hatched no better than those stored at 15°C. The hatchery where the trials were done is unusual in having three separately controlled egg stores, so it was possible to run comparisons of the three storage temperatures simultaneously which gave a very robust comparison of the three storage temperatures. The trial was repeated over four batches of eggs, from young, prime and old flocks. The graph below shows how eggs stored at 18°C hatched worse than those stored at 15°C by an average of 4.4% over 4 comparisons covering young, prime and older flock ages. In contrast, when hatch of eggs stored at 12°C was compared with hatch of eggs stored at 15°C, there was no overall improvement.

Our conclusion from these trials was that unless eggs are only being set when very fresh (no more than 4 days old) it is probably better to run egg stores at 15°C rather than 18°C. When setting eggs within the hatchery condensation is unlikely to be a problem following storage at 15°C, but if you are worried check the dew point table in Investigating Hatchery Practice to make sure.



Checklist - Egg management and setter balance

This is the first of four checklists which will be useful when investigating how well your hatchery is performing, and where improvements might be made.

EGG MANAGEMENT

Egg processing on arrival at the hatchery:

- Check egg shell temperatures on arrival [target max 1-2 °C (1.8-3.6 °F) higher than hatchery egg store].
- Check for condensation. Use extra fans to dry fast when necessary.
- Take representative sample trays from each batch of eggs delivered to the hatchery, and count any upside down eggs (target is less than 1%).
- Check for dirty and floor eggs. Separate these eggs and place on bottom trays, remove and discard excessively soiled ones.
- Remove cracked eggs, including hairline cracks.
- Complete egg processing without allowing egg temperature to rise. The processing area set temperature should be that of the egg store.
- Never pack eggs into boxes before they have cooled to storage temperature.

EGG STORE MANAGEMENT

- Identify storing zones according to egg production dates for first in first out principle.
- Aim to set eggs before they reach seven days old.
- Let eggs rest in the egg store 24-48 hours after transport.
- Hold egg store temperature at 15 °C (59 °F) for all egg ages.

- Never put warm eggs close to cold ones, or warm trolleys next to cool ones.
- Avoid temperature fluctuation by keeping doors closed.
- Avoid using humidifiers except in very dry climates, because static water reservoirs can encourage bacterial growth.
- Use circulation fans for uniform and fast egg cooling.
- Avoid packing eggs too close together; store eggs in setter trays and trolleys whenever possible.
- Turn eggs 4-6 times a day, if possible, if stored for over seven days.

PLAN THE SET SO IT IS BALANCED

- Do not mix young/old flocks, low/high fertility or small/large eggs.
- If some mixing is unavoidable, place the eggs closest to average next to the temperature sensor.
- Alter set times according to egg age, flock age and season.
- In multi-stage setters, mark trays clearly to identify flock of origin, pick up date and set date.
- If soiled or floor eggs must be used, set them in the bottom trays or in a separate machine.
- In multi-stage machines, follow manufacturers suggested setting patterns and intervals.
- Try to set the most fertile, and largest eggs (which produce the most heat) close to the fan.
- Plan any backfilling, taking account of the cooling capacity of the setters and hatchers – very few will cope with the heat output of 100% live embryos.
- If hatching parent stock, set male line and female line eggs separately, if possible.

Automated grading systems for hatching eggs

The quality of eggs coming into the hatchery can make a big difference not only to hatchability but also to the culling rate and livability levels in the seven days after delivery.

Some issues are covered in Hatchery Tips 6 (hairline cracks) and 55 (eggs set upside down). Soiled eggs will increase the percentage of rotten eggs (exploders) and embryo mortality. Chick livability will also suffer.

Most of these problems come from the farm, but it is not always easy to see them in newly laid eggs – neither hairline cracks nor the air cells are particularly easy to see at that stage. This is why automated screening after the eggs arrive at the hatchery can be beneficial in identifying most of these issues, with the eggs either removed and sent to breakers or re-orientated in the case of eggs placed upside down in the trays. As with most automated systems, however, they need to be adjusted, cleaned and maintained properly to deliver maximum impact.



Figure 1 Eggs manipulated to correct setting orientation.

When choosing a machine, it is essential that it is capable of delivering the level of accuracy required, in a reasonable time frame for the number of eggs sent to the hatchery daily.

However, given the choice between two suitable systems, it is advisable to choose the one with the best level of local technical support so that any issues can be dealt with quickly and effectively. On delivery to the hatchery, the machine first needs to be located somewhere clean and dry, with good access all around it for ease of maintenance. The people operating the machine need to be adequately trained to understand how to set it up and what results it should achieve.

It is well worth assessing samples of eggs before and after they go through the machine to check that they are removing cracks, eggs with abnormal shells and soiled eggs, and realign eggs set upside down. Record the data and analyze trends to ensure the machine delivers the expected improvements.

Machines that grade eggs based on egg weight need to be calibrated regularly. If the cut-off is not delivered as expected, settings may need to be adjusted by properly trained mechanics. Machine maintenance must be scheduled and regular to include functionality checks, lubrication, wear assessments and cleaning down.

Finally, ensure that eggs cannot accumulate on the belt at any stage – if they bang into each other, the incidence of hairline and star cracks will go up, not down, as a result of treatment.



Figure 2 Eggs accumulating on the belt will have increased numbers of cracks.

What happens to hatchability when egg stores go through a period of extreme cold?

Unless eggs are always set very fresh, it is probably safer to store them at 15°C, the temperature at which embryo development stops completely.

A related question, discussed by Elilob et al at the 2022 Incubation and Fertility Research Group (IFRG) meeting, is whether very low temperatures (between 0°C and 8°C) can be detrimental. This situation arises by accident, occasionally, when environmental control fails in farm egg stores or egg trucks during cold winter conditions. It is known that embryo development will stop, and that albumen quality (associated with better hatchability) will improve at low temperatures. But, can very cold conditions do any damage?

The Ankara University team (Ankara, Turkey) transported Ross 308 eggs directly from the breeder farm, and stored them for two days at 16, 8, 4 or 0°C. The eggs were then stored for a further two or 12 days at 16°C before being set. A small number of eggs from each treatment were opened to evaluate albumen quality and embryo development. The remainder were incubated. A total of 1500 eggs were set per treatment.

Albumen height after two days was highest in the 0°C treatment, and lowest in the 16°C treatment. Low storage temperatures did not affect hatchability when the eggs were set fresh (4 days), but two days storage at 0°C at the start of a two-week egg save did cause a small (3% point) drop in hatchability.

Investigating an incident of accidental damage, Salahi et al carried out a similar experiment in Iran, using Ross 308 eggs which had been unavoidably held in the egg truck for 40 hours in an outside temperature of -15°C.

None of the eggs froze, but they were able to isolate batches where the internal temperatures were -1.2°C, 1-2°C, 2.5-3.9°C, 4-6°C, and compared them to a control group which had not experienced the period of cold. The eggs were set fresh, and the pre-warming and set times adjusted. Storage temperatures falling from 5°C were associated with declining hatchability (**Fig. 1**), but the absolute impact was relatively small; the -1.2°C group hatched 5% points less than the controls.

To conclude, if there is a logistical problem that causes hatching eggs to be exposed to a temperature around 0°C for up to two days, the bulk of the eggs should hatch normally, provided they are allowed to warm to a more normal temperature before set, and set times adjusted slightly. Any hatch losses will be small.

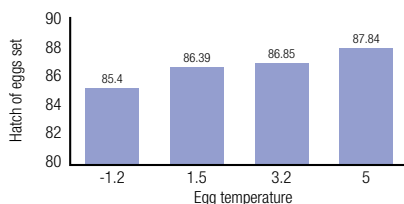


Figure 1 Effects of Cold Stress during Incubation on Hatchability and chick quality of broiler breeder eggs. Salahi et al 2012, Turk. J. Vet. Anim. Sci. 36 pp 159-167.

Cooling eggs after short periods of incubation during egg storage (SPIDES)

Short periods of incubation during egg storage (SPIDES) has been implemented in many hatcheries, and has proved to be a very effective way to restore the hatch loss usually seen after prolonged egg storage.

When using SPIDES, it is critical that the eggs are allowed to cool down from peak temperature quickly and evenly before they are returned to the egg store. If the eggs are above egg store temperature, they will warm the eggs around them, damaging hatchability.

When using a machine which has been designed to perform SPIDES treatments, both heating and cooling capacity are increased, and the eggs will cool properly as long as the full cycle is followed. However, many hatcheries use a standard setter to treat the eggs, and so alternative arrangements should be made to cool them after treatment.

Fig. 1 shows a thermal image of an egg store containing SPIDES treated eggs in the center of the picture, and the warming of the adjacent eggs to the side. Although the eggs were only 24 °C when replaced in the egg store, they were still able to warm eggs in adjacent trolleys to a level where embryo development will continue at a level likely to harm hatchability.

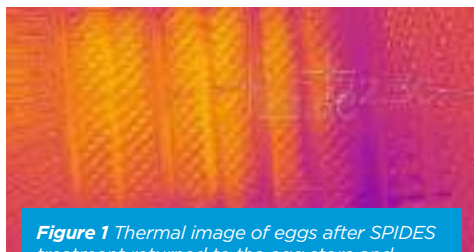


Figure 1 Thermal image of eggs after SPIDES treatment returned to the egg store and warming the surrounding (cool) eggs.

When transferring eggs that are still warm post-SPIDES treatment to the egg store, place them as far as possible away from any cooled eggs. A temperature logger placed on the trolley closest to the warmer eggs can record any rise in air temperature.

Fig. 2 shows a hatchery egg store where the cooling capacity was insufficient to cool the eggs after warm eggs were added. They cooled by only 1.5 °C before a second batch of treated eggs was added, at which point the temperature of the adjacent eggs increased as well.

If SPIDES is used on a routine basis, the egg store can be partitioned so that there is space dedicated to cooling eggs after treatment without damaging the other eggs. The area will need additional cooling capacity and enhanced air circulation to maximize the effectiveness of the cooling process.

By using SPIDES treatments while maintaining a stable egg store temperature by implementing good management of the post-treatment cooling procedure, much better hatchability can be expected from stored eggs, even into their fourth week.

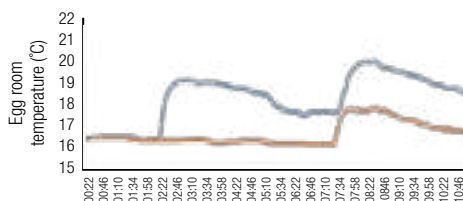


Figure 2 Air temperature close to SPIDES treated eggs (blue) and untreated eggs (orange) as eggs are restored to the egg store. The cooling system should be upgraded to manage regular additions of warm eggs.

What happens when eggs are set small end up?

Hatching eggs are set with the small end downwards in the setter tray, with the air cell facing upwards.

As the embryos finish their final three days of incubation in the hatcher baskets, they will naturally maneuver into hatching position and gravitate toward the end of the egg that was placed upward in the setter tray. Unfortunately, if the egg was set with the small end up, there will be no air cell to pip into, and a significant proportion of the chicks will not hatch.

Our expectation of the losses due to incorrect orientation date from many years ago; recently, the Aviagen hatchery at Stratford on Avon in the UK ran two trials to investigate whether our expectations remain correct.

In both trials, five trays of eggs were set small end up, with the position of the air cell identified by candling.

The remaining eggs were set small end down, as recommended. The embryos in Trial 1 were in ovo vaccinated at transfer, while chicks in Trial 2 were vaccinated after hatch. On the day of hatch, the number of clear and unhatched eggs were counted, and the unhatched eggs broken out. The number of chicks, culls and non-living on tray chicks were also recorded, and the overall appearance of the chicks assessed and noted.

Trials reported in the literature lead us to expect that if eggs are set small end up, one in five of the transferred eggs will not produce a live chick. Results from these two trials, shown in Fig. 1, were slightly worse than this, especially when in ovo vaccination was used. Hatch of transferred eggs was lower by 25.5% (vaccinated in ovo) and 22% (vaccinated post-hatch).

In about half of the unhatched eggs, the embryo was malpositioned upside down. There were also more embryos with malposition of head to left and simple late non-living embryos. However, the increase seen in the culling rate of 4-5 times was unexpected. The reasons for culling included button navels, scruffy down and very late emergence (still wet). Even more surprising, the chicks that were supposed to be first quality were also poor – inactive, weak, and visibly later to hatch than the chicks hatched from eggs set correctly.

In conclusion, eggs set with the small end down will lose 22-25% of their potential hatchability, have 4-5 times as many culls and chick quality will be generally poorer. Automatic egg packers usually achieve accurate orientation, however if eggs are packed by hand, training staff on the consequences of incorrect orientation is critical. It is also important to supply a suitable candling torch so the air cell can be located quickly and easily. QA staff should be checking for incorrectly oriented eggs in each batch picked up from the farm and informing farm managers of any problems.

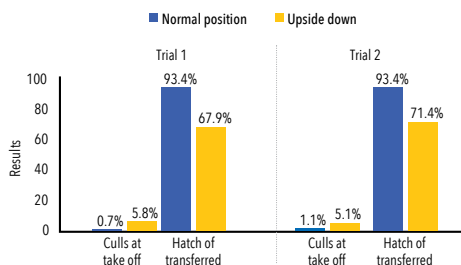


Figure 1 Results of Trial 1 (in ovo vaccinated at transfer) and Trial 2 (vaccinated after hatch).

Embryo development during storage

During egg storage, there is a tendency for embryo viability to decrease. Research over the last 120 years has tried to define the optimal temperature for egg storage, particularly the temperature at which embryo growth and development stops.

The suggested optima from these trials have been surprisingly variable. This is partly because measuring hatchability within a trial needs large numbers of eggs to give a definitive answer, and partly because some different, in retrospect misleading, measures of 'growth' have been used. At the 2022 IFRG meeting, Serdar Özlü presented results of trials where he assessed the embryo stage in eggs stored for three, seven or 14 days at temperatures of 15, 18, 21 or 24°C.

Having spent roughly 24 hours in the oviduct after fertilization, broiler embryos are usually around Stage X when the egg is laid (Eyal-Giladi and Koshkov 1976). At this stage they can safely go into a paused state, with some leeway if cooling is delayed, or there is deliberate reactivation due to a SPIDES treatment. However, if development goes too far, or takes place at relatively low temperatures, embryo survival will be affected, sometimes very badly.

Özlü showed that embryos held at 24°C increased their development stage by 11% in the first three days of storage, and by 44% in eggs held for 14 days. Storage at 21°C showed percentage increases of 6% and 27% to the same ages. When storage temperature was reduced to 18°C, the embryo stage increased by 1% to three days, and 7.35% to 14 days.

This was enough to adversely affect hatchability. Eggs stored at 15°C showed little or no development, fluctuating around the original Stage X by a maximum of 1%. Stored for 14 days, hatchability of eggs stored at 15°C was significantly better than that of those stored at 18°C.

Eggs which have been SPIDES treated will usually show a 2-3 point increase in embryo stage, with much better hatchability than eggs which have been stored in the same conditions without SPIDES treatment. In contrast, when storage temperatures are allowed to fluctuate from 18 to 21°C three times a day, hatchability suffers.

There is a big difference in outcome between in-storage embryo growth at incubation temperature and embryo growth under cool storage conditions. It is important to differentiate between the two, and to keep egg storage temperature at around 15°C, with no fluctuations. This means that farm, transport and hatchery stores need to have sufficient cooling capacity, be well insulated and have doors which are kept closed unless someone is passing through them.

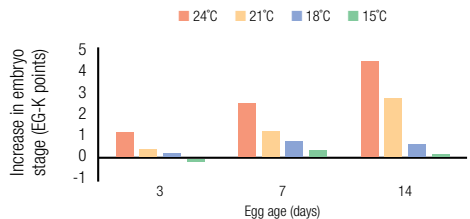


Figure 1 Changes in embryo stage at different storage temperatures (derived from Özlü et al 2022).



Balancing setters when mixing flocks for better heat distribution

During incubation, embryos in large eggs produce more heat per egg than those in small eggs.

Some of the increased heat production in larger eggs is naturally offset by lower fertility, so fewer eggs are producing any heat at all. However, large eggs can also be more resistant to cooling because the surface area to volume ratio allows less surface area for heat loss. In some machines, bigger eggs tend to restrict air flow, which will also limit cooling.

Heat management can become critical if the hatchery is candling and backfilling beyond the capacity of the setters, or when fertility is particularly high in older flocks.

Most modern hatcheries use large capacity single-stage setters. Because of their size, it is almost inevitable that they will be filled with eggs from more than one flock. If not carefully thought through, this can exacerbate any lack of uniformity in the setter.

Ideally, sets should be planned so that all the eggs in a single machine are approximately the same size and overall fertility (small eggs with higher fertility or large eggs with lower fertility).

Unfortunately, this may not always be achievable in practice. It can be possible to mitigate the negative effect of mixing flocks if the hatchery has an accurate picture of hot and cold spots in their incubators.

For example, if the setter has a central or sidewall pulsator and eggs placed close to these fans are more efficiently cooled, then we can plan the setting pattern according to the total heat production from each flock.

GENERAL PRINCIPLES

- Larger eggs should be placed close to the fan (or older flocks).
- Higher fertility eggs should be placed close to the fan.
- Try not to set young and old flocks in the same machine.

SPECIAL CASE:

If high fertility small eggs and low fertility larger eggs will have to be set together, it is possible to calculate the heat load of each flock then set the higher heat load close to the fan.

HOW TO CALCULATE HEAT LOAD?

Calculating the maximum heat production of a batch is not difficult. From data published by Lourens et al (2007) it is possible to use 140mW for 50-59g eggs, 150mW for 60-69g eggs. Multiplying the maximum heat production (mW) by the total number of eggs while correcting for flock fertility will give the heat load for each batch.

AN EXAMPLE

Flock A has 9,600 55g eggs with 95% fertility and Flock B has 9,600 65g eggs with 80% fertility. Both will be set in the same machine, so first calculate which eggs will produce more heat.

**Maximum Heat Production =
Maximum Heat Produced by an egg
x Total Egg Number x Fertility/100**

**Flock A: 140mW x 9,600 x 0.95 ÷ 100
= 1.2768kW max heat production**

**Flock B: 150mW x 9,600 x 0.80 ÷ 100
= 1.152kW max heat production**

In this case, lower fertility more than offsets the rise in heat output with larger eggs. In this case, the eggs from the younger flock should go next to the fan.

Urates seen on eggshells under UV light are no cause for concern

Ultraviolet (UV) light, specifically at a wavelength of 365nm and filtered, is a non-destructive tool used to inspect hatching eggs. It can help identify changes due to washing or dry cleaning of hatching eggs that are not visible to the naked eye.

When cleaned, eggs can lose their natural protective cuticle layer, making them much more susceptible to bacterial contamination and other damage. UV light allows us to identify issues before they can harm hatchability and chick quality.

When examining eggs under UV light, it is important to distinguish carefully between urate crystals and manure residue.

Urate crystals are a natural substance birds produce as a byproduct of their metabolism and do not create extra contamination.

Manure residue, on the other hand, is faecal material found on the surface of dirty eggs. It is harmful because it contains bacteria and other pathogens that can contaminate the egg contents, causing hatch losses and poor chick quality.

Urate crystals typically appear white in color under UV light. In contrast, manure residue typically appears yellow, brown or green in color and is composed of a mixture of faeces, urine and other waste materials. One easy way to determine the type of residue present on an egg is to check its color under UV light.



Figure 1 Appearance of pale brown faecal residue (right) and white urates (left) on eggs pictured under UV light.

Using a dehumidifier in the egg store

Egg storage is an important part of the incubation process. Storage conditions must be set to maintain the egg and embryo quality, and minimize hatchability losses.

During storage, moisture is lost through the eggshell into the air. If humidity levels in the air are relatively high, the air cannot take and hold much moisture from the eggs. This can prevent eggs from losing too much moisture before incubation starts. On the other hand, different types of bacteria and fungi need high levels of humidity to reproduce and grow. The majority require a relative humidity (RH) of 60% or more. Decreasing temperature and moisture (RH) in the egg store creates a less hospitable environment for micro-organisms to grow.

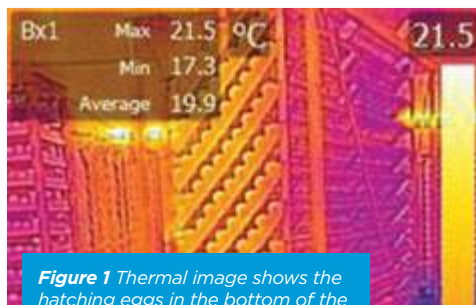


Figure 1 Thermal image shows the hatching eggs in the bottom of the rack warmed up by a dehumidifier placed too close to the egg pack.

An RH of 50-60% is required to balance the necessary moisture loss and acceptable hygiene in the egg store. If egg storage time is below 10 days, an RH of 50-60% could lead to 0.5% moisture loss during storage. Where eggs are held longer, there will be a little bit more moisture loss. This can be a benefit if the eggs are to be set in a single-stage setter, which is run sealed for the first few days.

