Factors affecting weight loss of eggs during incubation

The conditions required inside the incubator for optimal embryo development are the same worldwide. However, local climate plays a direct role in the temperature and humidity of the air supplied to the incubators, and can vary considerably from region to region.

by Jason Cormick, Hatchery Specialist, Aviagen. www.aviagen.com

The environment outside the incubator can greatly impact the incubation process, making it critical to understand the influence of atmospheric humidity on chick quality and strategies to create the best possible conditions for embryo development.

Ideal moisture loss

It is well known that eggs should lose between 10.5-12.5% of their initial weight (as moisture) from lay to 18 days of incubation. If eggs are stored for longer than seven days, add 0.5% to the moisture loss.

Immediately after lay, the egg cools, forming a small air cell at the top of the egg. Over time, the air cell becomes larger as moisture is lost through the shell during storage and incubation (Fig. 1).

Fig. 1. Expected air cell size after lay and 7, 14 and 18 days of incubation.

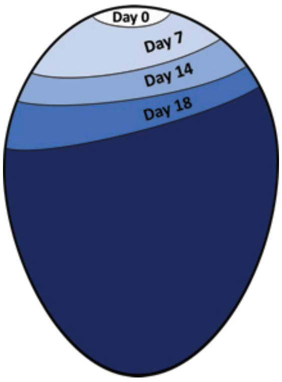

Fig. 2. Weigh the tray with eggs prior to set.

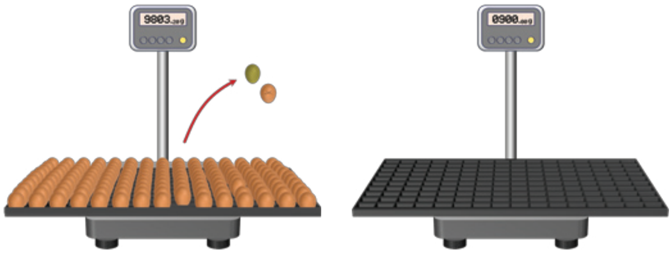

Fig. 3. Weigh the tray with eggs at transfer and then weigh the tray without the eggs.

Losing sufficient moisture ensures that the chick can turn to a comfortable pipping and hatching position, and the resulting air cell is large enough for its lungs to fully inflate once it has broken through the air cell membrane.

If there is insufficient moisture loss (<10.5%), chick quality will be compromised. As a result, chicks start slower and under-perform compared to chicks that have lost the correct volume of moisture during the incubation period.

In contrast, excessive moisture loss can result in dehydrated chicks. If eggs are experiencing greater than expected weight loss during incubation (>12.5%), it may be helpful to increase moisture by using humidity sprays.

To avoid cold spots when using humidity sprays, it is preferable to use short and frequent sprays.

Procedure for measuring moisture loss

● Step 1:
Prior to setting the eggs, weigh the tray of eggs and record the number of eggs (Fig. 2). For example, at set, the tray and 150 eggs weigh 9,900g (349.2oz).

● Step 2:
At transfer, first remove any contaminated or cracked eggs and weigh the tray with eggs again. After transfer, weigh the empty tray (Fig. 3). In this example, two eggs are removed before weighing, leaving the weight of 148 eggs plus the tray equal to 8,803.2g (310.5 oz). The empty tray weighs 900g (31.7oz).

While most trays within a single batch have similar weights, the variability of composition and density means that not all trays weigh the same. Therefore, it is imperative that the actual weight of the tray the eggs were sitting in is used and not an assumed/typical weight.

● Step 3:
Using the recorded weight of the eggs plus trays at set, calculate the average egg weight at set.

(Total set weight (9,900g or 349.2oz) - tray weight (900g or 31.7oz)) / number of eggs (150)
= average initial egg weight (60g or 2.11oz)

The calculations for steps 1-5 are summarised in Table 1 below.

● Step 4:
Using the recorded weight of eggs plus trays at transfer, calculate the average egg weight at transfer (day 18).

(Total egg weight at transfer (8,803.2g or 310.5oz)
- tray weight (900g or 31.7oz))
/ number of eggs (148)
= average egg weight at transfer (53.4g or 1.88oz)

● Step 5:
Using the average set and transfer weights, calculate the weight (moisture) loss as a percentage.

(Average initial egg weight (60g or 2.11oz) - average egg weight at transfer (53.4g or 1.88oz))
/ average initial egg weight (60g or 2.11oz) x 100
= percentage of weight (moisture) loss (11.0%)

Table 1. Measuring moisture loss.

Eggs + tray	Set weight (g)	No. of eggs 150	9,900
	At transfer (g)	No. of eggs 148	8,803.2
	Tray weight (g)		900
Eggs only	(Set weight - tray weight) (g)		9,000
	(Transfer weight - tray weight) (g)		7,903.2
Individual average egg weight @ set (g)			60.00
Individual average egg weight @ day 18 (g)			53.40
Weight lost to 18 days (g)			6.6
Percentage weight loss			6.6/60 *100
Moisture loss % to 18 days			= 11.00

Factors affecting weight loss of eggs

● Shell thickness:
Shell thickness impacts the exchange of moisture between the inside of the egg and the environment. Moisture needs to travel through the pores and into the environment; the thicker the shell, the longer it takes.

