Hatchery TIPS 57

WHAT HAPPENS WHEN EGGS ARE SET SMALL END UP?

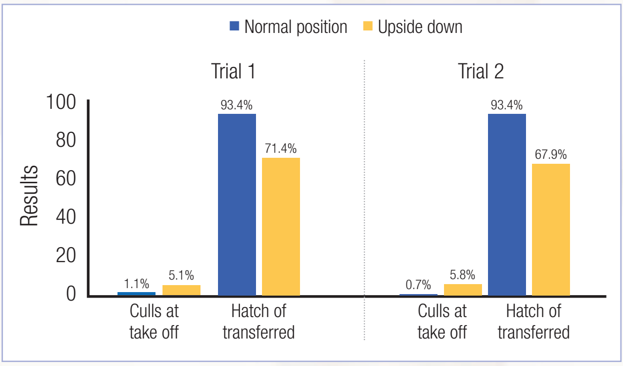
Hatching eggs are set with the small end downwards in the setter tray, with the air cell facing upwards. As the embryos finish their final three days of incubation in the hatcher baskets, they will naturally manoeuvre into hatching position and gravitate toward the end of the egg that was placed upward 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 batch of eggs were set small end down, as recommended. The embryos in Trial 1 were in ovo vaccinated at transfer, while those 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.

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



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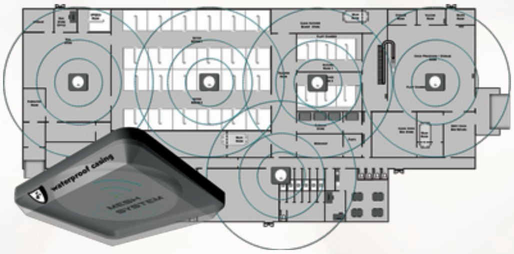
GETTING THE HATCHERY CONNECTED

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 is 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.

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PREVENTING CHICK FLUFF BUILD-UP ON HATCHER COOLING COILS

Chick fluff adhering to the hatcher cooling coil is a frequent observation in hatchers, 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 liveability. 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.

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

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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' liveability 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 as shown in the picture to the left, and not ready to eat and drink when placed at the farm.

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, as shown in the picture to the right.

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

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.

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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.

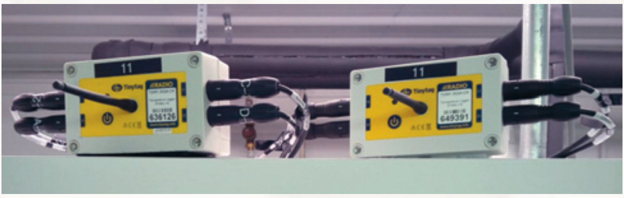
Some research projects look promising on a small scale in the laboratory, but are not used in commercial hatcheries. Occasionally this is because the ‘problem’ is not currently in need of a ‘solution’. More often, it is because a treatment which works beautifully in small incubators holding 400-500 eggs 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 programme out in a large hatchery, it is important to measure its impact on all the incubation essentials to give guidance and support when troubleshooting.

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.

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



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OPTIMISING CHICK QUALITY & HATCHABILITY IN PERIODS OF LONG EGG STORAGE

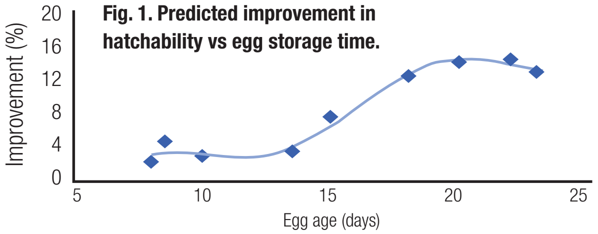
There are times in the year when chick production operations may struggle to keep egg age down. However, a good egg storage strategy can greatly improve both hatchability and chick quality from older eggs. It is not only the hatchery that needs to adjust; close co-operation with the team planning the 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 mould 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).

Fig. 1. Predicted improvement in hatchability vs egg storage time.



- 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!

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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.

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Hatchery TIPS 64

EMBRYO DEVELOPMENT DURING STORAGE

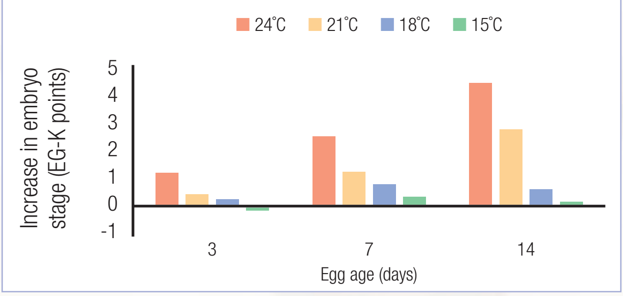
During egg storage, there is a tendency for embryo viability to decrease. Research over the last 120 years has tried to define the optimal temperature for egg storage, particularly the temperature at which embryo growth and development stops. The suggested optima from these trials have been surprisingly 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 fertilisation, 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.

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



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