In tropical areas, or during the summer in some temperate areas, a dehumidifier is needed to lower humidity levels and achieve the target humidity. Dehumidifiers work well, but there are some practical adjustments that will optimize their impact. The temperature of the air emerging from the dehumidifier could be 3°C-6°C higher than the room set-point, so the dehumidifier should be placed far enough away from the egg racks to avoid warming them. Placing the dehumidifier next to the air conditioner and higher than the egg racks is a good choice.

When the air temperature is reduced, the air can hold less water vapor. In most breeder hatcheries, a low temperature set point (12-15°C) for long egg storage is quite common.

Therefore, heat from the dehumidifier should be considered when setting up the air conditioning system to maintain a stable temperature in the target range in the egg store. There are two ways to collect the condensation water from the dehumidifier; either by using a sealed container with the pipe connected to the dehumidifier or by piping the water to the egg store drain. Do not let the water wet the floor of the egg store. Dehumidifiers need routine checks and maintenance in the same way as any other equipment in the hatchery.



Figure 2 The dehumidifier installed in a higher position which gives enough distance from the eggs in the egg store.



HATCHERY MONITORING TOOLS

Let your eggs guide you	28	Putting incubation research into practice	37
Correct use of tinytag loggers to measure eggshell temperature	29	Measuring vent temperatures accurately	39
When did you last watch your eggs turning?	31	Using your mobile as a powerful tool in your hatchery	41
Using temperature & humidity data loggers	32	The role of the incubationist in the hatchery	43
Are you measuring and calculating your chick yield correctly?	33	The chick yield vs. moisture loss box	44
Getting the hatchery connected	34		
How to calibrate and use temperature readings taken with tiny tag loggers	35		

Let your eggs guide you

When you set up your incubator, did you know that your eggs can give you the best guidance on whether the incubator temperature settings are correct?

Incubator temperature sensors measure air temperature at various places in the machine. For practical reasons sensors have to be sited somewhere they do not get in the way of loading or cleaning. Because of this, they may not always reflect the air temperature that is experienced by the eggs.

Provided that everything is correctly set up, and the machine is well maintained, then the air temperature is a good indicator that the embryo temperatures are correct as well. But if not, the machine temperature may not predict embryo temperature as accurately as you would like it to.

Once the setter has stabilized, it is wise to calibrate the machine sensors. This should be done using an accurate, certified calibration thermometer, every time the machine is loaded (single stage) or monthly (multi stage).

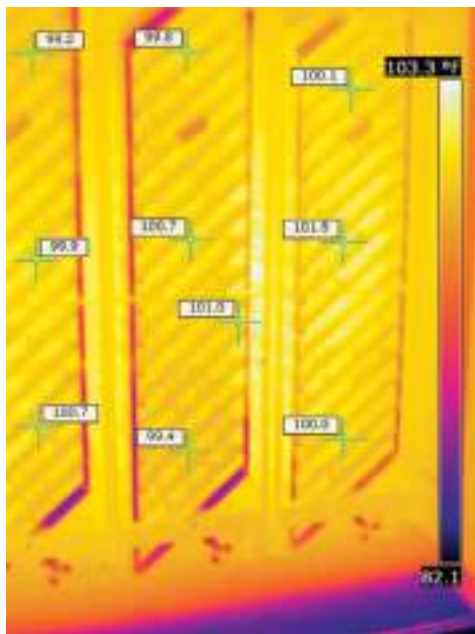
But this only tells you whether the air temperature recorded by the machine sensors is accurate. It may not be at a level which is optimal for the embryos.



So, you should also check that your eggs reflect the temperature calibration.

Check the egg shell temperature on day 2 of incubation, when the eggs are up to incubator temperature but the embryo is too small to be producing heat. The eggshell temperatures should all be within $\pm 0.2^{\circ}\text{F}$.

(0.1°C) of the air temperature in most types of setter. If they are not, it could indicate something is wrong (for example worn door seals, sticking solenoids, etc).





Correct use of tinytag loggers to measure eggshell temperature

Incubation temperature plays a critical role in chick quality and hatchability.

Because the temperature of the outside surface of the egg shell is very close to that of the embryo inside it, more and more hatcheries are using temperature loggers routinely to measure eggshell temperature. There is good research evidence to show that the optimal embryo temperature lies between 100-101°F/ (37.8-38.3°C) all the way through incubation. The embryo's heat production increases steadily through incubation.

This means that the air temperature settings need to be changed regularly to deal with the increasing amount of embryo heat being generated. Once we start to measure eggshell temperatures, we can use the information to improve hatchery performance by:

- **Fine-tuning air temperature set-points or program, so as that actual eggshell temperature sits in the ideal range throughout the whole incubation period.**
- **Finding eggshell temperature variation within a setter or between setters; thus identifying and allowing us to fix setter maintenance issues, so that all the eggs in a hatchery experience very similar incubation temperature.**

One of the devices commonly used to measure eggshell temperature is the Tinytag Talk-2 Model-4023, connected to a thermistor probe.

It can measure and record eggshell temperature continuously at pre-set intervals throughout incubation. Once set up, the incubator can work undisturbed – this is a big advantage in machines with no corridor or space for a person to work safely while the machine is running.

Temperature data loggers of this type are useful and powerful tools. However, there are ways to optimize the quality of the data collected.

- **Check and calibrate the loggers and probes before use.**
- **Attach the probe to the egg. We tested different materials to attach the probes, and found that a good-sized lump of Blu-Tack® (Picture 1) gives the most stable results (Chart 1).**

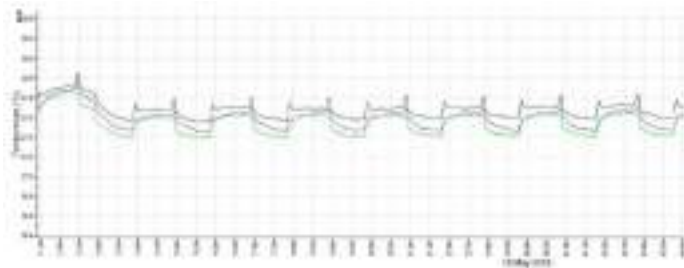


Chart 1 Temperature traces of Tiny Tags where the probe was attached with Blu-Tack (black line), plastic tape (blue line) or paper tape (green line). Note temperature fluctuation every 30 minutes, as eggs turn.



Correct use of tinytag loggers to measure eggshell temperature *Continued*

There are several factors which can make a difference to the absolute value of the temperatures recorded.

- The temperature over the air cell will be too high in early incubation and too low after 7 days – place the probe on or below the equator.
- Infertile eggs will not generate any embryo heat later in incubation, so will tend to under read after 8 days. If starting recording at day 0, the sample eggs should be candled and if necessary replaced at 6-8 days.
- Every time eggs are turned, the change in wind speed and direction across the thermistor will show in a change of temperature. Place the thermistor on the side of the egg away from the fan to minimize this.

At the end of incubation, gather all the data into an Excel file and plot the traces collected at different locations on one graph.



Figure 1 The Tinytag thermistor probe attached just below the equator of the egg with a thumb-nail sized lump of Blu-Tack.



When did you last watch your eggs turning?

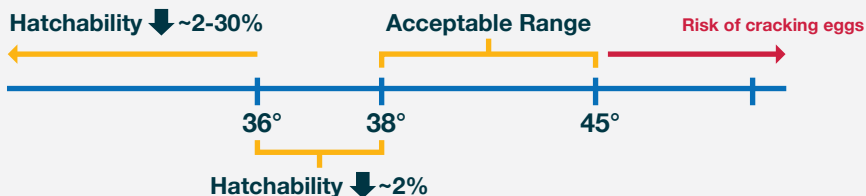
Hatchery managers have many responsibilities, making it difficult to find time to observe egg turning in setters.

However, egg turning is a critical process that directly impacts hatch rates and chick quality. Proper turning prevents embryos from sticking to the shell membrane, promoting uniform growth and reducing deformities. Taking a few moments to check the turning process can prevent costly mistakes:

- **Did the eggs turn when expected?**
- **Did all trolleys and trays turn properly?**
- **Was the turning action smooth?**
- **Was the turning angle correct on all trolleys and trays?**

Turning issues are among the most common problems identified during hatchery visits. Incorrect turning angles or complete turning failure can severely impact embryo development, especially early in incubation. Even mildly suboptimal turning can increase early and late dead embryos, malpositions, and unabsorbed albumen, ultimately reducing hatchability. Egg turning mimics a hen's natural behavior, rotating eggs frequently to distribute heat and humidity evenly. In artificial incubation, automated systems perform this task by rotating eggs, usually every hour. Without consistent turning, embryos can adhere to the inner shell membrane, resulting in developmental defects or death.

Egg turning is essential for successful incubation, but its effectiveness depends on well-maintained equipment. Since egg turning is continuous and repetitive, the equipment is prone to wear and tear. Regular maintenance is essential to prevent mechanical failures that could compromise hatch rates. By prioritizing regular inspections, cleaning, and calibration, hatchery managers can maintain optimal performance, ensuring higher hatch rates and healthier chicks. Addressing turning issues promptly can prevent costly losses and maximize productivity.





Using temperature & humidity data loggers

Hatcheries control environmental temperature and relative humidity from the egg room through to the chick room to produce and deliver good quality chicks.

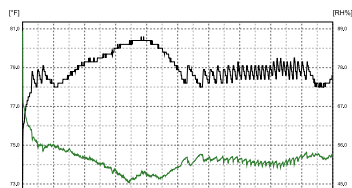
The room conditions are monitored by thermostats and hygrometers which are connected to the air handling unit (AHU) controller. Some modern hatcheries have additional monitoring software with integrated controls, allowing the hatchery staff to pull up real time and historical data. However, it is necessary to make sure that what the system measures is correct and what is seen on a display is really what the eggs, incubators and hatchers are experiencing.

Uncontrolled temperature fluctuations in the egg room will increase embryo mortality and therefore damage hatchability. Unstable conditions in incubator and hatch rooms will force the incubators to work harder trying to maintain optimal conditions. In so doing, they will often create hot and cold spots, which affects embryo growth rate and increases energy use in the hatchery.

Most hatcheries perform daily spot checks on temperature and humidity and record them. Others will look at the averages displayed by their integrated automatic monitoring tools. Even when temperature or humidity are seen to be out of the optimal range, action is not always taken. Using a temperature and humidity data logger, which is capable of autonomously recording temperature and humidity over a defined period at certain intervals, comes in very handy to check on the integrated systems. The digitally stored information can be downloaded into an excel spreadsheet or directly viewed as seen in Graph 1.

The logging summary of the incubator room shows an average room temperature of 26.1 °C (79 °F) and an average relative humidity of 51.7%. A closer look reveals that the room was running warmer for several hours during the day compared to a more stable temperature during the night. Humidity was also slightly affected during the day. By just looking at averages one would think everything is fine when in reality it is not. The temperature fluctuation was caused by doors being left open.

Loggers can be placed at different positions within the room to find out if the temperature or humidity levels are even throughout the room. It is good practice to locate the loggers at egg level in various locations throughout the egg room or at the actual air intakes of the incubation equipment. This way it is possible to learn and understand the behavior of the hatchery ventilation and control systems, and if everything is as it should be. Loggers can also be used inside the machines to monitor machine stability. There are many types of affordable small temperature and humidity loggers available on the market. It is important to look for good quality ones that give accurate readings, and have the option to be adjusted when needed after calibration. Look for configurable parameters, good battery life and a sturdy, waterproof design capable of withstanding the hatchery environment.



Graph 1 Incubator room temperature and relative humidity.



Are you measuring and calculating your chick yield correctly?

Most commercial hatcheries nowadays measure and use chick yield as a Key Performance Indicator (KPI) to evaluate both hatch timing and incubation.

But the big question is: Are you recording your chick yield correctly?

Chick yield is the average weight of the chicks at pull, expressed as a percentage of the average egg weight at set. It tells you when the eggs are losing enough water during incubation, and also whether the chicks are being pulled at the right time at the end of the hatcher period. It is usually measured on sample trays – two or three trays per farm per set – and the full procedure is described in ***Hatchery How To Measure Chick Yield*** which is available on the Aviagen website.

It is worth auditing the procedure in your hatchery regularly to make sure that the method being used is correct, and has not drifted over time, or with changes in staff.

At the start: The fresh egg weight is based on the average weight of the eggs on a full setter tray. The empty tray weight must be measured and recorded, and subtracted from the full tray weight every single time.

Even in a new hatchery, tray weights will vary; and, once they have been topped up to replace damaged units, it is highly likely that there will be between-tray differences in weight. Check the eggs on the sample trays before they are weighed, including a quick pass over a candling table.

CALCULATE AVERAGE FRESH EGG WEIGHT:

$$\text{Avg fresh egg weight} = \frac{\text{weight of full egg trays} - \text{weight of empty trays}}{\text{Number of eggs in tray}}$$

Remove and replace any dirty eggs, any with abnormal shells and any broken or hairline-cracked eggs before the full tray is weighed. When setting these trays, make sure to place them in different representative locations in the setter, distributed top to bottom and front to back of the incubator. Record setter number and location.

At Transfer: When transferring, make sure to move the labels correctly to each hatcher basket so that the final chick weight can be associated with the correct initial egg tray weight.

At Hatch: Chicks should be weighed immediately after they are removed from the hatcher. Before weighing any chicks, place an empty chick box on the scales and zero (tare) the display. Skipping this step will give an artificially high chick weight. It is important to count all the first class chicks from each labeled hatch basket into the empty box one group at a time. Record the number of chicks and the weight. Don't weigh cull chicks as they will not be typical of first class chicks on the tray, and so will affect the average weight.

Record all the background details on a spreadsheet, along with the weights and calculated yield. This will allow you to check which machines are delivering the best chick yield, and to focus attention on the machines which need adjustment.

CALCULATE AVERAGE CHICK WEIGHT FOR EACH TRAY:

$$\text{Average Chick Weight} = \frac{\text{All Chicks weight in the box}}{\text{Number of chicks in the box}}$$

CALCULATE CHICK YIELD %:

$$\text{Chick Yield\%} = \frac{\text{Average Chick Weight} \times 100}{\text{Average Fresh Egg Weight}}$$



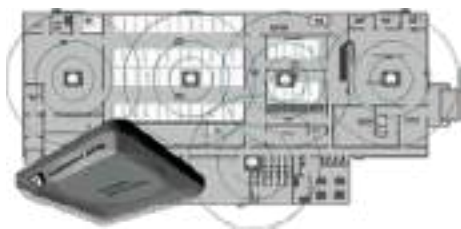
Getting the hatchery connected

Technological developments in recent years have afforded many the opportunity to have an internet connection at their fingertips, practically at all times.

The rise of Wi-Fi, voice activated technology and other interactive advancements have allowed for convenience in daily life, but have not progressed into all areas of the hatchery. Most hatcheries have an internet connection, but it tends to be limited to the office area with a direct wired connection to the incubators.

Mesh Wi-Fi systems:

Because of their design, many hatcheries act like a Faraday cage (an enclosure that actively blocks electromagnetic fields) by blocking the penetration of wireless signals. The introduction of Mesh Wi-Fi with individual, yet connected nodes, allows for a total coverage of the hatchery, opening up new possibilities.



Sensors:

There are a plethora of wireless temperature and humidity sensors that can be used as independent monitoring systems within the hatchery. Many of these sensors have the added bonus that they are battery powered, and can be precisely placed.

As an example, instead of monitoring temperature high on the wall, sensors can be placed inside chick boxes to get as close as possible to chicks, and to be alerted immediately if there is a developing situation.

Cameras:

Wi-Fi connected cameras have become very affordable. A simple camera placed in the Chick Holding Room allows remote monitoring, and by listening in, can also identify chick calls during holding. The cameras also come with software that can be configured to alert when movement occurs in specific areas, which is useful for security purposes.

Quick response (QR) codes:

QR codes are a two-dimensional barcode that, when viewed by a mobile phone, tablet or AR glasses, link directly to a site on the internet that houses a document or video describing how to perform a certain task, such as break out investigations or troubleshooting issues. An increasing number of QR codes will connect to the company's support team; this an important resource when needing to repair, replace or re-order a replacement part.

Remote assistance/ viewing:

Having eyes-on viewing into an operation is a huge advantage. This can be used internally in the hatchery to allow Production Managers to see chick quality on the hatch day, as well as externally for auditing and support from equipment suppliers, or by specialists and veterinarians to quickly identify and rectify issues. Remote assistance/viewing not only reduces biosecurity risks by bringing fewer people into your operation, but also increases the speed of actions and resolutions (reducing losses), as well as a reduction of carbon footprint.



How to calibrate and use temperature readings taken with tiny tag loggers

Over the last 20 years, the importance of controlling embryo temperature, as indicated by egg surface temperatures (EST), has become well understood.



It is now very simple to record EST, using miniature data loggers with an external flexible thermistor probe such as the Tinytag made by Gemini Data Loggers

(<https://www.geminidataloggers.com/data-loggers/tinytag-talk-2/tk-4023>).

The *Aviagen Hatchery How Tos No. 3 and No. 6* describe how to measure egg shell temperature, and where best to place the probes in different types of machine.

Temperature loggers will save records of EST within a setter, the data can be analyzed and displayed in different ways and the record can cover the entire time eggs are in the setter.

Their unit cost is low enough that several can be set up in a machine, to assess temperature variability.

Their main disadvantages are that the loggers cannot be read in real time (newer models can be read in real time through a wifi or radio link, but they are more expensive), the records are accurate only to 0.5°C and the probes cannot be recalibrated by the user.

However, there is a way to check a batch of loggers so that differences between loggers can be identified and corrected as necessary.

Checking between-logger variability

Tiny tags do not have a calibration option. However it is possible to check the variability of readings obtained within a batch of loggers, and correct the temperatures recorded using a simple excel calculation.



Figure 1



How to calibrate and use temperature readings taken with tiny tag loggers *Continued*

		1	2	3	4	5	6
1	26/07/2016 09:05:01	99.367 °F	100.075 °F	99.863 °F	100.115 °F	99.971 °F	99.247 °F
2	26/07/2016 09:05:06	99.367 °F	100.072 °F	99.857 °F	100.112 °F	99.965 °F	99.253 °F
3	26/07/2016 09:05:11	99.367 °F	100.072 °F	99.851 °F	100.115 °F	99.958 °F	99.259 °F
4	26/07/2016 09:05:16	99.367 °F	100.072 °F	99.845 °F	100.115 °F	99.955 °F	99.265 °F
5	26/07/2016 09:05:21	99.370 °F	100.069 °F	99.835 °F	100.112 °F	99.949 °F	99.272 °F
—	—	—	—	—	—	—	—
355	26/07/2016 09:34:31	99.312 °F	100.072 °F	99.675 °F	100.140 °F	99.900 °F	99.259 °F
356	26/07/2016 09:34:36	99.305 °F	100.069 °F	99.685 °F	100.121 °F	99.894 °F	99.250 °F
357	26/07/2016 09:34:41	99.296 °F	100.069 °F	99.688 °F	100.106 °F	99.885 °F	99.238 °F
358	26/07/2016 09:34:46	99.287 °F	100.066 °F	99.691 °F	100.088 °F	99.878 °F	99.222 °F
359	26/07/2016 09:34:51	99.275 °F	100.063 °F	99.694 °F	100.069 °F	99.872 °F	99.204 °F
360	26/07/2016 09:34:56	99.262 °F	100.063 °F	99.694 °F	100.054 °F	99.866 °F	99.182 °F
		99.802 °F	100.097 °F	99.717 °F	100.164 °F	99.934 °F	99.223 °F
Average of all loggers		99.825 °F					
Corrections		0.000	0.295	-0.075	0.362	0.132	-0.519

*Probe 1 is the closest to average

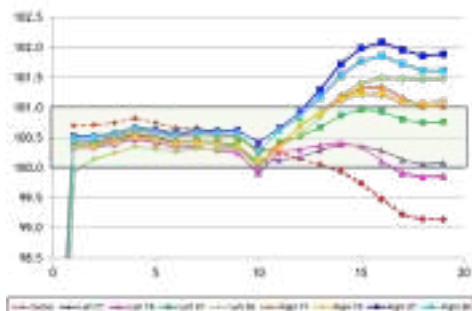
For this purpose:

- **Identify each thermistor/logger with a number**
- **Hold all the thermistors together using adhesive tape and place them into a setter containing day 2 – 4 day eggs for at least an hour as shown in Figure 1.**
- **Download and export the data from all the loggers into Excel**
- **Calculate the average temperature readings of the last 30 minutes for each logger**
- **Take one logger as the reference (the one closest to the average) and calculate how much each of the others loggers differ from this reference probe. Install the loggers in a setter for a full run, following the methods described in *How Tos 3 and 6***
- **After completing the run, apply corrections to each logger before any further analysis**

Once corrected, the EST values can be plotted versus time, to show where hot and cool spots lie within the machine, and also how temperatures change and become more variable during incubation.