Therefore, as flocks age, eggs become heavier with no proportionate increase in shell weight, shells become thinner and it is easier for moisture to leave the egg.

● Partial pressure:
Partial pressure is created by the volume of air in the atmosphere exerting pressure to the surface of the egg and therefore is affected by altitude.

At higher elevations, the air is less dense, and partial pressure is reduced, making it easier for moisture to leave the egg.

● Eggshell pore numbers:
The number of pores in the eggshell is also affected by the altitude at which the egg is laid, due to the ability of birds to alter the porosity of the eggshell.

Eggs laid at higher altitudes have fewer pores than eggs laid at sea level, because gaseous exchange/moisture loss is easier with reduced partial pressure.

When eggs laid at higher altitudes are hatched at sea level, they require less humidity than usual during incubation to compensate.

Taking eggs from sea level to a higher altitude to hatch is not recommended.

● Environments:
The incubation environment includes the immediate environment (for example, the incubator where the eggs are hatched), and the external climate that influences it. Both have the greatest influence on moisture loss.

Water vapour travels through the semi-permeable eggshell membrane, then through the pores of the shell and into the environment.

The RH (saturated) within the egg holds at 100%, and the external environment is always lower.

The greater this difference, the faster the moisture will leave the egg (Fig. 4).

Incubator environment

Multi-stage incubators contain eggs at various stages of incubation, some of which require high oxygen levels. Therefore, multi-stage incubators are continuously ventilating.

This continuous air replacement means moisture is being removed and replaced with drier air, resulting in a greater moisture loss in multi-stage than single-stage incubators. Single-stage incubators allow the ventilation to be sealed; some incubators can be completely airtight.

While this is highly beneficial for temperature stabilisation at the beginning of incubation when the early-stage embryo is highly sensitive to fluctuations, it does mean that moisture loss becomes more critical later on.

Increased moisture loss can be achieved by ventilating sooner and/or by increasing the damper set point.

Local external environment

The external environment has a huge impact on the air supplied to the incubators, and it is important to consider the variations that can occur. Environments differ greatly depending on the Zone in which a country is located (Fig. 5).

Countries in the Tropical and Subtropical Zones are the hottest, while those in the Temperate Zone have the greatest variance of conditions/seasons. These seasons can often require different incubation conditions to compensate.

Climate

Polar Zones:
These zones remain cold for much of the year. Spring and summer are short, and humidity can vary considerably but is generally low.

Temperate Zones:
These zones have the greatest variability usually having four distinct seasons with humidity and temperature being exceptionally low in winter to exceedingly high in summer.

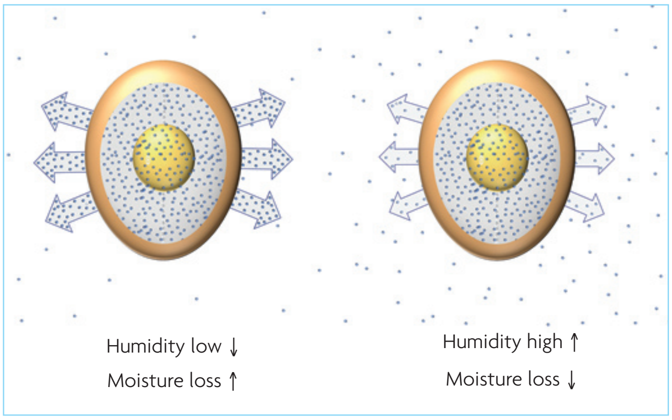

Fig. 4. Environmental humidity and moisture loss.

Subtropical Zones:
These are the driest zones, and home to the world's deserts. Temperature will be high during the day but plummet at night. Humidity remains low all year.

Tropical Zone:
Regions along the equator are the closest to the sun and therefore remain hot all year round and typically have a lot of rain fall, resulting in a high humidity.

This Zone includes Central America, Central African countries, and South East Asia. In this Zone moisture loss during incubation can be much harder to achieve than in any other zones.

Summary

Insufficient moisture loss results in both a loss of hatch (as chicks find it difficult to break out) and a loss of chick performance (as chicks that succeed, although difficult, will be lethargic upon arrival at the farm and remain inactive upon placement).

Factors influencing moisture loss include shell thickness, partial pressure and eggshell pore number. Incubator environment and local external environment also play important roles in moisture loss.

In the early period of single-stage incubation, sealing the incubator can achieve a more uniform and stable temperature with reduced moisture loss than multi-stage incubation.

To compensate, losing more moisture during the second half of the setter period is required. Ventilating sooner and/or increasing the damper set point can help increase moisture loss. The external environment has a huge impact on the air supplied to the incubators.

It requires different incubation conditions to compensate for climate zone differences. In high humidity regions, the air supplied to the incubator will need special treatment. The next article will focus on strategies to optimise moisture loss in high humidity. ■

The next part of this article, which will look at incubation in high humidity regions, will be published in International Hatchery Practice, Volume 35 Number 7

Fig. 5. World climate zones.