As an example, in the chart below, sensors were placed at the top and bottom of trolleys at the back and front of the machine, to the left and right of the central fan. Temperatures for each 24 hour period have been averaged, to remove temporary blips during machine checks and variability due to egg turning. The red line shows the air temperature at the sensor, which was warmer than the EST readings until 6 days, and cooler after 12 days. At 17 days:

- **EST at the right hand side of the machine was warmer than at the left (101.5°F vs 100.6°F)**
- **The front of the machine was cooler than the back (100.6°F vs 101.5°F)**





Putting incubation research into practice

The development of avian embryos has been of interest to both biological and environmental researchers for a very, very long time. Indeed, the first thermostat was invented by Cornelius Drebbel in the early 1600s to control the environment in a chicken incubator.

More relevant to modern commercial hatcheries is the huge volume of research published in the last 80 years. This has allowed us to define the essentials of incubation, in terms of the ideal embryo temperature (egg shell temperature or EST) of 100°F (37.8°C) from day 0 to day 21, weight loss to 18 days of 10.5-12.5% and chick yield at take-off of 67-68%.

Eggs must be turned once (or twice) an hour through 90°, from set through to 16 days incubation.

We also know that because the heat output of the embryo changes during incubation, and the optimal embryo temperature is constant, the incubator will need to heat eggs for the

first 9-10 days after set, and cool them from then onwards. This might be done by varying the set point in a single stage setter, or in a multistage setter by using the heat from older embryos to heat the freshly set eggs.

Some research projects look promising on a small scale in the laboratory, but are not used in commercial hatcheries. Occasionally this is because the 'problem' is not currently in need of a 'solution'. More often, it is because a treatment which works beautifully in small incubators holding 400-500 eggs proves difficult or impossible to scale up to machines holding many thousands of eggs.

When reporting on the impact of new incubation treatments, it is beneficial to those trying to implement on a larger scale if the report includes not only the treatment, but also how it affected the incubation essentials of EST, water balance, chick yield and turning angle. Equally, if trying a new program out in a large hatchery, it is important to measure its impact on all the incubation essentials to give guidance and support when troubleshooting.



Figure 1 Radio controllers for TinyTags allow real time measurement of egg shell temperature (EST) in operating setters.



Putting incubation research into practice *Continued*

Incubation trials at Aviagen often involve implementing a novel egg storage or incubation treatment on a larger scale. Some treatments have been useful, others less so. Measuring the real time EST using Radio TinyTags (Fig. 1), water balance and chick yield have helped us to understand why.

Finally, it is always worth remembering that changes at the hatchery can have an effect on chick welfare and quality, on broiler performance and even processing performance. Before mass implementation at the hatchery, it is worth checking what that effect might be.



Measuring vent temperatures accurately

We know that newly hatched chicks cannot control their body temperature very well, and need some help by keeping the environment close to their needs. It is easy to tell from the chicks' behavior whether they are too hot (Figure 1) or too cold (Figure 2).

Hot or cold chicks also tend to be noisy. By checking their body temperature you can quantify how hot or cold they are, compared to the Aviagen target of 103°F - 105°F and make adjustments to the environment accordingly. This hatchery tip gives some hints as to the best way to get repeatable, accurate results when checking chick temperatures.

All the Aviagen trials measuring vent temperature have used a Braun® ThermoScan® thermometer. These are widely available, well priced and consistent. Of the current models, the ThermoScan 5 or 7 are the most suitable, because they pre-heat the measuring tip. However, they should still be checked regularly, and we advise replacing the unit every 12 months.

There are other excellent paediatric infrared (IR) thermometers available, but these may give slightly different readings. So if you want to use an alternative, calibrate it against a Braun device.

Switch the thermometer on and leave to settle in the room where it will be used for 15-20 minutes at the start of any measuring session.

To measure vent temperature, hold the chick with its vent towards you, and use your thumb to push the rump upwards.



Figure 1 Chicks which are too hot start to pant.



Figure 1 Chicks which are too cold huddle together for warmth.

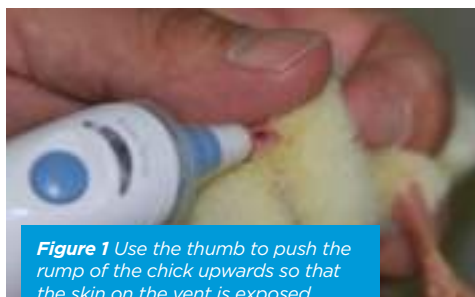


Figure 1 Use the thumb to push the rump of the chick upwards so that the skin on the vent is exposed



Measuring vent temperatures accurately *Continued*

The tip of the thermometer should be placed on the area free of any down (**Figure 3**).

If the vent is wet, after a dropping has been passed, then any visible moisture should be blotted away, or another chick sampled – a chick with a wet vent will appear to have a much lower temperature than others in the group.

Once moved to a different environment chick temperature will change quite fast. Chart 1 shows the temperature of 50 chicks in the order they were measured. They had been moved from a hot environment to a cooler one just before measurement started. Whenever possible, chicks should be measured in the place where they are being held.

If they have to be moved, for example out of a hatcher or a delivery vehicle, then the vent temperatures will only be representative of the former environment for around 15 minutes. After this time, a new sample should be taken.

Vent temperatures can give accurate and repeatable guidance to the comfort of chicks at all stages between hatching and arriving at the farm.

Take care to measure accurately, record the data to place and time and use it to make improvements to the environment for the chicks.

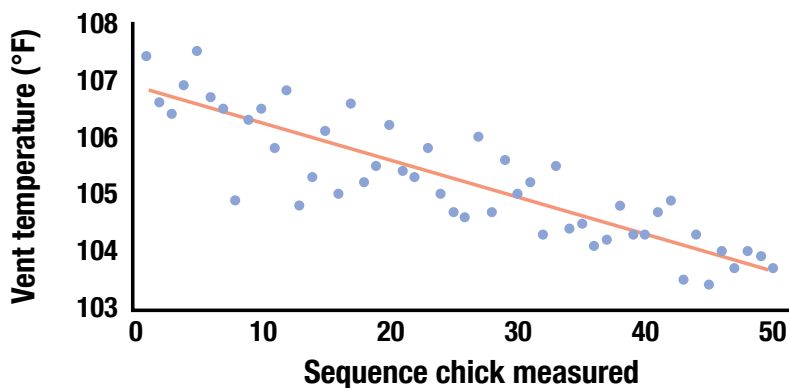


Chart 1 Vent temperatures dropping as a box of chicks adjusts to a cooler environment.



Using your mobile as a powerful tool in your hatchery

A mobile application, most commonly referred to as an app, is a type of software designed to run on a mobile device, such as a smartphone or tablet computer.

Mobile applications frequently serve to provide users with easy measurement and analysis which are equivalent to those provided by dedicated tools. App software is supplied through application stores managed by Apple® or Google®.



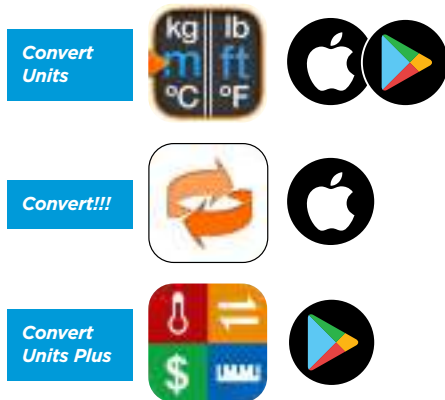
Today there are many applications which can be used in hatcheries. In this tip we will introduce some of them.

Angle measurement



To check egg turning angles or ventilation damper angles the mobile device can be used as an angle meter. Angle Meter Pro is available for both IOS and Android, and can even measure angles through a window if necessary.

Converting Units



Globally, manufacturers give standards for flows, volumes or pressures in different units. The actual units chosen will usually depend on where the supplier is based.

Depending on the measurement tools or calculation methods actually in use at the hatchery, it is often necessary to convert these values to different units.

These small applications are capable of converting almost all values. There are hundreds of similar programs available for IOS and Android.



Using your mobile as a powerful tool in your hatchery *Continued*

Measuring fan speeds

**Strobe Light
Tachometer**



**Strobe RPM
Hz LightC**



Fan speed checks are an essential part of routine maintenance. These applications use the mobile device's flash light as a tachometer.

To measure fan speed, start the application, set the expected RPM (Revolutions per Minute) value to the target for that machine, and in the dark direct the blinking light towards the fan and observe the fan blades. If the fan looks as if it has stopped turning, then it is turning at the expected RPM value.

If it still looks as if it is turning, alter the expected RPM from the menu and read its current speed. It is possible to multiply the RPM by the number of fan blades for easy reading.

Converting between RH% and F

**E+E Humidity
Calculator**



Many hatcheries have more than one make or age of machine. When recording humidity, some machines use relative humidity % (RH%) and others wet bulb temperature. This tool will convert between the two.

It is also useful if you are calibrating an electronic humidity sensor which is programmed to give a wet bulb reading. Set machine air temperature and expected RH% on the App, which will give a predicted wet bulb reading.

The app can also be useful calibrating machines with electronic humidity sensors, which are calibrated using saturated salt solutions but give the humidity reading as a wet bulb temperature.

For this, you need to tell the app the incubator air temperature in F, and the predicted RH reading from the salt solution. The app will tell you what the wet bulb temperature should be, which you can check against the actual reading on the incubator. If the two are not in agreement, adjust the machine reading until it is the same as the one on the app.

The apps that are available for smart phones include many which are of great practical value. The few that we mention in this tip cover those which are particularly useful in the hatchery and are available at low or no cost to the user.



The role of the incubationist in the hatchery

We can describe the ‘rules of incubation’ very clearly now, putting them into terms that define the needs of the embryo for temperature control, time, weight loss (humidity control) and turning.

However, the day-to-day management of the incubators needed to allow them to deliver the correct environment to what can often be quite variable eggs and machine load levels can be a challenge. It is not made any easier with both hatcheries and the incubators inside them getting steadily bigger and bigger.

The development of accurate gas sensors and data loggers has made it easier to record and analyze actual conditions inside an individual machine, but keeping on top of the information can be very time consuming. In the past, the hatchery manager was usually expected to deal with setting up and managing the incubators. In modern hatcheries, a dedicated incubationist reporting to the hatchery manager is the best way to make sure that the machines are set up to suit the needs of the eggs they are presented with.

A dedicated incubationist can make a considerable difference to hatchery performance because, over time, they can monitor and correct the performance of every incubator. Thus, measuring weight loss to 18 days can not only show that water loss is satisfactory on average, but will also enable the incubationist to drill down to the performance of individual machines and banks of machines – often finding irregularities in how well machines are sealed and how effectively they are ventilated. Monitoring chick yield will help to keep pull times right for short or long journey times.

Temperature checks may be as basic as checking machine calibration or as complex as setting up data loggers to measure eggshell temperature at critical areas within

each machine. Again, making small corrections will even up performance within the machine. Modern loggers, with Bluetooth or ethernet connectivity, make it much easier to make real-time checks and monitor the impact of changes. Monitoring chick vent temperatures in the hatcher at intervals through processing makes it possible to refine holding conditions to keep chicks comfortable and resilient.

Turning frequency and angle can make a big difference to both hatch and chick quality. It is amazing how many hatcheries rely solely on the machine counter rather than observing and measuring turning angles regularly (Pic. 1). Regular breakouts of unhatched eggs are informative, giving early warning of transfer damage and of turning problems as well as storage issues (pic. 2)

Most importantly, the incubationist will keep good records of all the information they collect so that they can monitor trends, ensure that no machine is struggling and that the Hatchery Manager can be confident that the hatchery is performing well.



Figure 1 Measuring turning angle with a mobile phone app.

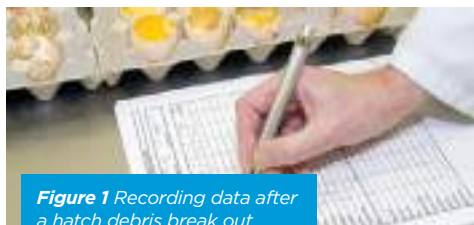


Figure 1 Recording data after a hatch debris breakout.



The chick yield vs. moisture loss box

In hatchery management, achieving the right balance between chick yield and moisture loss is essential for Optimizing chick quality and hatchery performance.

The Chick Yield vs. Moisture Loss Box is a powerful tool for visualising this balance. It can be easily generated using the scatter plot function within Excel. Plotting one against the other will allow the hatchery manager to assess if adjustments are needed.

Interpreting the Chart

Vertical Axis (Y-axis): Represents chick yield percentage, which is the weight of the chick as a percentage of the initial egg weight.

Horizontal Axis (X-axis): Represents the percentage of moisture loss during incubation, which is crucial for proper embryonic development.

In both cases, the value plotted should be the mean for the batch of eggs, rather than individual tray values. The chart features four quadrants separated by red lines, creating a central green box indicating the target zone. This zone signifies the optimal ranges for both chick yield and moisture loss. When points fall within this green box, it indicates that conditions are ideal, reflecting optimal hatchery performance and chick quality.

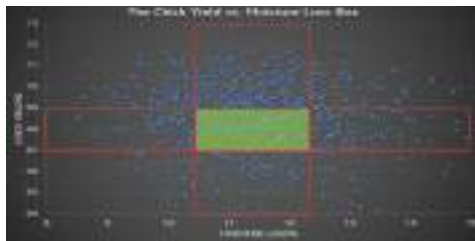


Chart 1 shows moisture loss vs chick yield values from 12 months of data collection in a hatchery.

Analysis of Data Points in the Chart

Some variability around the target is normal, and in this case, it is reasonably symmetrical.

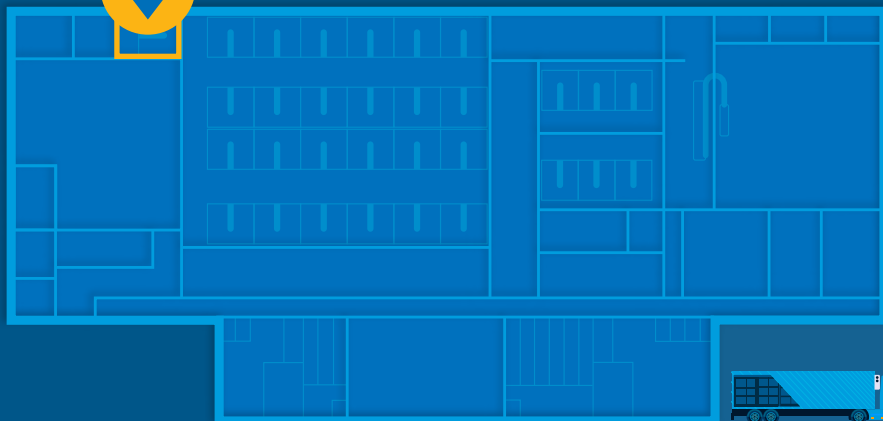
Above the Target Box: Points above the target box indicate a higher chick yield, suggesting that chicks are being pulled too green. The data set plotted here suggests that chicks are pulled too early more often than they are pulled late.

Below the Target Box: Points below the target box indicate a lower chick yield, possibly due to chicks being left in the hatcher for too long after they emerge. Values below 65% are associated with poor broiler performance.

Left of the Target Box: Points to the left indicate low moisture loss, which could be due to high humidity or insufficient airflow within the setter.

Right of the Target Box: Points to the right suggest high moisture loss, due to low humidity or excessive ventilation.

Plotting chick yield against moisture loss regularly allows hatchery managers to see where their hatchery performs relative to the target and make necessary adjustments to incubation conditions. The goal is to bring as many data points as possible into the target zone, ensuring high chick quality and consistent hatchery performance.



SPIDES

Cooling eggs after short periods of incubation during egg storage (SPIDES) **21**

If you are heat treating stored eggs to improve hatchability (SPIDES), how long should the eggs be kept warm? **46**

Optimizing chick quality & hatchability in periods of long egg storage **47**



If you are heat treating stored eggs to improve hatchability (SPIDES), how long should the eggs be kept warm?

Aviagen's early SPIDES trials were aimed at defining the safe limits for heat treating eggs during storage – how long, how often and how hot the treatments should be.

In these trials, we held eggs for 21 days, and gave up to 5 treatments during the storage period. We found that in this situation, individual treatments were best kept as short as possible.

If we pushed the length and number of treatments too far, hatchability got worse.

Chart 1 shows the percentage of lost hatch that was recovered after different treatment combinations, compared in terms of the cumulative time the egg shell temperature was held above 32°C (EST>32°C).

We showed that hatch recovery was achieved in any treatments where the cumulative time above 32°C was between 6 and 24 hours, but that the optimum effect was seen when the cumulative time was between 6 and 14 hours. There was a steady deterioration in the hatchability recovered for treatments above 15 hours, which dropped to no benefit when EST >32°C was over 26 hours and almost complete hatch failure when the cumulative treatment time was 39 hours.

The trial summarized in **Chart 1** does not show what impact, if any, there might be in further shortening the cumulative exposure time from 6 hours. However, some recent trials which were performed in collaboration with Prof Okan Elibol at the University of Ankara have shown that shorter treatment times can also be suboptimal. These trials were done using a Petersime® Restore cabinet, and a storage period of 14 days.

The eggs were treated once only, on the 5th day of storage, and were given either 3.5 or 5.5 hours above 32°C EST. There were three repetitions, using eggs from flock ages of 37, 54 and 55 weeks. There was no fresh egg control in these trials; so it was not possible to calculate how much hatch was lost due to storage, or the percentage recovery. However, in each of the three comparisons, a single exposure of 5-5.5 hours gave a higher hatchability than the shorter exposure of 3-3.5 hours.

When designing a SPIDES program, for optimal results the treatment should be set up so that the cumulative EST >32°C is between 5 and 14 hours.

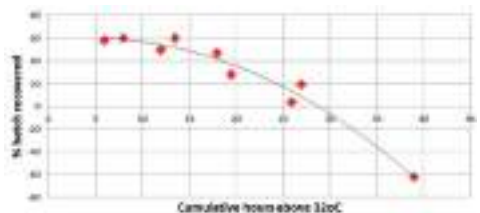


Chart 1 Percentage of lost hatchability due to storage recovered after multiple SPIDES treatments.



Figure 1

Optimizing chick quality & hatchability in periods of long egg storage

There are times in the year when chick production operations may struggle to keep egg age down.

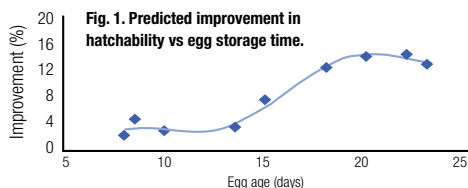
However, a good egg storage strategy can greatly improve both hatchability and chick quality from older eggs. It is not only the hatchery that needs to adjust; close co-operation with the team planning the egg sets will simplify the decision-making process, and small shifts in placement dates can sometimes make a big difference (if the customer agrees).

When egg ages start to drift up, preparing for the consequences and putting in measures to help the embryos survive longer storage will pay dividends in better chick numbers and quality. The key is to have a good egg stock management strategy. Make sure the eggs are properly cared for while being stored by:

- **Adjusting the egg storage temperature from farm to hatchery to reduce embryo loss over a prolonged duration of egg storage (Table 1).**

Storage period (days)	Egg store temperature °C (°F)	Humidity (%)
1-3	15-18 (59-64)	65
3-14	15 (59)	65
14+	12-15 (54-59)	65

- **Avoiding excessive humidity while storing eggs. This can be enough to allow condensation to form on the eggshell, which makes it easier for micro-organisms to pass through the shell pores into the egg. Humidity over 80% RH is often associated with mold formation on walls and ceilings of the egg store.**



- **Using 'SPIDES' (short periods of incubation during egg storage) treatments. Well-implemented SPIDES treatments can recover 60% or more of hatch loss compared to untreated stored eggs (Fig. 1). For the best result from SPIDES treatments, the eggshell temperature must stay above 32°C (90°F) for between 5 and 12 hours (accumulated over several SPIDES treatments if appropriate).**
- **Turning eggs four times each day while they are being stored (to stop albumen deterioration and embryo adherence to the shell membrane) will improve the hatch of stored eggs, in addition to the benefit seen from SPIDES treatments.**
- **Preventing temperature fluctuations in the egg storing room; the room should be well insulated, the cooler able to cope with the local climate at its hottest and the egg store door should be kept closed unless someone is passing through it.**
- **Employing an egg stock management system that always uses the oldest eggs from the oldest flocks first. This is because eggs laid by older hens tend to deteriorate faster.**

With appropriate egg storage management, using eggs efficiently will increase hatchability and chick quality. Every egg in the hatchery is valuable!



SETTER ROOM

<i>Pre-warming eggs</i>	10	<i>Hot eggs damage chick quality</i>	51
<i>Checklist - Egg management and setter balance</i>	18	<i>Calibrate CO₂ sensors regularly</i>	52
<i>What happens when eggs are set small end up?</i>	22	<i>Check hatch debris regularly to identify egg turning problems</i>	53
<i>Balancing setters when mixing flocks for better heat distribution</i>	24	<i>Temperature calibration probes</i>	54
<i>Let your eggs guide you</i>	28	<i>Calibrating electronic humidity sensors</i>	55
<i>Correct use of tinytag loggers to measure eggshell temperature</i>	29	<i>Zero calibration of pressure sensors</i>	56
<i>When did you last watch your eggs turning?</i>	31	<i>Sense-check your CO₂ sensor calibration</i>	57
<i>Using temperature & humidity data loggers</i>	32	<i>Use water loss data to assess setter function</i>	58
<i>How to calibrate and use temperature readings taken with tiny tag loggers</i>	35	<i>How to calculate water loss correctly</i>	60
<i>Keep setter floors dry</i>	50	<i>Incubation in high humidity climates</i>	61
		<i>Balancing a set in single stage setters</i>	62
		<i>Checklist - Setters and Hatchers</i>	63



Keep setter floors dry

Wet setter floors are often seen in hatcheries. Staff do not usually pay much attention, and often think they are unavoidable.

Wet floors can have several negative effects on incubation conditions and chick quality. Firstly, water will evaporate off the open water surface, causing localized cooling of the surface. The rising water vapor will then hit the eggs placed on the lower egg trays.

This has a cooling effect on these eggs slowing down their embryo development compared to eggs in other positions in the setter.

In addition, with machine temperatures around 100°F (37.8°C) the wet warmth provides an ideal environment for promoting the growth of mold and bacteria – especially on wet surfaces. The water vapor can also carry bacteria and mold spores which can settle on the egg shell or penetrate through micro fissures in the shell into the egg. In other words eggs on the bottom of a machine with a wet floor will be cooler and in danger of becoming contaminated.

With some single stage setters, especially if they are sealed for most of the first half of incubation, it is very difficult to avoid wet floors and walls. The eggs release moisture through the egg shell, and in a well sealed incubator humidity builds up to very high levels. At these very high humidity levels and at incubation temperature, condensation on the walls and pipework is almost unavoidable, and the water soon drips down to the floor.

The best way to prevent the humidity building to such a high level is to open the dampers slightly once the setter is up to temperature, leaving it very slightly open for the first 24 hours of incubation.

Once the dampers are closed, the humidity will build again, so it is usually best to start ventilating the setter after day seven of incubation at the latest.

Once single stage setters are being ventilated, or in a hatchery which uses multi stage setters, then the floors should always be dry. If water is seen on the floors, then action needs to be taken to stop it.

Wet floors in incubators can be caused by:

- **Leaking connections to the cooling pipes, the humidity spray nozzles or solenoids.**
- **Pinholes in the copper cooling pipes.**
- **Condensation from the cooling pipes or solenoids – especially if the water chiller is set colder than necessary.**
- **Catching troughs or gutters not in place, blocked or leaking.**
- **Spray nozzles not functioning properly.**

Most of the above causes have to do with maintenance and can be avoided by having an effective preventative maintenance plan in place.



Figure 1 Standing water on the floor of a single stage setter at the end of the sealed period.

Hot eggs damage chick quality

There is an optimal embryo temperature range where embryos will be comfortable.

When eggs get too hot, chick quality will suffer long before hatchability is affected.

Check the eggshell temperatures on days 16 to 18 of incubation, when the embryos are producing a lot of heat, to see if there are any dangerous hot-spots developing in the setters.

Use a Braun ThermoScan infra-red ear thermometer, or Tiny Tag temperature loggers to monitor the eggs in the center of the egg trays in as many different locations as you can.

Chick quality will be affected wherever you find eggshell temperatures exceeding 102°F (38.9°C). Chicks from overheated eggs will hatch earlier, so are more prone to dehydration. They will also be paler, shorter and the yolk sac will be bigger. Unhealed navels will be more common.

When chick quality is poor, not only will there be more culls and downgrades at the hatchery, but also performance on the broiler farm will be poorer.

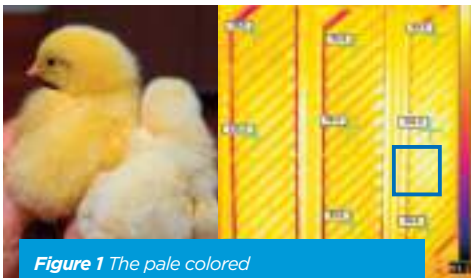


Figure 1 The pale colored chick was overheated.

Figure 2 Hot area in a single stage setter.

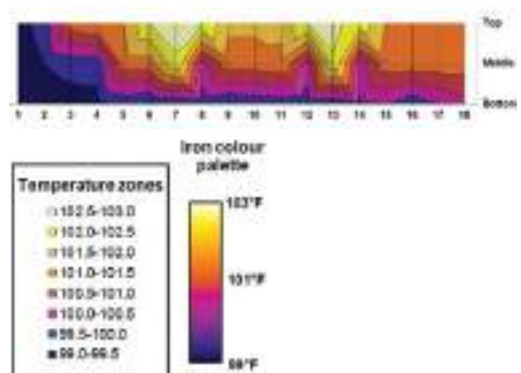
Chicks from eggs which have been overheated will not grow as well, and will tend to have higher mortality throughout the flock life. Feed conversion may also suffer.

If ventilation is adequate, hatchability is not usually affected until higher eggshell temperatures are reached.

It is easy to visualize the variation in eggshell temperature in the setters by entering the temperatures into an Excel spreadsheet, and plotting a graph using the chart type 'surface' and the option 'contour'. In the example given below, taken from a fixed rack multistage setter and using a thermal image iron color palette, the graph shows a cool spot near the door and two hot spots in stacks 7 and 13.

Places where eggshell temperatures exceed 102°F (38.9°C) indicate that action is needed.

Check door seals, fan speeds, setting patterns (was the set balanced?), spray nozzles, cooling coils, solenoids, water flows, fan blades, turning angles and frequency and incoming air temperature and humidity.





Calibrate CO₂ sensors regularly

Most modern single-stage setters and hatchers are fitted with carbon dioxide (CO₂) sensors, automating adjustment of the machine dampers according to the CO₂ accumulated from the developing embryos.

Most modern single-stage setters and hatchers are fitted with carbon dioxide (CO₂) sensors, automating adjustment of the machine dampers according to the CO₂ accumulated from the developing embryos. This can work well, but only if the CO₂ sensors are accurate. Sensors which under or over record will result in the machine being incorrectly ventilated. When this happens, it can lead to gradually declining chick quality and hatchability.

The first step is to make sure that the CO₂ sensors are all reading correctly. Prolonged exposure to high humidity levels during sealed incubation, and to chick fluff and humidity during hatching or even washing water can all affect the sensor or sensor protection cap leading to inaccurate readings. The sensors must be calibrated regularly. Ideally, the sensors should be calibrated at low, mid and high CO₂ levels, proving that they are reading correctly across the desired range. A simple calibration can be done using an electronic meter (which is itself regularly calibrated against known standards) to check that both machine and calibration sensor are giving the same reading at room CO₂ levels.

This will usually be higher than the 400ppm (0.04%) normal for fresh air; both people and chick embryos will be producing CO₂ in the building which will drive the concentration up. However, mid- and high-end values can be checked during incubation only if your calibration instrument sensor can be inserted into the incubator next to the machine probe without opening doors or air vents.

Alternatively, higher CO₂ levels can be calibrated using a CO₂ gas mixture with a known, certified CO₂ concentration while the machine is empty. These are used to fill a cap or bottle sealed around the sensor unit. Mixtures with certified CO₂ concentrations of 5,000 and 8,000ppm (0.5 and 0.8%) are readily available on the market.

Having calibrated the sensors, you must then make sure that the machine is still able to support higher levels of CO₂. Levels can only rise if the incubator is well sealed against air leakage. Check that the seals around doors and dampers are not worn, and make sure that both can be closed tightly. The calibration on damper opening should also be checked. An easy way to check that the machine can be properly sealed is to stand inside the empty, powered down incubator with the doors and dampers closed. If you can see any light, the machine will not seal properly. High CO₂ levels will not of themselves improve hatchability or chick quality. However, measuring CO₂ build up can be a useful tool to show when a machine needs fresh air. For this to work consistently the sensors need to be calibrated accurately and the rate that CO₂ accumulates in the machine must be predictable. If either of these fail, then ventilation rates will be incorrect.



Figure 2 The photograph above shows typical CO₂ sensors in a setter, protected by sensor protection caps. If the caps become clogged with dust or condensation, the sensor will give an artificially high reading.

Check hatch debris regularly to identify egg turning problems

Egg turning is a key input for normal embryo development.

Brooding hens roll the eggs in their nests; in hatcheries, trays of eggs must be tilted to either side of horizontal. For the best hatchability, eggs should be tilted once an hour to achieve a 38-45° angle to each side. Hatchability will be depressed if turning angles are too shallow, or turning is not frequent enough, especially in the first 7 days.

During the early stages of embryonic growth, the chorio-allantoic membrane (CAM) forms to enclose the albumen. This is the source of the network of blood vessels seen on the inside of the egg shell in hatch debris. If turning is inadequate for any reason, the CAM will not form properly, and short-circuits the small end of the egg, leaving a circular patch with no covering of blood vessels.

Failure of egg turning or inadequate egg turning (frequency or angle) will cause raised levels of early dead (membrane and blood ring) and late dead embryos. The late deads will show characteristic signs of turning failure due to poor growth of the CAM, leaving residual albumen in the bottom of the egg.

There will also be more undersized embryos, and the incidence of two specific malpositions, malposition-II (head in small end of the egg) and malposition-III (head to left) will be raised. This specific combination of embryo mortality categories is a typical indicator of egg turning issues in the hatchery.

Turning problems are one of the more common issues seen by Aviagen hatchery specialists when visiting commercial hatcheries. There are two main reasons for this. In older hatcheries, multi-stage incubators are getting older. Their turning systems have become worn.

Occasionally they fail completely, or more often do not manage to achieve adequate turning angles. In newer hatcheries, with single-stage incubators, it can be tricky to spot problems because the focus is on keeping the machines sealed for the first few days and this can make people very reluctant to open the setter doors to check the turning. The very big modern setters put a big load on the turning mechanism and this can cause turning angles to drop below the optimum. Unfortunately, the critical sealed period is also the most critical period for egg turning.

In order to identify and resolve egg turning issues, especially mild chronic ones, a routine hatch debris breakout program should be implemented in every hatchery. A rise in both early and late deads with poor CAM growth, malposition II or III or residual albumen on the hatched chick is a strong indication of a turning issue. Check the turning angle in both directions, and make sure that eggs are turned once an hour with regular inspection, opening the setter door to do so.



Figure 1 The CAM did not reach the pointed end of the egg, leaving some albumen unavailable to the developing embryo.



Figure 2 A chick with residual albumen on the down.



Temperature calibration probes

It is important to check and calibrate the temperature sensors in setters and hatchers regularly, using a calibration probe which is accurate to 0.2°F, and readable to 0.1°F.

With regular calibration we start to see benefits in consistency and predictability between machines, because their temperatures are exactly the same.

Today, with advancing technology, we have a great opportunity to use new, more accurate tools to calibrate setters and hatchers. It is possible now to buy reliable and accurate calibration thermometers (accuracy of $\pm 0.2^\circ\text{F}$) at an affordable price. However, it can be a challenge to get the calibration probe into the right place to check the machine sensor. In principle, the best place to put the calibration probe is right beside the machine probe. Unfortunately, this may not be possible if the probe does not have a long lead to reach into the machine.

For this reason, probes are often inserted through a specially drilled hole to just inside the machine door, without first checking how closely the temperature there corresponds to the temperature next to the machine sensor. To achieve a proper calibration, the calibration probe has to be placed at a location which is consistently within 0.2°F points of the air temperature at the machine probe. Without doubt, a position next to the machine probe will give the best accuracy. Unfortunately, some calibration devices have very short cables and simply will not reach to the machine probe from outside the setter door.

In situations like this, if it is not possible to find a close location, the only way to achieve a satisfactory calibration reading is to look for a reachable position which

runs at a similar temperature to that around the machine sensor(s). When looking for such a position, the machine should be fully loaded and turned to the calibration position following manufacturer's suggestion. Machine doors and seals should be checked and maintained as necessary to avoid false readings due to air leakage. For single-stage machines, check between days 2 and 3.

For multistage machines, check at least 24 hours after the last set. First, the machine probe should be calibrated properly. For this purpose it is worth the extra trouble to place the calibration probe right next to the machine probe, however difficult this may be. After completing an accurate calibration at the sensor, place the calibration probe in different positions to find a spot which runs at the same temperature as next to the sensor. Each time the probe is moved, allow the machine to run normally for at least one hour before reading the temperature.

When the machine probe and calibration probe readings are similar (less than $\pm 0.2^\circ\text{F}$ difference), drill a hole in the wall or roof to allow the calibration sensor to be inserted at that point. Once you have found the best position in one machine, the same location can be used for all the other machines of that type and capacity.



Figure 1 A hole drilled in the door and protected with a metal plate allows the insertion of the calibration probe close to the temperature sensor.



Calibrating electronic humidity sensors

Calibrating the humidity sensors in incubators can be tricky.

However, if the machine has electronic humidity sensors a saturated solution of a specific chemical compound, presented to the sensor in a sealed container, will give an accurate and predictable reading which can be used to calibrate the machine.

Saturated solutions of different salts will, depending on the temperature, always give the same reading on an electronic humidity sensor. Two of these compounds are suitable for use to calibrate setter or hatcher electronic humidity sensors at incubation/hatcher temperatures (98-100°F). Magnesium nitrate hexahydrate $[Mg(NO_3)_2 \cdot 6H_2O]$ will read 50% and sodium chloride $[NaCl]$ will read 75% RH. If the machine shows a wet bulb temperature, rather than a percentage RH, then the predicted reading will alter slightly depending on the air (dry bulb) temperature in force at the time of calibration.

The table below shows what to expect at different dry bulb temperatures for both chemicals. Correct preparation of the solution is very important. Too much or insufficient water addition will give inaccurate results. Salts should be of consistent purity, ideally laboratory grade.

Steps:

1. Fill the sensor protection bottle quarter full with the dry salt. Prepare a syringe full of water.
2. Add a small amount of water to the salt and shake well.
3. When the salt becomes sticky (it will stick to the bottle) the solution is ready to use. Turn off the humidity alarm of the machine.

4. Screw the bottle to the fitting above the humidity sensor. The humidity reading will stabilize once the salt solution has reached incubation temperature (about an hour).
5. Once the humidity becomes stable, calibrate your sensor to the expected value for the machine temperature at the time (see Table).
6. Remove the bottle to finish calibration, turn on the alarm and run the machine normally. Humidity will shortly start showing actual level. One batch of solution can be used for five machines.

It is good practice to repeat this calibration every set for single stage machines and every month for multi-stage machines.



DRY BULB TEMPERATURE (actual machine temperature)	APPROXIMATE WET BULB TEMPERATURE (°F)	
	Sodium Chloride	Magnesium Nitrate Hexahydrate
100	92.5	83.5
99.5	92.0	83.0
98.5	91.0	82.2
98.0	90.5	81.8



Zero calibration of pressure sensors

Incubators will usually only work properly if there is an air pressure gradient between the air inlet and the exhaust.

This means that the rooms and plenums supplying and exhausting air need to operate at the correct pressure differential. The incubator supplier will provide the specifications needed for their machines, and hatchery ventilation systems must then be designed to deliver the required room static pressures.



Once in service, air spaces will need to be monitored with suitable pressure sensors, so that the air pressure can be corrected as necessary on a continuous basis (left).

There are two ways to calibrate pressure sensors. The first one is to do a full range calibration (Span) which includes the zero and extremes of the range covered by the sensor. This method needs some special equipment and procedures and is therefore not always possible to apply under hatchery conditions. The second method is to apply only a zero calibration. By this method, the sensor can be calibrated at neutral pressure to zero.

There are many kinds of pressure sensors and most of them have a special button, jumper, screw or menu to allow zero calibration (examples shown right).

To perform a zero calibration, first remove all the tubes entering the sensor, leaving the hose connectors vented into the same air space. By doing this, the difference between low pressure and high pressure tubes will be zero.

Depending on the make of sensor, and following the manufacturer's directions either:

- **Press and hold the 'zero' switch for about 4-5 seconds.**
- **Or set the jumper for zero calibration option and hold for 4-5 seconds.**
- **Or turn the screw until the display shows zero.**
- **Or if the sensor has a setup menu, follow the menu instructions to make the reading zero.**

The zero point should now be set and, if a display is present, the display will read zero. A zero calibration should be performed at least once a month. The hatchery environment is potentially a very challenging one, with the possibility of water, chemicals and fluff particles around the sensor. This can affect sensor accuracy. Some sensors have an automated zero calibration option, but it is still wise to check the sensors regularly to see if they are working correctly. Accurate control of static pressure in the hatchery is critical if the incubators are to work properly. Regular zero calibration of the pressure sensors will help to make this possible.



Figure 1 Zero switch.



Figure 2 Menu driven zero calibration.



Sense-check your CO₂ sensor calibration

CO₂ sensors are used by most manufacturers to adjust the ventilation rates of setters and hatchers.

The control systems in those machines will monitor CO₂ level and use the recorded value to reach decisions about ventilation rates. This is a good way of creating dynamic ventilation profiles for flocks with different fertility and egg sizes.

High fertility batches will produce more CO₂ and will be ventilated more when running on CO₂ sensors, whereas running on a fixed program could normally meet only average needs.

However, the level of O₂ in a machine will be highly correlated with the level of CO₂. This means that any calibration inaccuracy of a CO₂ sensor can create serious problems. A drift in the CO₂ sensor will mislead the ventilation program and create problems, depending on the drifting value. It is very common to see hatchability, chick quality and chick yield issues related to misaligned CO₂ sensors.

Therefore, we have to be sure that the calibration of the CO₂ sensors is accurate. Fortunately, in addition to routine calibration, there is a fast and easy way to check CO₂ sensors when a machine is empty.

Outside air contains 300-400ppm (0.03-0.04%) of CO₂. Inside, if the hatchery ventilation is working well, corridors (or air intake plenums) should have 400-600ppm (0.04-0.06%). When we run machines empty with 100% open dampers, we should read CO₂ level similar to that in the corridor.

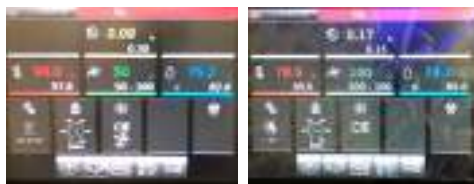
If the readings are too low or too high, we need to recalibrate the CO₂ sensors with a zero-calibration kit. If calibration is not possible, replace the failing sensors.

The pictures show control panels of two pairs of setters. In both pairs, the machine on the right hand side (with higher CO₂ reading) will ventilate more than the one on the left. The first machine (0.2% CO₂) will have insufficient ventilation, especially at the last stages while the other three will be over ventilated to a lesser or greater extent.

In setters, insufficient ventilation will cause insufficient weight loss and late embryo mortality. Over-ventilation will cause excessive weight loss and cold spots. In hatchers, insufficient ventilation will cause excessive chick yield, navel problems, late mortality and ascites. Over-ventilation will cause cold spots, wide hatch window and dehydration.



0.02% vs 0.16%



0.08% vs 0.17%

Figure 1 Some examples of CO₂ calibration drift.



Use water loss data to assess setter function

The water loss of hatching eggs will affect hatchability and chick quality.

The ideal weight loss from 0-18 days is between 10.5-12.5%. The main factor affecting incubation water loss is the humidity of the air in the setter.

Most hatcheries monitor water loss and use it as an effective management tool to fine tune setter humidity programs.

But sometimes, the water loss varies between machines or in different hatches over time, even when the setters are all running with the same humidity programs and set-points.

When this sort of variability is seen, it is usually because the humidity levels achieved in the setter have been affected by factors such as the humidity of the fresh air coming in to the setter, its ventilation rate or the functionality of the humidifier inside the machine. If one of these factors has changed even slightly, or is not working properly, water loss may change.

So we can also use water loss data to assess the functioning of a hatchery.

Here are some examples:

1. This was in a hatchery located in a temperate climate. The air supply to the setters was not humidity controlled. But warm air in the summer can hold more moisture, so actual incubation humidity is much higher and the eggs lose less weight (see Chart 1).

2. A different hatchery, again in a temperate climate. This hatchery had four setter rooms. Room 1 held setters 1-6, room 2 setters 7-12, room 3 setters 15-19 and room 4 setters 20-24. Setter rooms 1 and 3 shared one exhaust plenum. Setter rooms 2 and 4 shared another one. After the exhaust fan was changed on the plenum for setter rooms 2 and 4, incubators in these two rooms were ventilated more than the others, causing relative humidity to be lower and as a result the eggs lost more weight (see Chart 2).
3. A third hatchery, located in a hard water area. Water for humidification was taken directly from the tap. In Setter No.6, the nozzles were blocked due to the hard water (see Figure 1). As a result, incubation humidity was lower and the eggs lost much more water (See Chart 3). The three examples in this tip show how the local environment can affect humidity in different parts of the hatchery. If the issues are not identified and corrected, water loss will not be in the optimum range, and hatchability and chick quality will suffer.

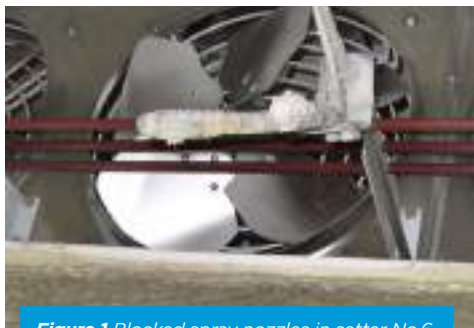


Figure 1 Blocked spray nozzles in setter No.6



Use water loss data to assess setter function *Continued*

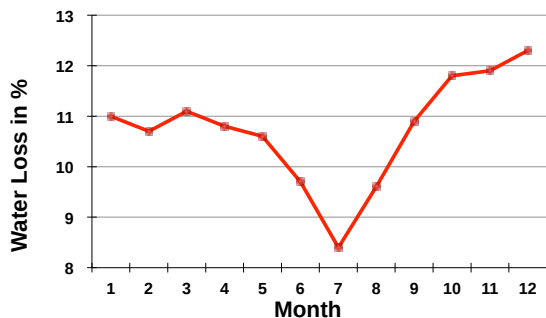


Chart 1

Water loss profile in a hatchery showing the effect of season when the air supply is not humidity controlled

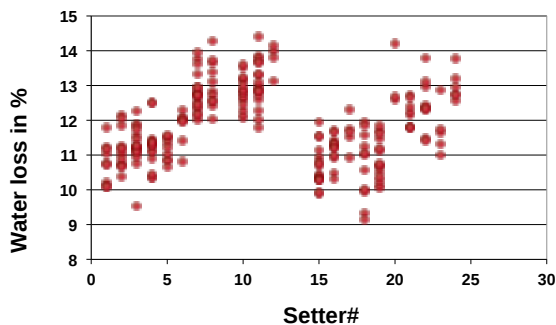


Chart 2

Water loss in different setters due to differences in exhaust plenum ventilation

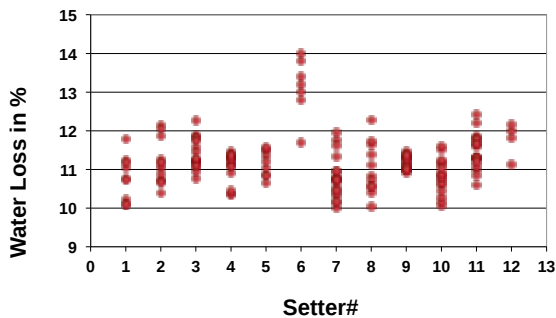


Chart 3

Eggs in setter 6 lost more water due to low humidity

How to calculate water loss correctly

Correct egg water loss during incubation is important for hatchability and chick quality.

Water loss is controlled by incubator humidity and critical to correct measurement of egg water loss is the correct calculation.

Water loss is the average weight of the eggs at transfer expressed as a percentage of the average egg weight at set. It is usually measured on 3 sample incubator trays from each breeder flock in each set. Trays should be placed in the incubator so that one is positioned near the top, one near the middle and one near the bottom of the incubator rack. The full procedure is described in *Hatchery How To Measure Egg Water Loss*, which is available on the Aviagen website.

Based on the procedure, water loss can be calculated as;

$$\text{\% Water} = \frac{\text{Full tray weight at set} - \text{Full tray weight at transfer}}{\text{Full tray weight at set} - \text{Empty tray weight}} \times 100$$

If incubated correctly, eggs lose on average 10.5-12.5% of their weight by transfer at 18 days.



Figure 1

Although the calculation by itself is simple, there are some important points to be aware of for the accuracy of calculations;

- **Do not use a standardized weight for the empty trays. Setter tray weight can differentiate depending on tray production lots, quality of materials, degradation over time etc. To have an accurate result, empty trays must be weighed for every tray of eggs.**
- **Do not include dirty eggs with abnormal shells and broken or hairline-cracked eggs. These eggs will lose more water and consequently show higher water loss than normal.**
- **If egg transfer is not done at 18 days, the calculated water loss needs to be corrected to 18 days for accuracy and appropriate quality control.**

Example: Eggs are transferred at 19 days and water loss is 12.5%. Water loss corrected to 18 days can be calculated as;

$$\left(\frac{12.5}{19} \right) \times 18 = 11.8\%$$

- **During storage hatching eggs will lose about 0.5% per week and this number should be included in the total loss at transfer. For example: If the eggs lose 11.8% between setting and transfer (18 days) but are stored for one week before setting, the total moisture loss between laying and transfer will be 11.8 + 0.5 = 12.3%.**

Egg water loss measurement has been implemented in most commercial hatcheries as a powerful tool of quality control for the incubation process. In order to have good information, correct calculation is critical to obtain accurate results.



Incubation in high humidity climates

Why is humidity important?

Moisture loss during incubation is essential to chick quality and performance. The egg needs to lose between 10.5-12.5% moisture from point of lay to 18 days of incubation.

How moisture leaves the egg

After lay, water vapor travels through the semi permeable eggshell membrane, then through the pores of the shell and into the environment. The greater the difference in humidity between the internal environment of the egg (saturated) and the external environment, the faster moisture will leave the egg.

If there is too much moisture in the environment around the egg due to high humidity, chick quality will be compromised.

In temperate climates, even when the atmospheric humidity is high, air temperatures are relatively low, so heating the air for the purpose of incubation automatically lowers the relative humidity.

However, in hot humid (tropical or sub-tropical) climates it is necessary to remove the excess humidity from the air before it is delivered to the incubators.

How do we remove moisture from the air?

Ideally, we want to supply air with an absolute humidity of 13.4g/m³. At 15.7°C air cannot hold more than this amount, so if the air is cooled down to 15.7°C, the excess moisture will condense and can be removed from the air (Fig. 1).

Because the air travels through HVAC system at high speed, it is usually necessary to chill the air using cooling water at 10-11°C to ensure enough moisture is removed.

Then, the air needs to be re-warmed to prevent cold spots in the machines while ventilating. This can be done with a cross plate heat exchanger (Fig. 2).

These use the hot return air from the setter to re-warm the now dry air, prior to delivery to the setter room. An auxiliary heater may also be used for supplementary heat, as necessary.

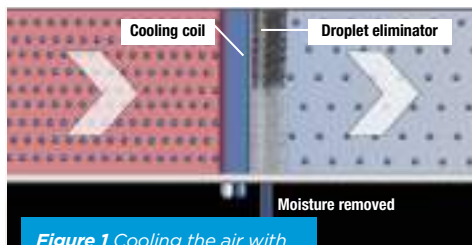


Figure 1 Cooling the air with a coil and droplet eliminator.



Figure 2 Cross plate heat exchanger.

Balancing a set in single stage setters

Although the optimal eggshell temperature for maximum hatch and chick quality is in the range 37.8-38.3°C (or 100-101°F), it is not always easy to keep within this range in a commercial setter.

One of the most common causes of uneven temperatures is when the eggs are loaded into the setter without allowing for differences in their potential heat output or when gaps in the set allow air to short circuit the optimal path.

Nowadays, more and more hatcheries install enormous setters, to save space and cost. Depending on the make, there will be one air temperature sensor in each setter or in each sub-section of it. In principle, the sensor controls heating and cooling to keep the air temperature within the machine set-points and keep eggshell temperature within the optimal range. For this to work properly embryo heat production needs to be spread evenly throughout the setter and all the eggs affected by a temperature sensor should be of similar size and fertility. Unfortunately in the real world parent flock sizes are often variable and never match the setter capacities available. A large setter will have to be filled using eggs from more than one parent flocks, or sometimes run partially full. If not managed carefully, it is very easy to create an unbalanced loading pattern.

The heat output of a batch of eggs will depend on several factors. It is important to take these into account when deciding where to put each batch of eggs in a large setter.

- **Egg size.** Large eggs produce large embryos, which produce more total heat per egg.
- **Flock age.** Eggs from flocks under 30 weeks tend to produce less heat per egg than would be expected for their size.

- **Fertility.** There are more eggs with live embryos when fertility is higher. If a flock is more fertile, heat production per 1,000 eggs will be higher.

Unbalanced egg loading in the setter may exaggerate variability in eggshell temperature (especially after 12 days of incubation) and consequently widen the hatch window and cause poor chick quality.

Embryo (eggshell) temperature will be cooler where eggs have a lower heat production and these chicks will hatch later and some of them may be culled because they are still wet and lethargic at take-off.

Embryo temperature will be hotter where eggs have a higher heat production causing chicks to hatch earlier, with some of them getting dehydrated before pulling. If eggshell temperature goes to a very high level, 103°F or above, hatchability and chick quality will be depressed.

Here are some tips to balance egg loading in the setter:

- **As a good start, follow the recommendations from the incubator manufacturers.**
- **When you have to mix egg sources in a setter, always choose the ones from similar flock ages and with similar fertility.**
- **Put eggs closest to average next to the temperature sensors.**
- **When you can not completely fill a setter, always set the eggs in a pattern which will not change the normal air flow or cause short-cuts of air flow in the setter. Fill any gaps with empty trays or trolleys.**
- **Always check eggshell temperature and its evenness if you try a new egg loading pattern.**



Checklist - Setters and Hatchers

This is the second checklist which we hope will be useful when investigating how well your hatchery is performing, and where improvements might be made.

SETTERS

- **Calibration**

Calibrate thermometers in single-stage setters every set, multistage setters every month.

Check turning mechanism and angles.

Calibrate damper openings at 0%, 50% and 100%. Avoid hot/cold spots by checking fixed dampers.

Calibrate CO₂ sensors every three months.

- **Egg shell temperatures**

Target 100 F (99.5 F- 101.5 F) egg shell temperature of fertile eggs from day 1 to day 20.

Check egg shell temperatures at days 2, 15 and 17.

Check egg shell temperatures in different positions to identify hot/cold spots.

- **Weight loss**

Target 10.5-12.5% weight loss from lay to 18 day transfer.

Calculate target weight loss for every set, accounting for weight loss during egg storage.

Alter RH% set points to meet the target.

TRANSFER

- Transfer on day 18 (19 if vaccinating in ovo).
- Keep eggs warm – waiting time <15 mins.
- Candle /remove infertile and early dead embryos.
- Backfill baskets to balance the number of live embryos across the hatcher.
- Evenly distribute eggs across the hatcher basket.
- Transfer eggs gently to avoid damage.

HATCHERS

- **Calibration**

Calibrate temperature and humidity sensors monthly.

Calibrate CO₂ sensors every three months.

- **Set points**

≤98 F after transfer and ≤97 F at the end.

If a constant set point is unavoidable, use 97.5 F.

Adjust set points according to estimated chick numbers.

Avoid hot/cold spots by not using humidifiers.

- **CO₂ levels**

Avoid high CO₂ set points at the end of hatch.

Monitor hatches with a wider hatch window carefully.

- **Hatch window**

Observe hatch window and investigate problems.

Keep window below 30 hours.

- **Pull and cleaning**

Keep hatcher doors closed and fans running until all chicks are out.

Empty all hatchers in the same corridor before cleaning.

Close hatcher doors during pulling, unless passing through them.



TRANSFER

Checklist - Setters and Hatchers **63**

Do you make regular checks
for transfer damage? **66**

Backfilling hatcher baskets
for low fertility flocks **67**

Optimizing the environment
during egg transfer **68**



Do you make regular checks for transfer damage?

With the increasing use of automation at transfer, it is tempting to believe that transfer damage is rare.

Yet, when we visit hatcheries, we often see significant amounts of transfer damage when doing a breakout. To make an accurate check for transfer damage, you need to look a bit further than the standard simplified QA check. Ideally, count the number of unhatched eggs per tray in a full stack of hatcher baskets, then look more closely at the eggs in the 3-4 worst trays. Ideally, this should be done so that every transfer crew is monitored at least twice a month; more often if they have new team members.

Transfer damage is caused by rough handling when the eggs are moved from the setter tray to the hatcher basket (cracks from earlier in incubation are easy to see, because in these the egg contents will have completely dried out). Transfer cracks will have some drying out, especially of the shell membranes, but the contents will still be soft (if the egg was infertile, or the embryo died early in incubation the egg contents will generally still be liquid).

The damage shown in the top photograph is usually caused when the tray or buggy has to be pushed hard to get it into position. It tends to be seen on the top trays (after transfer) or on whole buggies if the hatchery floor is damaged. Excessive pressure in the vacuum lifter can damage the blunt end of the egg; in this case the shell does not flake away from the egg. The other common form of external damage is when the handling system has bars or ridges which can cause a linear hole in the side of the egg.

Although it is fairly easy to identify the characteristic external damage caused at transfer, it is possible for the impact

to kill the embryo without damaging the shell. When this happens, there are usually blood clots visible, caused by rupture of the external blood vessels.



Figure 1 Impact damage to egg shells during transfer. Impact was to the side of the egg, and the embryos were close to full term and slightly dried out. The shell membranes are white and papery.



Figure 2 Impact damage.

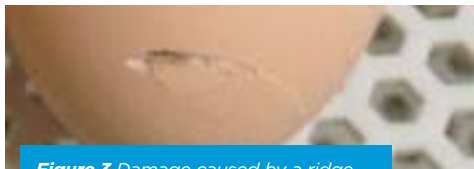


Figure 3 Damage caused by a ridge or bar on the handling equipment.



Figure 4 Transfer damage does not always damage the shell; this shows a late dead embryo where rough handling has caused bleeding, and the blood has then clotted.

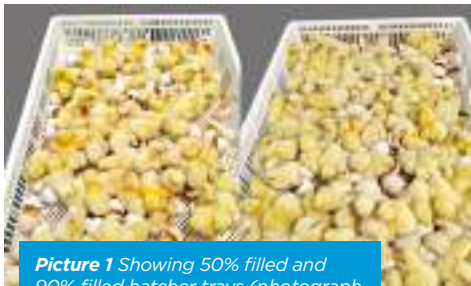
Backfilling hatcher baskets for low fertility flocks

Many manufacturers have developed automatic egg candling and transfer systems that help the hatchery transfer process to be completed in an efficient and timely fashion.

Unfortunately, few of them make it easy to backfill the hatcher baskets when a flock has poor fertility.

The term 'backfilling' refers to the action needed when flock fertility, defined as candled clears, falls below 75%. After the clear (infertile and early dead embryos) and contaminated eggs have been removed during the transfer process, any baskets that have fewer than 90% of eggs containing live embryos need to have added to them enough reserved candled eggs from the same flock to make up for the eggs that were removed. Thus, if the setter trays hold 150 eggs, and 25% of them are removed at candling, then each hatcher basket will need to have 22 fertile eggs added.

Correct and effective backfilling will maintain and enhance the metabolic heat output from each hatcher basket, reduce cold spots and tighten the hatch window in the embryos' last few days of development.



Picture 1 Showing 50% filled and 90% filled hatcher trays (photograph taken at 507 hours of incubation).

Chart 1 shows predicted hatch spread when hatcher baskets contain 55%, 75% or 90% eggs with live embryos; it is tightest with a 90% fill, as opposed to a wider hatch spread when the baskets are only 55% filled. Backfilling can be done by trained hatchery staff with a gentle hand packing technique or by using a portable egg lifter. It is important to place the replacement eggs into the hatcher baskets with great care.

If care is not taken, there may be internal or external damage to the egg, similar to that seen with other forms of transfer damage. These can cause late stage mortality and reduce chick quality.

It is very important not to overfill the baskets. Hatchers are not designed to cope with the heat output when 100% full of live embryos, especially from older flocks with a larger egg size. Overfilled baskets also restrict airflow, which exacerbates the excessive embryonic heat output, damaging chick quality and performance.

The time and labor required will probably make backfilling in broiler hatcheries uneconomic. However, hatcheries handling high generation stock will find it a useful technique to improve the hatch window and final chick quality at hatch.

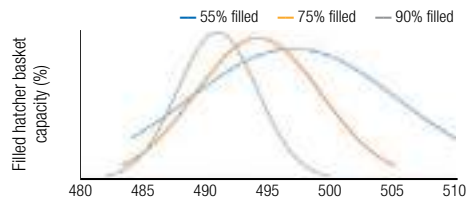


Chart 1 Hatch window as per filled hatcher basket capacity (%) incubation).

Optimizing the environment during egg transfer

Can you improve the environment for the eggs when you transfer them to the hatcher? Room temperature is often discussed, but air flow is important too.

Questions about the need for air flow during transfer may arise because, in theory, eggs cool down once removed from the setter and the goal is to achieve an environment that keeps them warm. It may seem counter-intuitive to want to manage good air flow. However, during embryo development, the embryos switch from an endothermic phase to an exothermic phase after approximately 12 days. By 18 days, when they are due to be transferred, the embryos themselves will produce a lot of heat, which means that the setters must deliver much more cooling and air ventilation to prevent the embryos from overheating.

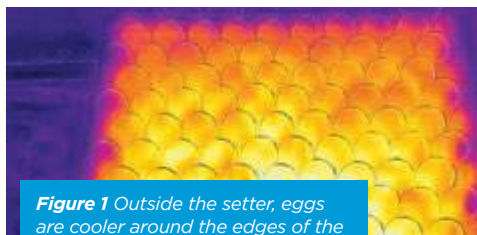


Figure 1 Outside the setter, eggs are cooler around the edges of the tray, but may overheat in the center

When transferring eggs, some hatcheries have a dedicated transfer room to prevent cross contamination. However, often these rooms do not have proper ventilation or have a very high room temperature set-point.

When the egg trolleys are pulled out of the incubator and waiting to be transferred, only the eggs close to the outside edge of the egg trays will cool down.

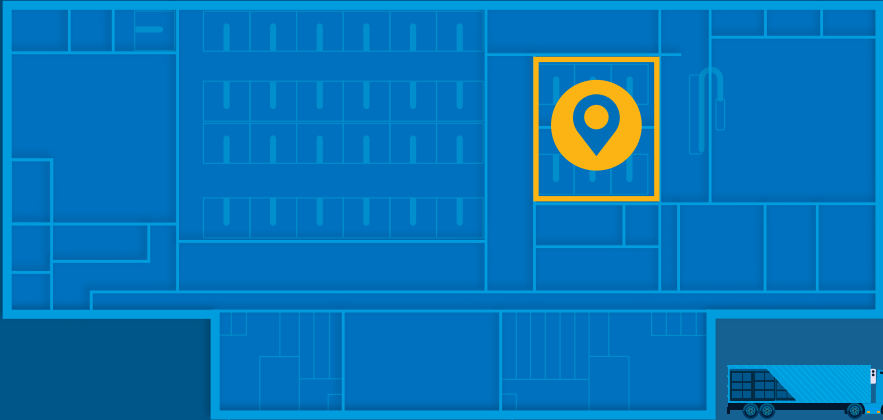
On the other hand, the eggs in the middle of the egg trays can be easily overheated (above) because there is insufficient air flow to help remove the heat they are generating. Embryos subjected to heat stress are likely to express poor chick quality, embryo malpositions or even embryo death.

To prevent embryos from becoming overheated during transfer, only pull one trolley at a time and keep the remaining trolleys inside the machine for better temperature control until you are ready to transfer them. Make sure there is a smooth air movement in the room or use a low-speed fan to help the embryos dissipate heat (but avoid blowing air directly onto the eggs, because this could cause some embryos to become chilled). Try to transfer each individual trolley within 15 minutes.

To determine if embryos are overheating, a Braun Thermoscan IRT6520 thermometer can be kept in the transfer room to measure eggshell temperature (EST) during transfer; if the EST is greater than 102°F (right), the solutions suggested above should be considered.



Figure 2 Keep a Braun Thermoscan in the transfer room and check egg shell temperature in the center of the egg pack regularly, aiming to keep all eggs below 102°F.



HATCHER ROOM

<i>Using temperature & humidity data loggers</i>	32	Did you know that if chicks are held too long at high temperatures, it can affect their growth?	70
<i>How to calibrate and use temperature readings taken with tiny tag loggers</i>	35	Correct positioning of hatcher buggies	71
<i>Putting incubation research into practice</i>	37	What is your meconium score?	72
<i>Calibrate CO₂ sensors regularly</i>	52	Hitting the chick yield target	73
<i>Temperature calibration probes</i>	54	Logging temperature in the hatcher basket	74
<i>Calibrating electronic humidity sensors</i>	55	Preventing chick fluff build-up on hatcher cooling coils	75
<i>Zero calibration of pressure sensors</i>	56	Assessing chick maturity at take-off	76
<i>Sense-check your CO₂ sensor calibration</i>	57	Humidity changes in the hatcher indicate hatch time and spread	78
<i>Incubation in high humidity climates</i>	61		
<i>Checklist - Setters and Hatchers</i>	63		



Did you know that if chicks are held too long at high temperatures, it can affect their growth?

The newly hatched chick can not control its body temperature very well.

Air temperature, humidity, and airspeed interact and will all have an effect on the body temperature and the comfort of the young chick.

It is easy to see if chicks are uncomfortable from their behavior – chicks that are too hot are noisy and pant (as shown in **Figure 1**) in order to lose heat.

Chicks that are cold will huddle together to keep warm (see **Figure 2**) and their feet will feel cold.

In a recent trial, the Aviagen Hatchery Specialist team showed that chicks that were panting had a high vent temperature (averaging 106°F), while comfortable chicks had a vent temperature that averaged 104°F.

When the two groups were held in the hatchery for 12 hours, the over-heated chicks lost nearly twice as much weight.

Samples taken at the hatchery showed that chicks that had been overheated had slight gut damage, so they could not absorb nutrients as well.

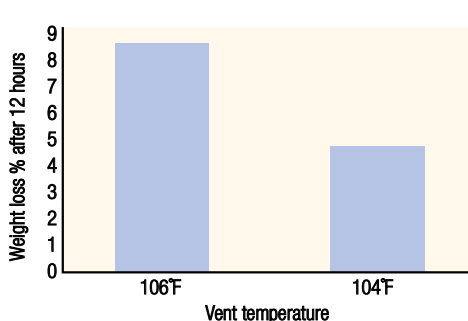
Grown on in a broiler trial, these chicks were 60g lighter at 35 days than chicks that had been held in comfortable conditions.



Figure 1 Chicks that are too hot.



Figure 2 Chicks that are cold.





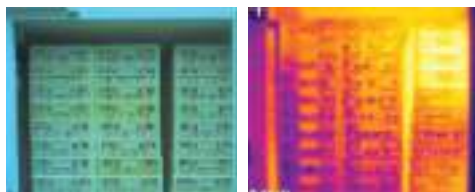
Correct positioning of hatcher buggies

The ventilation capacity of modern hatchers is calculated by the manufacturers to ensure that enough fresh air is introduced and waste air removed.

The fans inside the hatchers are designed to provide an even airflow over all the eggs or chicks in the hatcher baskets. When everything is correctly set up, they prevent hot spots or CO₂ build up around the chicks. Overheating or excessively high CO₂ levels in the hatcher will cause poor broiler performance or in extreme cases reduced hatchability and higher culling rates.

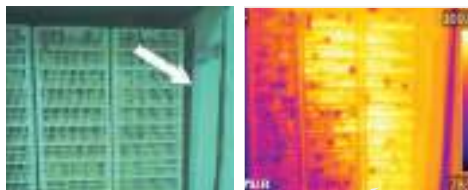
Moving air will always look for the path of least resistance and therefore when pushed around inside the machine it will take the easiest route back to the fans. Positioning the hatcher buggies the correct way, following the manufacturers' recommendations is therefore essential to providing the needed airflow over the eggs or chicks.

There are various different fan arrangements in different makes of hatcher. Hatchers with a centrally mounted fan will throw the fresh air around the baskets and draw the air back in towards the center of the fan. A different design has the fans mounted to push air upwards, with air then drawn down through the hatcher baskets back to the negative pressure area below the fans. Both systems work well.



However, in either scenario if the hatcher buggies are not positioned correctly leaving too much gap between them some of the air will use that gap as an easy path of return to the fans, depriving some of the hatcher baskets of the air they need.

One of the common problems we see in hatcheries is when the baskets are not stacked correctly at transfer, allowing the stack to lean away from the vertical. The pair of pictures above clearly show the consequences when the outer buggy, leaning away from the vertical, is creating a larger air gap at the top and, as such, is lacking the necessary airflow through the trays. The thermal image shows how this creates a hot spot in the upper right hand corner of the hatcher.



Some older designs of hatcher have baffles installed toward the front of the sidewalls (see above). In these machines it is crucial that the baffles are kept in good repair, and that the outer buggies are touching these baffles in order to force the air through the hatcher baskets back to the fans. We talk a lot about controlling embryo temperature in the setters, and how overheating between days 11 and 18 affects not only hatchability and chick quality, but also broiler growth and livability. New research is showing that keeping tight control of eggshell temperature in the hatcher right up to the point of external pipping is critical if the best performance in the hatchery and the broiler farm are to be targeted.



What is your meconium score?

If chicks are held in the hatcher for too long, they do not grow as well in the broiler house.

A good way to tell if this is happening is to check how many of the eggs in a hatcher basket are stained with meconium (the dark green first droppings of the chick).

To find out what your meconium score is, pick out the 5 dirtiest eggs from each of 5 hatcher trays per flock. Select the eggs immediately after the chicks are removed from the hatcher. Score the eggs against the 5-point scale shown below.

If the dirtiest eggs are in groups 4 or 5, then the chicks are being left in the hatcher for too long. Delay the next set by 3 hours and make a note to check again when these eggs hatch in 3 weeks time. When you check them, if there are still eggs in groups 4 or 5 you will need to delay the next set by a further 3 hours.

If all the eggs are clean, check that your total incubation time is not too short – this would be indicated by wet chicks in each hatcher basket and, if very short, live pipped embryos.

If your meconium scores vary from tray to tray, setter temperatures may be variable.

Use the meconium scores to adjust setting times so that clean eggs predominate on every tray.

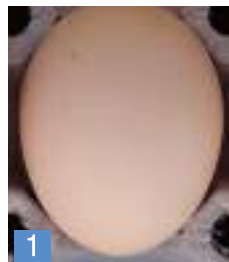
Remember to check every hatch – flock age, egg age, and season can all affect the total incubation time.

INCUBATION TIME TOO LONG

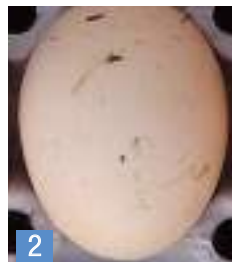
- 5 or more dirty eggs per tray
- All chicks dry at time of chick take-off

INCUBATION TIME TOO SHORT

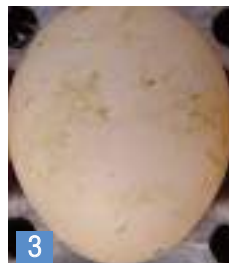
- Clean egg shells in hatch debris
- Some chicks still wet
- Live pipped embryos



1



2



3



4



5



Hitting the chick yield target

The process of converting a fertile hatching egg into a chick is dependent on getting several key factors right.

Like some other of the incubation essentials (especially embryo temperature and moisture loss to 18 days), chick yield is something of a Goldilocks trait – the chicks should not be too dry, nor too wet but just right.

Chick yield is driven not only by incubation humidity and egg moisture loss but also by elapsed time in the incubator and it is important to remember this when considering the optimal chick yield for an operation, because chick yield doesn't only indicate hydration status, but also maturity. When chasing chick quality, both are important, and it is counterproductive to chase higher levels of hydration while sacrificing maturity.

We advise that chicks should fall into the band of 10.5-12.5% weight loss to 18 days and 67-68% chick yield at pull. Observation of trial hatches has shown that batches of eggs can be surprisingly good at recovering from 18 day weight losses which are too high or too low, ending up with an acceptable chick yield at hatch. Other batches achieved perfect 18 day moisture loss, but chick yields which were well outside target levels.

In a recent investigation, the Aviagen hatchery team audited hatcheries for a large scale integration. One of the factors considered was chick yield, and also the incubation time normally given at that hatchery (counted from the setter coming up to temperature until the chicks were pulled from the hatcher to be sent to the farm).

The incubators involved covered a huge range of types, from old multi-stage to brand new single-stage units.

Each hatchery manager decided what the incubation time should be, based upon his own knowledge and experience. Each hatchery was hatching the same broiler breeder line.

It can be seen from **Figure 1** that there was a considerable range in the hatching times – from 499 hours to 522 (21 days is 504 hours). Indeed, incubation time accounted for almost half of the variability in chick yield across the business. Subjected to regression analysis, other factors which might be expected to affect chick yield, such as weight loss to 18 days, and the number of days the setters were run sealed did not have a significant effect on chick yield at hatch.

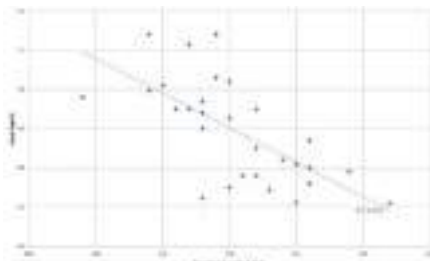


Chart 1 Chick Yield vs Incubation Duration.

Chicks which are pulled too early, with a chick yield over 69%, will have relatively poorly healed navels, and be more susceptible to handling and impact damage.

To reduce the chick yield by 1%, the chicks will need 5 hours longer incubation time. This is probably most easily achieved by setting the eggs earlier; taking good care that the hatcher temperatures are kept under tight control once the chicks are out, aiming to keep vent temperatures between 103 and 105°F (39.4-40.5°C).



Logging temperature in the hatcher basket

In the hatcher, the air temperature in the body of the machine will often be very different from the air temperature inside the hatcher baskets.

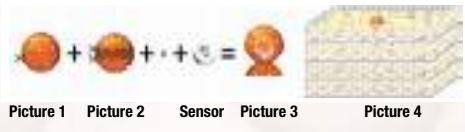
Air temperature at the probe can be quite variable in the short term, responding to changes in cooling, heating and ventilation, as well as the heat production from the hatching chicks as they emerge.

For these reasons the internal box temperature is far more relevant to chick welfare and performance than the air temperature within the machine, but this has been hard to measure and record accurately in the past.

The development of reasonably priced and accurate Bluetooth-enabled temperature loggers allows us to record temperatures within hatcher baskets anywhere within the hatcher, throughout their time in the hatcher (or in stacked boxes during chick holding and transport).

We know the chick's vent temperature is optimal between 103-105°F (39.4-40.6°C), but this is impossible to measure in the hatcher without disturbing its local environment. However, an optimal vent temperature roughly correlates to 86-89.6°F (30-32°C) in basket temperature, although this will be modified by air speed and wind chill.

How the sensor is positioned in the basket is critical because it needs to be above the height of the eggs (around chick head height once the chicks have hatched), in the center of the box. To avoid the sensors coming into contact with the chicks, it is important to encase them inside protective covers (with air holes to allow free exchange of air).



To build a cover, you will need two practice hockey balls and one small bolt. Cut the first ball into two – 1/3 and 2/3 as in **Picture 1**. Cut the second ball the same way, then cut a band off the larger portion so that both 'cups' are the same size as the smaller portion in the first ball (see **Picture 2**). Take two of the smaller pieces and bolt the curved sides together; these become the cup and stand for the sensor as in **Picture 3**. Once the sensor has been placed inside the cup, place the larger piece as a lid over the top; this should come down over and lie tightly over the lower cup. Place the whole unit in the middle of the basket that you want to monitor (**Picture 4**).

These baskets can be placed around the hatcher in a matrix to cover the key positions within the machine. It is recommended to have at least six units, numbered so their location in the hatcher is known. Avoid the very top or bottom baskets.





Preventing chick fluff build-up on hatcher cooling coils

Chick fluff adhering to the hatcher cooling coil is a frequent observation in hatcheries, seen late in the incubation process as the chicks emerge and after they have hatched (Fig. 1).

When the hatcher's cooling system runs at a lower temperature than the surrounding air temperature, condensation can occur.

For example, if the air temperature in the hatcher is 36°C and the relative humidity is 50%, the dew point is 24°C; however, the cooling water temperature flowing through the coils is normally between 12°C and 15°C.

This is significantly lower than the dew point, causing moisture to condense out of the air on to the cooling pipe surface. The airborne hatchling chick fluff will then adhere to the 'sweaty' cold pipe.

Chick fluff build-up can be problematic because, when mixed with water, the fluff forms an insulating coat to the coil, creating barriers to heat exchange and lowering the water cooling system's efficiency.

The hatcher will then struggle to maintain the correct environment, which may result in a high air temperature or increased ventilation to achieve additional air cooling, resulting in an unbalanced air temperature within the machine. Also, excess water condenses to create droplets, which may puddle on the hatcher floor.

This will increase the likelihood of bacterial problems, since the water provides an ideal environment for them to grow. A flush of bacteria can infect freshly hatching chicks through their unhealed navels, resulting in decreased chick livability.



Figure 1 Example of a hatcher cooling coil covered with chick fluff.

Furthermore, puddles of water will cause a cold area at the bottom of the incubator, delaying the hatch in the area and causing an uneven machine temperature.

To help prevent chick fluff build-up on hatcher cooling coils, reduce condensation by increasing the cool water temperature to near the dew point. Because some hatcheries only have a single chilling unit for hatchery cooling equipment, a system which recycles chiller water for the hatchers may be a viable option. It is also good practice to increase ventilation to evaporate condensate water and lower the humidity level in the hatcher. However, over-ventilation can result in an uneven machine temperature, as well as cold and hot spots, so exercise caution.

If condensate cannot be avoided, the cooling pipe can be cleaned manually. This can be done safely after the majority of the chicks have hatched, as opening the hatcher doors will not have an impact on the hatching environment.

The less condensate on the cooling pipe, the better hatching environment, leading to reduced contamination and a lower probability of uneven hatcher temperature, all of which contribute to higher-quality chicks.



Assessing chick maturity at take-off

The process of hatching is a drastic physiological change-over for the embryo. Internal pipping involves the transition from chorioallantoic (exchange of nutrients and gasses within the egg) to lung respiration and, during external pipping, the chick works very hard to break the eggshell.

This process is exhausting for the chicks, so before take-off they need to spend some time in the hatcher to rest and dry out. It is critical for day-old chicks' livability and performance after placement that hatcher conditions are correct for the final stage, and that they are at the right maturity level when they are pulled from the hatchers to be processed.

Immature or 'green' chicks will still be wet, lazy and sleepy (Fig 1), and not ready to eat and drink when placed at the farm.



Figure 1 Green chick – wet down, eyes with a sleeping look, not ready to eat and drink.

On the other hand, chicks can also be dehydrated when pulled out from the hatchers. Those chicks will be dry and noisy. A great tool to assess chick maturity at take-off is to measure chick yield. Day-old chicks with the right maturity at take-off will have a chick yield between 67-68%. Chicks with yields above 68% can be considered green chicks, and chicks with yields below 67% can be considered dehydrated chicks. Both will perform poorly at the farm when placed.

Assuming the incubation time is correct, chicks incubated in low temperatures or high humidity will tend to look green at take-off, because both will experience delayed development. Conversely, eggs incubated in high temperatures or low humidity will become dehydrated in the hatchers. Unbalanced machines, with hot and cold spots, can make the hatch spread very wide by affecting development speeds, (Fig 2).



Figure 2 Hatch baskets in the same hatcher showing chicks at different maturity levels at take-off due to cold spot (tray on the left).



Assessing chick maturity at take-off *Continued*

The incubation time for a batch of eggs can be affected by several variables including temperature, egg size, parent stock breed, egg storage time, breeder flock age and setter type. After the chicks hatch, if held too long in the hatcher, they can overheat and dehydrate. Therefore, it is important to monitor chick yield to make sure that adjustments are made as needed.

Day-old chicks with the right maturity at take-off, which have had enough resting time after they hatched out, will be active and ready to feed and drink when placed at the farm. Chicks that did not have enough time to dry out in the hatcher (green chicks) will be more interested in sleeping than starting to eat and drink when placed on the farm.



Humidity changes in the hatcher indicate hatch time and spread

A critical aspect of managing the hatch process is determining the hatch window.

The hatch window is the time between the first and the last chick emerging. A hatch window of twenty-four hours is seen as optimal (and achievable) in single stage hatcheries, although multi-stage systems will take longer. It is important to know your hatch time, and to manage the hatch window to optimize hatchability and chick quality.

In the past, hatch window has been determined by opening the hatcher at intervals and counting the chicks in sample trays. Unfortunately, opening the hatcher doors for repeated counts risks disturbing the hatcher environment and altering the hatch window in the process.

A less intrusive approach is to monitor humidity and carbon dioxide (CO₂) trends through the hatch, using parameters already reported by the hatcher.

Carbon dioxide production by the embryo increases steadily through incubation. However, towards the end of incubation, the shell is not porous enough to allow complete gas exchange, and surplus CO₂ is stored (buffered) in the egg contents. Once the chick pips the egg shell, there is a marked increase in CO₂ output as the stored gas is released.

When a chick breaks through the shell it will still be coated in fluid, which causes a rapid rise in humidity as the bulk of the eggs pip and hatch out. Once all the eggs are hatched and the chicks dry off, humidity starts to fall again. The process is summarized in **Fig. 1**.

By checking the time elapsed between Point 1 and Point 3 we can estimate the natural hatch window, comparing outcomes by flock and egg age, as well as by machine. This method offers several advantages over the traditional open doors and count system. By avoiding disturbances in the hatcher environment, the humidity curve method provides an accurate representation of the true hatch window, enabling hatchery workers to plan subsequent procedures effectively.

Having historical data describing humidity curves available allows the incubationist to make informed decisions based on trends and patterns, leading to improved hatching outcomes over time. Monitoring the humidity curve during the incubation period provides a non-intrusive and data-driven approach to determining the hatch window.

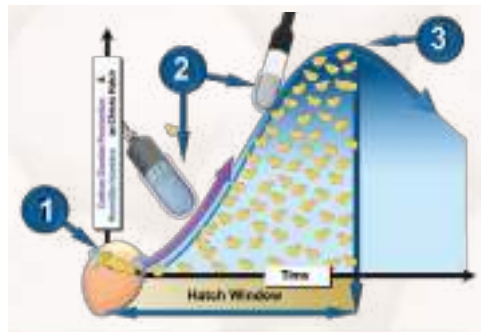
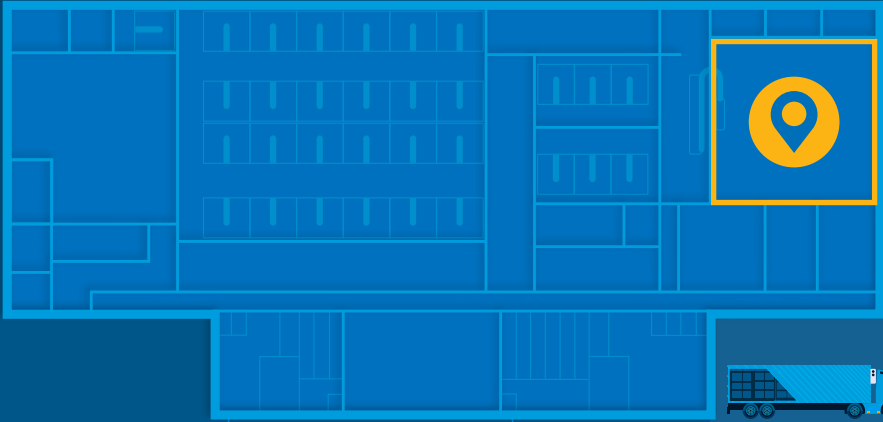


Figure 1 The build up in humidity as a hatch progresses in a commercial hatcher.



CHICK PROCESSING AND STORAGE

Are you measuring and calculating your chick yield correctly?

33

Measuring vent temperatures accurately

39

Did you know that if chicks are held too long at high temperatures, it can affect their growth?

70

What is your meconium score?

72

Hitting the chick yield target

73

Chick box layout for laminar ventilated chick holding rooms

80

Managing chick holding room temperatures

81

Keeping chicks comfortable

82

Checklist - Chick processing and holding

83

Chick weight loss post pull – what is normal?

84

Is measuring vent temperature accurate?

85

Optimizing chick holding: shedding light on the blues

87



Chick box layout for laminar ventilated chick holding rooms

ARTICLE
UNDER
REVIEW



Managing chick holding room temperatures

Newly hatched chicks cannot regulate their body temperature very well. Body temperature in young chicks therefore depends on the surrounding environment.

Yet it is crucial to help chicks stay in their thermal comfort zone after they hatch. If chicks are too hot or cold, they will use more energy during holding. If they are too hot, they will also pant and get dehydrated. These chicks will not perform well on the farm.

It is extremely busy on a hatching day in a hatchery and it can be hard to monitor and respond to chick comfort.

Sometimes problems with chicks being too hot or cold are only seen when DOA numbers increase. On the other hand, it is not simple to keep chicks within their comfort zone in a chick holding room. There is not one ideal chick holding room temperature, which is suitable in all hatcheries, because it depends on chick size, physical condition, room humidity, chick box type and air speed around the boxes.

You need to find the ideal holding room temperatures for different seasons in your own hatchery.

One Aviagen internal study has shown that vent temperature is a good indicator of chick comfort. A chick will be comfortable when its vent temperature is in the range of 103-105°F (39.4-40.6°C). Identify sample chicks and measure chick vent temperature hourly in the chick holding room. If chick vent temperature is too high, lower room temperature settings. If chick vent temperature is low, then increase room temperature settings.

If chicks are sampled and chick vent temperature measured at different locations in the chick holding room you can determine where any hot/cold spots are.

Then you can use the information to improve chick trolley design, chick trolley placement in the room, air circulation in the room and room ventilation, so that all chicks will be comfortable throughout the entire chick holding room. Using Excel to map the temperature distribution will help to identify problem areas.

In **Figure 2** the chicks were all slightly cold, except in the back right corner, furthest from the door. Raising the room temperature slightly, with some additional cooling fans in the back corner allowed the chicks to maintain a vent temperature above 103°F.



Figure 1 These chicks are too hot.

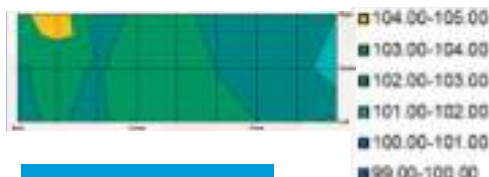


Figure 2 Chick vent temperature by location.



Keeping chicks comfortable

Newly hatched chicks can not regulate their body temperature and rely on suitable environmental conditions to keep them comfortable.

In an ideal production system, chicks would be moved from hatcher to farm promptly and quickly. In real production systems there can be several hours between take off and when the chicks are placed on the farm.

The best first week mortality and post-hatch performance will be seen from chicks kept in good conditions between leaving the hatcher and placement on the farm. Suitable room conditions are:

- Room air temperature 22-28°C (depending on air speed around the boxes).
- Relative humidity 50-65%.
- 85m³ fresh air per hour per 1000 chicks – the CO₂ level in the room should not go over 2000ppm.



Figure 1 High CO₂ level measured in a holding room with insufficient ventilation.

The chicks will be calmer if the chick holding room has dim blue light. Temperature, humidity and air speed all interact to determine the temperature around the chicks. A good ventilation system will remove hot, humid air from around the boxes, without creating a draft directly on to the chicks.

Air temperature at chick level inside the box should be around 30-32°C (86-89.6°F), 60-70% RH. Chicks use behavior to help control their body temperature, so monitor chick behavior to know if they are comfortable or not. Chick vent temperature is easy to measure, and highly correlated with deep body temperature. The optimum chick vent temperature is 39.4-40.5°C (103-105°F).

- Chicks that are too cold, vent temperature below 39.4°C (103°F), start to huddle and have cold legs and feet.
- Chicks at correct temperature are quiet and evenly spread out.
- Chicks that are too hot, above 40.5°C (105°F), start panting.

Chick vent temperature measurements can be used to check chick comfort in hatchers, chick rooms, in chick trucks and during the first two days of brooding. Chicks should be sampled throughout the area where they are being held and from near the top, middle and bottom of chick box stacks. Pay particular attention to areas:

- Where chicks are observed to be panting or huddling.
- Where there is fast air movement around the chick boxes.
- Near walls and doors.

Most of the above causes have to do with maintenance and can be avoided by having an effective preventative maintenance plan in place.



Figure 2 A good layout for a chick holding room with well spaced buggies.



Checklist - Chick processing and holding

This is the third checklist which we hope will be useful when investigating how well your hatchery is performing and where improvements might be made.

CHICK PROCESSING

- If banger numbers are high, unload by hand to avoid spreading contamination.
- Check belts, conveyors, needles and other equipment daily to ensure chicks cannot be injured.
- Change vaccination needles every 1,000 chicks.

CHICK HOLDING AND TRANSPORT

- Check chick vent temperatures (target 103-105 F) in different zones every hour. Alter room temperature set point as needed.
- Adjust room ventilation rate according to chick numbers (aim for <1,500ppm CO₂).
- Do not place chicks beneath air inlets or in direct airflow; if they are in a draft they will become chilled.
- Plan delivery times to minimize holding duration and account for climate.
- Do not overload chick trucks.

CHICK HOLDING ROOM VENTILATION

- Run the room at slightly negative pressure (not lower than -10pa).
- Distribute fresh air evenly and avoid temperature differences, drafts or fluctuations.
- Place stacks of boxes in an unbroken row (shown right) and use fans to create a steady air velocity in between the rows of chick boxes. This will help to maintain air speed and consistent heat removal.
- All roof circulation fans should work upward.



Figure 1 Chicks at a comfortable temperature, no draft.



Figure 2 Chilled chicks in a direct draft from a ceiling air inlet.

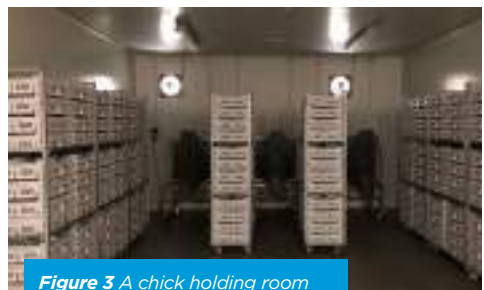


Figure 3 A chick holding room with good layout and ventilation.



Chick weight loss post pull – what is normal?

Hatching egg quality has a significant impact on hatchability and chick quality.

Chicks have a natural powerful robust provision when they hatch, the yolk reserve, which keeps them well supplied with food and water for a number of days until they start consuming feed and drinking water for themselves.

After chicks hatch it is normal for them to lose some weight. Some of that loss will be due to the residual yolk being used up, some will be meconium passed through the vent and some will be moisture loss as they breathe.

If the interval and the environment between take-off and placement on farm are good, then the weight loss is likely to be very small.

However, it is useful to have some idea of what is normal weight loss when assessing situations where things have not gone as planned.

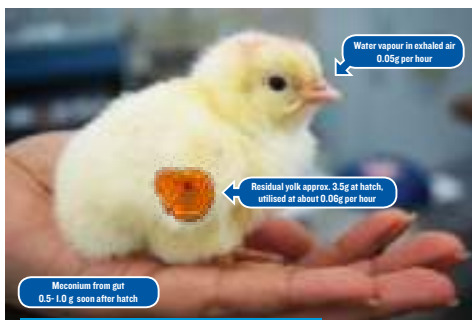


Figure 1 Sources of weight loss in the hatchling chick.

Recently, we compared weight losses of hatchling chicks across two trials. In the first, the chicks were removed from the hatcher within 6 hours of emergence, and kept for 24 hours in a climate respiration chamber held at 91.4°F (33.3°C) and 40-60%RH.

In the second, the chicks were pulled at the end of the hatcher period after approx. 504 hours incubation and held in chick boxes in the hatchery, also for 24 hours. Hourly weight loss over the 24 hours post hatch was 0.11g in both trials.

In summary, **Figure 1** shows the normal losses under optimal environmental conditions which keep the chicks comfortable: around 0.05 g/hour water vaporization in exhaled air. Furthermore, the meconium will leave the gut soon after hatch, which means a loss of about 1 g.

Then, in addition, chicks have in their yolk sac residual yolk of about 3.5 g at hatch, which will be used at a rate of about 0.06 g per hour. After 24 hours, the chicks had lost between 9 and 10% of their weight at take-off.

In the field, under less optimal holding conditions, higher weight losses in 24 hours are often observed. This is especially common if the chick holding area is too hot. Chicks will start panting, a common mechanism to get rid of surplus heat, if their vent temperature reaches 105°F (40.5 °C).

Panting chicks will lose more weight and this is probably one of the factors causing dehydrated chicks when they are observed in the field.



Is measuring vent temperature accurate?

Day-old chicks cannot control their body temperature, and during the time they spend in the hatchery, are sometimes exposed to temperatures which are uncomfortable, or even actively harmful.

Aviagen advises that day-old chicks be held in conditions which allow them to maintain a vent temperature between 103 and 105 F (39.4 and 40.6 C).

Vent temperature is measured using a Braun ThermoScan thermometer, holding the sensor close to the skin of the vent. It has been suggested that measuring rectal temperature by inserting a paediatric rectal thermometer about 0.5cm into the chick's vent is more accurate than measuring vent temperature.

Unfortunately, it also has the potential to damage the gut wall of the chick during insertion.

Fig. 1 shows the relationship between the rectal and vent temperature of chicks which were held in a range of different thermal environments, set up to induce vent temperatures between 99 and 107.5 F (37.2 and 41.9 C).

It shows a tight relationship between the two measurements, with an R2 value of 0.865 (the closer the R2 value is to 1.00, the stronger the relationship between the variables), indicating that the vent temperature is an accurate measure of body temperature in the day-old chick.

To get the best accuracy when checking vent temperature, take the measurements where the chicks have been held, because their body temperature will adjust to a new environment quite quickly.

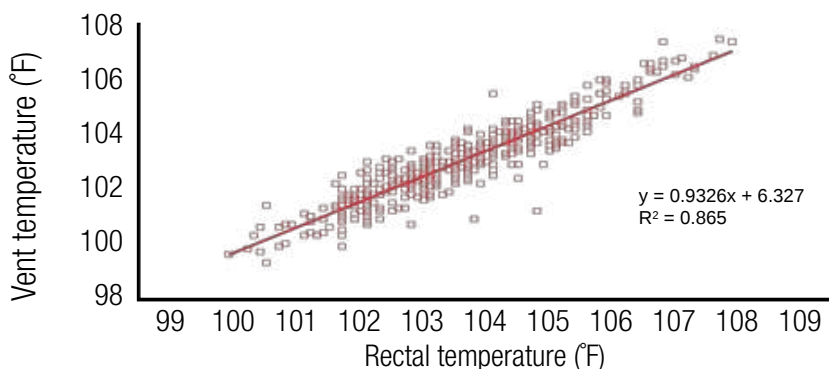


Figure 1 Relationship between rectal and vent temperature.



Is measuring vent temperature accurate? *Continued*

To measure vent temperature, ensure the thermometer has a clean tip cover, pick a chick up and hold it so that you can see the vent, position the chick's rump towards you and gently push the rump upwards so that the vent is exposed, rather than covered with down (Fig. 2).

Shield the chick from any drafts with your body while measuring, and ensure that the tip of the thermometer only touches bare skin. Any chicks which have a wet vent should be dried, or a different chick should be chosen for measurement.

The vent temperature measurement is the preferred method, being just as accurate and safer for the chick. Unfortunately, it is only really suitable for chicks in the hatchery – once they start to eat, drink and grow the vents are too wet to give an accurate result.

However, in the hatchery, the measurement is an invaluable tool for checking a room or holding area for hot and cold spots, before taking corrective action as necessary. Your chicks will be more comfortable and resilient as a result.



Figure 2 Measuring the vent temperature of a day-old chick.



Optimizing chick holding: shedding light on the blues

Over the years, chick-holding practices have evolved, guided by an enhanced understanding of chick requirements.

One crucial aspect is creating an environment that promotes restful sleep for the chicks.

The hatching process is exhausting for the birds, so a resting period is not merely preferred but essential. When chicks go to sleep in the boxes, they preserve energy. Also, as they are sitting low, airflow is encouraged through the boxes, aiding oxygen supply and cooling.

As we delve further into Optimizing chick-holding practices, it's essential to appreciate the visible light spectrum's significant role in creating an environment conducive to chick comfort. Human eyes have three types of cone-shaped receptor cells: blue, green and red; these allow us to see in the range of 380–700 nanometers (nm).

A chicken, however, has four types of cone receptor cells: ultraviolet, blue, green and red, giving it a far greater range of 315–750 nm. One of the trends in recent years has been to install blue lights in chick-holding rooms, as this can reduce the light in the room enough for the chicks to sleep while allowing team members to safely navigate through the room. However, some lights on the market, advertised as blue lights, emit below 400nm, which is entering the ultraviolet range.

People with prolonged exposure to UV light have been shown to have an increase in damage to their eyes and skin, so these lights can be potentially damaging to anyone who works in the room routinely. Also, as the birds can see in the ultraviolet range, they will become more active rather than going to sleep.

When chicks become active, they burn more energy, creating greater thermal output while simultaneously interrupting the airflow through the boxes, increasing the risk of discomfort or overheating. This has gone unnoticed simply because we cannot see in this range, but it is something we must tackle.

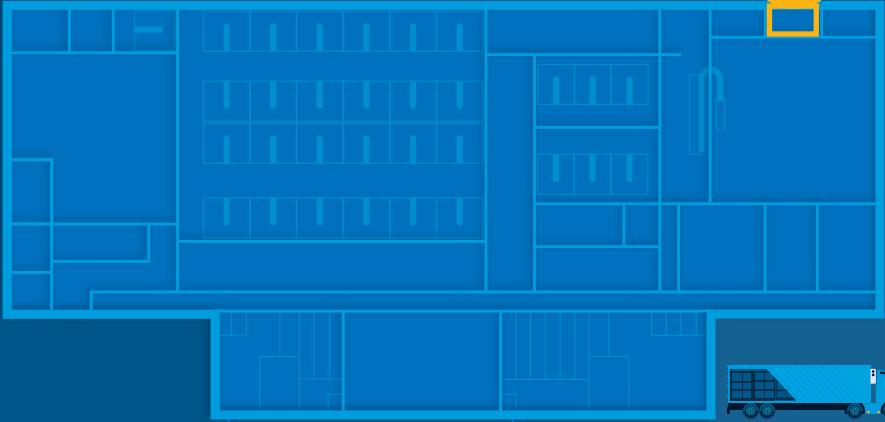
While this may sound very confusing at first, it can be very quick and simple to identify whether your blue lights are safe. The simplest way is to use any of the surfaces that fluoresce UV light (any glow-in-the-dark product, most organic matter). However, it is better to isolate the precise range using a UV test card.

These cards change colour on their test areas, highlighting the range of UV emitted. Conclusion: When purchasing blue lighting, it is critical to determine the spectrum in which the lights are emitting.

Even after the purchase, regularly assessing their safety ensures the well-being of both chicks and team members, fostering an environment that prioritises their comfort and health.



Figure 3 A chick holding room with good layout and ventilation.



VACCINATION

How to optimize the timing
of in ovo vaccination?

90

Keep vaccine preparation
rooms biosecure

91





How to optimize the timing of in ovo vaccination?

When using in ovo vaccination in your hatchery, several important decisions need to be made about the way in which it is organized and delivered.

Two key points are (1) when to vaccinate and (2) the correct point on the egg surface to deliver the vaccine.

So how do you establish the best time (stage of development) to carry out the vaccination?

This can often be overlooked, people preferring to vaccinate according to organizational convenience rather than aiming to optimize embryo response.

For in ovo vaccination to be effective, the vaccine must be delivered to the amniotic fluid or into the embryo itself. If deposited in the yolk, the allantoic fluid or the air cell of the egg it will not work well. Suppliers of in ovo vaccines and vaccination systems advise vaccinating between 18 days 12 hours and 19 days.

Regardless of the pre-determined vaccination time, it is helpful to monitor embryo development through visual evaluation of sample embryos just before vaccination. Use the information collected to optimize the time when eggs are vaccinated: the optimum time is when the yolk is being pulled into the abdomen.

Many factors can widen the spread of hatch time, so it is worth doing some strategic checks on factors known to increase hatch spread (see below) and adjusting vaccination time or, if appropriate, correcting them if shown to be an issue.

Samples need to be taken at different places in the incubator to identify whether chronological age and physiological age are close, because any divergence may directly influence the site of application and therefore the effectiveness of the in ovo vaccine.

Vaccination must start after internal pipping, again because the embryos may not be in the ideal position to receive the vaccine and so it will not be delivered to the appropriate place.

So for maximum vaccination impact, we must pay attention to the uniformity of embryo development at the time of vaccination.

This can be affected by:

- **Type of incubation (Single Stage X Multiple Stage);**
- **High or low temperature and humidity;**
- **Problems with turning angles below 38°;**
- **Inadequate ventilation;**
- **Age of the breeders;**
- **Size, weight and shape of eggs;**
- **Storage duration of the eggs;**
- **How long the eggs have been incubated and the development stage reached by the embryos. This may be affected by egg age at set, breed (for example, Ross® 708 hatch faster than Ross 308) and generation (broilers hatch faster than parent stock).**

These factors can directly influence the effectiveness of vaccination, hatchability and chick quality.



Keep vaccine preparation rooms biosecure

Biosecurity is crucial in ensuring the long-term health of day-old chicks.

Vaccine preparation rooms play a central role in this process, being locations where vaccines and diluents are handled. If not treated with due care, bacteria and other pathogens can contaminate the vaccine batches, which are injected into the chicks as they are vaccinated. Stringent biosecurity control and isolation measures are essential.

To prevent cross-contamination in the vaccine preparation room, follow these recommendations:

- Make sure that the room is well-sealed at all points. Keep the door shut when not in use.
- Ventilation should be set up so that the room static pressure is maintained at a higher value than that of any of the surrounding rooms to stop dirty air from entering the room. Use an air sanitiser to keep bacterial levels in the air low.
- Before entering the room, staff should put on fresh PPE (lab coats, masks, gloves and face shields). Shoes should be changed before entering the room. Hands should be washed and sanitised before entry.
- Set up a regular cleaning and disinfection program of room surfaces and equipment at the end of each hatch day, using approved and effective products. Check that it is done, and include the room in the regular hygiene swabbing of the whole hatchery.
- Restrict access to the room to approved and trained staff only.
- Don't share equipment between different areas if possible. If unavoidable, ensure the equipment is thoroughly cleaned, disinfected, and swabbed before entry.
- Maintain a rolling program of staff training so that all hatchery employees know why the room needs special treatment and the consequences if anything goes wrong.

Maintaining biosecure vaccine preparation areas in hatcheries is vital for protecting animal health and the economic success of the operation. Strict adherence to biosecurity protocols ensures that vaccines are prepared and administered effectively, protecting the birds and the operators involved in the process. To achieve this goal, monitoring all possible details that might negatively influence hatch quality and field performance is necessary.





MAINTENANCE

How to calibrate and use temperature readings taken with tiny tag loggers **35**

Calibrate CO₂ sensors regularly **52**

Calibrating electronic humidity sensors **55**

Zero calibration of pressure sensors **56**

Have you got a hatchery maintenance plan in place? **94**

Do we supply enough air to our incubators? **95**

Checklist - Ventilation **96**

Maintain the fans in your setters and hatchers **98**

Be careful when you change To different fans in an incubator **99**

Have you got a hatchery maintenance plan in place?

During hatchery visits we often notice that maintenance is reactive rather than preventative – things are only fixed when they break down.

This can compromise hatchability and chick quality which are the two most important performance factors a hatchery's success is measured on. A scheduled maintenance program minimizes the risk of machine failure and the impact of incorrect machine operation on hatch and quality. A few things to consider when setting up a maintenance program are:

- **Have a dedicated person responsible for maintenance reporting to the hatchery manager.**
- **Produce a list of all the equipment to be maintained including frequencies.**
- **Keep records on all performed maintenance.**
- **Keep track of the spare parts on hand.**
- **Include the building structure and ancillary equipment in the program.**
- **All sensors (temperature, humidity etc) need to be calibrated regularly.**

Maintenance is required on any equipment that can affect the performance of the hatchery. This includes setters, hatchers, all chick processing equipment, any measuring equipment (thermometers, hygrometers, pressure gauges), ventilation, generators, all possible water treatment systems, alarm systems and trucks.

All maintenance should be done according to manufacturers' instructions, by using their provided checklists and their recommended maintenance intervals as a minimum. Keeping good records is useful to monitor if the same equipment keeps failing or needs more

maintenance than others as this could indicate that there is an underlying problem elsewhere. Keeping track of the spare parts and their usage avoids over ordering unnecessary parts. Some of the incubation manufacturers now offer technical audits which are extremely helpful to get you started with your maintenance program. Monitoring the equipment allows us to see if the equipment is performing within the acceptable limits and to take action if we notice unacceptable readings.

Regular visual checks should still be done several times a day to ensure temperature, humidity, ventilation and turning are all as they should be. Over time it should be possible to assess costs and benefits of the maintenance program.

Preventive maintenance generally has benefits in all industries and the hatchery is no exception. It contributes to a better hatchability and chick quality, safer work environment, reduced power and utility costs as efficiency is increased, lower insurance costs and retaining a higher value of assets.

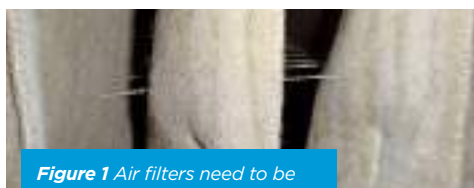


Figure 1 Air filters need to be checked and replaced regularly.

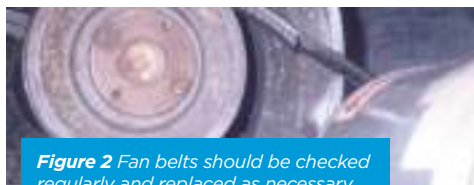


Figure 2 Fan belts should be checked regularly and replaced as necessary – this belt is not fit for use.



Do we supply enough air to our incubators?

Incorrect ventilation is a common problem in hatcheries.

Even if the basic hatchery ventilation has been correctly specified, the various components need to be installed, calibrated and set up properly. Air pressures must be correct in each room, and the volumes entering the room must be enough to meet the needs of the embryo, and also to maintain room air pressures. If a hatchery has been extended, it is quite common that the ventilation capacity is either not increased at all, or not increased sufficiently for the number of extra incubators.

There are several ways to check if ventilation rates are meeting the hatchery's needs. Room air pressures, supplied air volumes and CO₂ levels are all good indicators. This tip will explain how to calculate the supplied air volumes – the same method can be used to check air handling units or exhaust capacities.

Each brand and model of incubator has its own specific ventilation needs. For optimum performance, we have to supply the correct pressures and air volumes for the make of machine installed in the hatchery. These will have lower and upper limits, so keeping them on the average level will bring some energy savings when compared to keeping everything at the upper limit. To measure the air intake of a machine, first we need to know the minimum and maximum fresh air needs, which should be specified by the manufacturer. For the calculations, we will need an air speed meter (anemometer), a ruler and a calculator. All the measurements will be done from the machine air inlet area. Depending on the make of incubator, the air inlets may be placed in front of the machine or in an air supply plenum. Before taking any measurements, the dampers will need to be fully opened. Avoid windy days for this procedure.

Equipment

- Anemometer (Kestrel make multi meters which include a suitable vane anemometer)
- Ruler
- Calculator

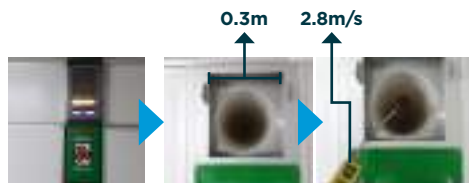
Preparation

- Find the air inlets for the setter or hatcher
- Remove any obstructions, such as a grill
- Open all dampers to 100% open
- Close all room doors, and check static pressures are balanced for that room

Measurements and Calculations

- Measure the dimensions of the air inlet
- Calculate the cross sectional area = $\pi \times (\text{diameter}/2)^2$ where $\pi = 3.14$
- Measure the average air speed in front of the inlet
- Use the formula to calculate air intake

$$\text{Air Intake} = \text{Air Speed (m/s)} \times \text{Cross Section Area (m}^2\text{)} \times 3,600$$



$$\begin{aligned} \text{Cross Section Area} &= \pi r^2 = 3.14 \times \left(\frac{0.3}{2}\right)^2 \approx 0.07\text{m}^2 \\ \text{Air Intake} &= \text{Air Speed (m/s)} \times \text{Cross Section Area (m}^2\text{)} \times 3600 \\ &= 2.8 \times 0.07 \times 3600 \approx 705 \text{ m}^3/\text{h} \\ \text{Converting m}^3/\text{h to cfm} &: \text{m}^3/\text{h} \times 0.588578 \\ &= 705 \times 0.588578 \approx 415 \text{ cfm} \end{aligned}$$



Checklist - Ventilation

This is the fourth checklist which we hope will be useful when investigating how well your hatchery handles the needs of ventilation.

AIR HANDLING UNITS

- Clean air ducts and filters regularly.
- Keep cooling coils clean and avoid blockages.
- Check belts regularly; change when cracked.
- Check filter change warning pressure sensors for filter condition, making sure the sensors are working properly.

PLENUMS

- Be sure that temperature, RH and CO₂ levels are consistent across the plenum.
- Make sure that all access hatches are closed properly.
- If present, clean cooling coils and humidifiers regularly.

AIR PRESSURE

- Calibrate pressure sensors and check air volumes of rooms or plenums on a monthly basis.
- Check reference points regularly.
- Use a filter attached to the reference tube outside end.
- Avoid pressure fluctuations.
- The pressure sensor range should be less than 10 times that of the target pressure for the room, as they have a 1% error of reading value. If the target pressure set point is 5pa, the sensor should have a maximum 50pa range.

EGG STORAGE ROOM

- The temperature of the egg store should be consistent throughout the room.
- If humidity exceeds 90%, ventilate to reduce it and avoid fungal growth.

SETTER AND HATCHER ROOMS

- Maintain 22-28°C temperature and 50-60% RH in setter and hatcher rooms.
- Keep doors closed.
- Keep CO₂ levels below 1000ppm.
- Clean and maintain spray nozzles regularly if present.
- Never wash empty hatchers while the hatch continues in the same room. This can cause high humidity and a risk of contamination.
- Calibrate room/plenum inlet dampers regularly.
- Clean hatcher exhausts regularly.
- Avoid sharp angled bends in flexible exhaust ducts.



Figure 1 Keep doors properly closed.



Checklist - Ventilation *Continued*



Figure 2 Avoid sharp bends in flexible ducts.

TRANSFER ROOM

- Aim for a room pressure less than the setter room and more than the hatcher room.
- Provide extra ventilation when using in ovo vaccination.
- Keep doors closed during transfer unless actually in use.

VACCINE PREPARATION ROOM

- Hold at a higher positive pressure than any other surrounding room.
- Ventilate continuously.
- Use a high efficiency particulate air (HEPA) filter if possible.
- Use double slider windows for vaccine serving.

Maintain the fans in your setters and hatchers

Incubators sold by the various manufacturers have a range of fan designs.

Incubators sold by the various manufacturers have a range of fan designs. However, the fans all have the same function, which is to move fresh air into the cabinet, and to provide an airflow pattern within the filled cabinet which is balanced and of sufficient airspeed over all of the eggs or chicks to keep them at their optimal temperature. Regular and effective maintenance is crucial if the fans are to deliver the right amount of air in the right places and at the right speed. There are several aspects of fan set up, wear and (lack of) maintenance which will cause the fans to need attention. Fan blade damage – if the fans are bent or dented, they will not deliver optimal airflow. Damaged blades should be replaced as soon as possible.

Fan positioning is important, and problems can be seen after a fan has been replaced if it is not positioned correctly. This is especially important when the fan needs to be mounted in a fan housing. The fan must be mounted at the correct height within the housing, so that the air can only move in the desired direction. If the fan is mounted slightly above the housing, air will tend to escape to the sides. The fan must always be mounted centrally within the housing – if it is offset then a 'blow-by' effect can be caused, where some air is sucked back away from the desired airflow. Make sure that the fan is pushing the air in the correct direction. Fan speeds need to be checked regularly using a suitable tachometer.



Figure 1 Clean fan blades, well centered fan and correct height.

Regular maintenance should be set up to check:

1. **Belt tension** – too loose and the rubber belt will slip on the metal pulley – listen for a squeal on start up. This can cause the fan to slow down. If the belt is too tight it will grind into the pulley and wear out more quickly.
2. **Pulley size, condition and alignment** – a worn pulley should be replaced using one of the same size. Once in place, the fan belt should sit in the pulley groove, with its top surface level with the edge. If the belt sits proud or inset, either it is worn, or the wrong belt is being used. Make sure that the pulleys are in a straight line.
3. **Belt worn out** – fan belts tend to become brittle, glazed or cracked. Belts are relatively cheap, so replace them regularly as part of a preventative maintenance program.
4. **The rating of the fan motor** – when replacing a failed or failing motor, make sure that it has the correct specification to be an exact replacement. Check that the voltage supplied to the new fan is correct.

Fan cleanliness – especially in multistage machines and hatchers dust, dirt and chick fluff can settle on and stick to the fan blade edges, making them less efficient. This should be cleaned off regularly. If the water used for humidification has a high mineral content, a hard residue can form on the fan blades, again making them less efficient. The residue should be removed carefully, making sure that the blade is not deformed in the process.



Figure 2 Incorrect fan belt sitting low in the pulley.



Figure 3 Worn fan belt.

Be careful when you change to different fans in an incubator

One fundamental factor for hatching good quality chicks is having the correct eggshell temperature (EST) throughout incubation.

The incubator is set up to control air temperature, which is not the same as EST. Two factors make the two temperatures diverge – the heat production of the embryos as they grow and develop, and the ability of the air moving through the machine to take up and remove surplus heat. Embryo heat production increases rapidly after 10 days of incubation and then plateaus briefly at 17-18 days of incubation at around 138mW/egg. Air movement within the setter plays an important role in removing surplus heat from around the eggs, its effectiveness driven mostly by air speed between the setter trays.

In reality, air speed varies within the setter. Eggs located in a position with low air speed, will have higher eggshell temperature in the last week of incubation than eggs located where air speed is higher. It can be a big challenge to achieve even air speed (and hence eggshell temperature) in the setters in many hatcheries.

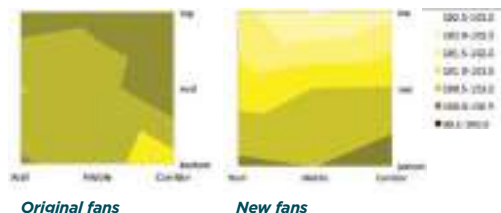
A possible way to get more uniform air speed in the setter could be by replacing existing fans with stronger ones or simply by speeding up the existing fans. Average air speed in the setter will be increased by either modification. But in making the change to the fan speed, air speed within the incubator may become even less uniform.

In a European hatchery with fixed-rack multi-stage incubators, the manager was not satisfied with eggshell temperature and its uniformity. She thought that the original propeller fans were not strong enough to deliver the air all the way down to the floor.

In trial machines, the fans were replaced with stronger axial fans. To everyone's surprise, they saw no improvements in chick quality and hatchability. In fact, the stronger fans made things worse: the machine became too cold at floor level and too hot higher up. During the experiment, air speed in the two trial setters was measured with a hot-wire anemometer and eggshell temperature was measured with Tiny Tag temperature loggers. The new fans increased air speed by an average of 0.5m/s. However, the average EST increased, with the hottest area moving from the bottom of the machine to the top.

The EST area plots show that despite the higher air speed, the average EST was higher, with more eggs falling into the band above 102°F which is where problems of quality may be expected to start. In a setter, air doesn't always take the route we expect. Setting pattern, egg size and even turning angle can affect airflow – air always goes by the easiest route where there are fewer or no obstacles. On the other hand, resistance increases as air speed goes up and this relationship is not linear. So, the airflow pattern in the setter can be very tricky. When we try to change ventilation inside of the setter, we should always evaluate the change by checking how actual eggshell temperature changes. Information about how to measure eggshell temperatures can be found in *Aviagen Hatchery How To No. 6*.

Day-17 EST Distribution in the Setter





BIOSECURITY

*Assessing alternative hatching
egg disinfectants*

12

*Keep vaccine preparation
rooms biosecure*

91

*Is your smartphone safe to take
into the hatchery?*

102





Is your smartphone safe to take into the hatchery?

There are many smartphone apps available which make the phone a convenient tool for hatchery monitoring.

However, despite smartphones being useful gadgets, they do present some biosecurity risks if they are taken into the hatchery.

A recent study conducted by Aviagen® hatchery specialists quantified bacterial contamination on 36 smartphones whose owners were asked (without prior warning) to remove the phone case and swab the phone's screen and camera lens areas – as shown in the picture. The swabs were taken to a lab, streaked onto non-selective agar plates and incubated overnight. A lab technician counted the colonies on all plates. In total, 91% of the plates grew some bacteria, carrying up to 2,000 CFU (colony forming units).

We did not identify the organisms in this trial, but some of the bacteria that could be living on your phone include *E. coli*, *Staphylococcus aureus*, *Streptococcus* and *Pseudomonas*, all possible threats for chick livability as they are the main causes for omphalitis and first week mortality.

It is for this reason that some companies make the hatchery a “cell-phone free zone” while others allow the device to be brought inside after some kind of disinfection procedure.

If you are taking your phone into the hatchery, a correctly carried out disinfection process should take place every time. Suitable processes include:

- **Fumigation with paraformaldehyde** – this is the most effective process. Unfortunately, formaldehyde is not permitted in many countries.
- **High Intensity Ultra Violet light.** An Aviagen study in the UK showed that 10 minutes exposure is enough to inactivate 99.9% of bacterial load. The disadvantage is that UV lamps can be very expensive and need to be replaced regularly.
- **Disinfectant wipes** – in the study described above participants were asked to completely wipe their phones with ammonium chloride wipes and swab again after some minutes. Wiping the phones with disinfectant wipes significantly reduced the bacterial load, see graph overpage.



Figure 1 Picture showing areas swabbed on each phone



Is your smartphone safe to take into the hatchery? *Continued*

As well as daily dry cleaning and disinfection there are other everyday practices that will help to reduce the amount of bacteria that is lurking on your phone; such as:

- The phone case should never be taken inside as it may be carrying bacteria and other microorganisms. Ideally use a silicone or similar case which can be washed, and always remove the case daily while you dry clean and disinfect the phone.
- Avoid taking your phone into the bathroom – this is a great opportunity for microorganisms to get onto your phone.

This tip is a guide to help you to keep using your smartphone and all the available hatchery assessment apps without bringing any hazardous bacteria into the hatchery.

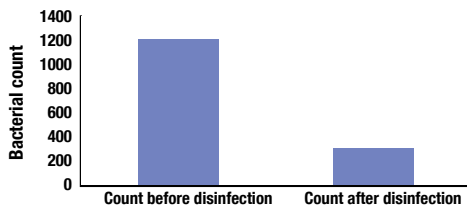
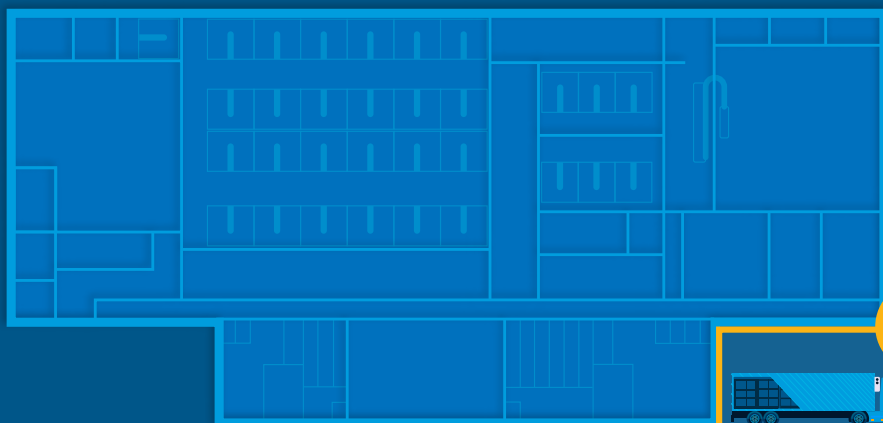


Chart 1 Average bacterial load on 36 mobile phones swabbed before and after disinfection. Before disinfection 91% of the phones had bacteria present. After disinfection only 29% still had bacteria present.



CHICK TRANSPORT

Chick transport conditions

106





Chick transport conditions

The need for optimal egg handling, incubation, and chick processing conditions to allow the embryo to develop normally and in good health is already well established.

These needs are still just as important after the chicks leave the hatchery, all the way into the brooding environment.

At hatch, on average, between 10 and 12% of the chicks' body weight comes from residual yolk, which supplies the newly hatched chicks with nutrients and water until they reach the farm. This is a logical evolutionary adaptation for precocial chicks (which can run around and explore soon after they hatch); they hatch over a period of hours, and the earliest to hatch must be kept safe until they are all emerged and ready to leave the nest.

Newly hatched chicks, although well developed at hatch, and supplied with enough nutrients and water to sustain them for 60 hours or more, are still relatively poor at controlling their own body temperature – this ability develops slowly over the first week or so. Environmental conditions suitable for the chicks to maintain an optimal body temperature is probably the most important aspect to control when creating good transport conditions. Optimal vent temperature for unfed chicks is between 39.4 and 40.6°C; up to date advice on the best way to measure vent temperature can be found in two other tips in the section covering chick processing and storage.

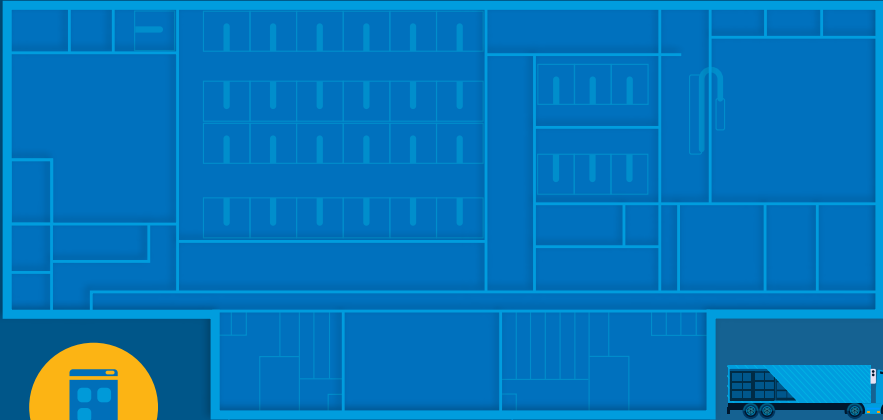
Chicks travel grouped in small populations of 20-80 held in cardboard or plastic boxes, so they do have the capacity to overcome challenging temperatures by behavioral modification, at least in the short term. Too cold, and they will huddle together; too hot and they spread out and pant.

However, they cannot maintain either for long and for anything but the shortest trip, they need the air temperature in the box to be around 30°C. Wind chill caused by the relative air speed in the surrounding room will affect the set point. In still air, the external temperature may need to be as much as 6°C lower, but at high air speeds, it could only be 2°C.

If the temperature is consistently incorrect, it will have an impact on chick survival. We are usually very wary of overheating – if severe, the consequences can be catastrophic. Some of the early trials of in-hatcher feeding had high early mortality because it was not realized that fed chicks produce a lot more heat, and so the vehicle needs more cooling capacity. On the other hand, recent trials at Aviagen have demonstrated that slight chilling (box temperature of 24°C), while survivable short term, eventually jeopardizes the chicks' ability to control their body temperature. Once that happens, first week mortality can more than double. An equivalent rise in box temperature (to 36°C) had a much smaller impact on mortality, causing it to rise by about half.

Chick transport is the last part of the process of providing farms with day-old chicks. They are often surprisingly tough, but getting the ambient temperature right will go a long way towards improving early livability.





USEFUL APPS

Using your mobile as a powerful tool in your hatchery **41**

The chick yield vs. moisture loss box **44**

Making the most of your hatchery data.
Using pivot tables to boost hatchery management **108**





Making the most of your hatchery data. Using pivot tables to boost hatchery management

Almost every Hatchery manager assesses his results by collecting performance data such as hatchability, hatch of fertile, water loss, hatch debris, mortality patterns, percentage of culls and first week mortality.

But the best way of keeping track and using the information to manage the hatchery is by analyzing the data collected as a whole, identifying how each key performance indicator (KPI) is performing and checking how they are interrelated. There is no point in collecting vast quantities of data if you cannot then make good use of them. Keeping data on sheets of paper stored in desk drawers will not help you boost your KPI's.

Nowadays, with data collection being a routine component of day-old chick production, there are many sophisticated tools available to track the hatchery environment. Data loggers can collect real time data describing (for example) temperature, humidity or CO₂ using remote sensors and transmitting the information to a networked computer, a tablet or even a cell phone. However, no matter how much easier data collection has become, the information still needs to be summarized and used to correlate cause and effect.

The best way of summarizing all the data collected is by putting it into a database or spreadsheet in such a way that all the information can be analyzed as a whole, looking closely at details where necessary.

Excel is one of the most widely available programs for data analysis, and many people working in a hatchery will have some familiarity with it.

While not everybody uses them, it is full of surprisingly sophisticated tools for analyzing data, and can cope with very big data sets. As such, it can provide rich information for improving a hatchery's KPI's.

Avoid producing daily report sheets as they are difficult to analyze. A better way is to consolidate the data, and then use Pivot tables to control process and KPI's. (**Figure 1**).

Pivot tables allow the user to create any kind of report needed in order to evaluate different KPI's, machines or data loggers in one unique screen. Moreover they are easily manageable by any Excel user, just requiring a little training.

The most important step is making sure that your data is organized following a database layout as shown in Figure 2 (organized in columns, consistent naming, data within acceptable ranges, sensible data without errors).

Once set up to your satisfaction, Pivot tables can be used to generate dynamic graphs, updated each time the Pivot table is run. These can show data over several seasons, allowing the manager to evaluate trends which can be really helpful in Hatchery troubleshooting allowing the manager to compare different banks of setters/hatchers, individual machines as well as the seasonal variability which can so affect hatchery performance.

Once data driven performance management is implemented, it is possible to set targets, look at data as whole, monitor performance, analyze trends and differences and implement improvements in specific aspects which are affecting Hatchery performance.

your hatchery data. Using pivot hatchery management *Continued*





Privacy Notice: Aviagen® collects data to effectively communicate and provide information to you about our products and our business. This data may include your email address, name, business address and telephone number. To view the full Aviagen privacy notice visit [Aviagen.com](https://www.aviagen.com).

Aviagen and the Aviagen logo are registered trademarks of Aviagen in the US and other countries. All other trademarks or brands are registered by their respective owners.

©2025 Aviagen.