

# SOLVING INCUBATION PROBLEMS

*Nick French*

# SOLVING INCUBATION PROBLEMS



What is the optimum incubation environment



How do we check we are achieving the optimum environment

Temperature  
Humidity  
Ventilation  
Egg turning

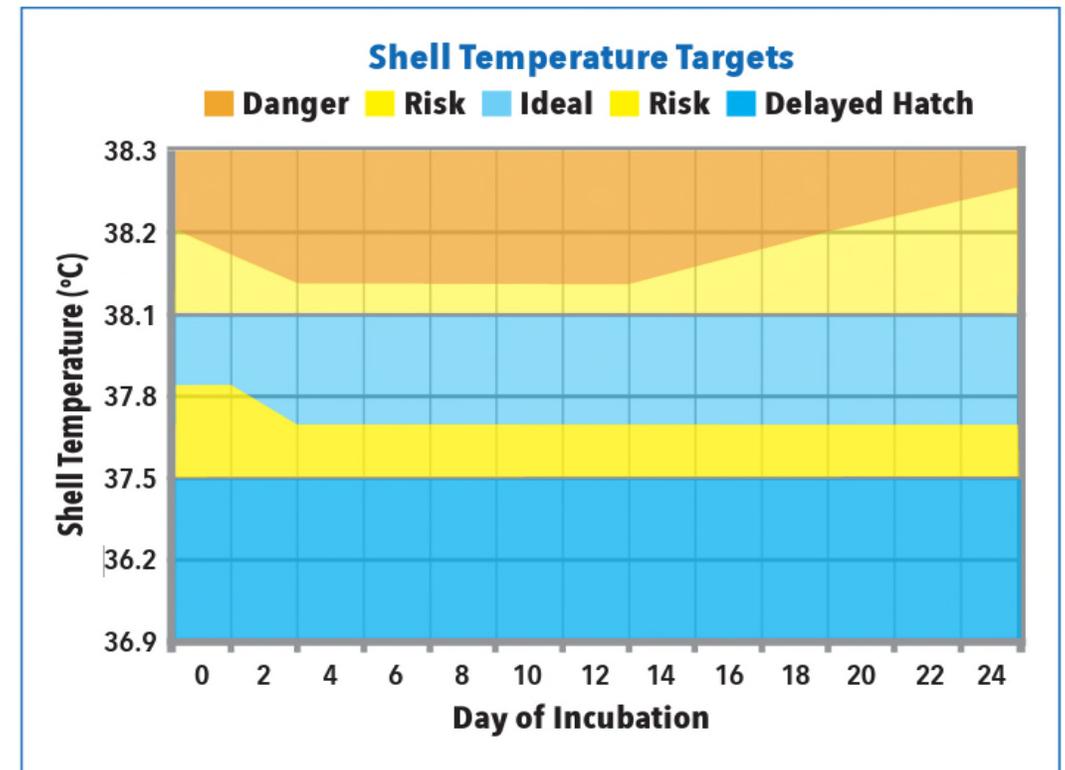


Solving Problems

The tools required  
Observation  
Maintenance and calibration

# OPTIMUM INCUBATION ENVIRONMENT

- The most important factor – incubation temperature.
- Incubation temperature = embryo temperature (not setter temperature)
- Eggshell temperature  $\approx$  embryo temperature
- Optimum eggshell temperature = 37.8–38.1°C (100 – 100.6°F)



# INCUBATION TEMPERATURE: SETTER AIR, EGG SHELL AND EMBRYO

- As the embryo grows it requires more oxygen and produces more metabolic heat
- First half of incubation setter air temperature close to eggshell temperature
- Second half of incubation embryo produces more metabolic heat → shell and embryo temperature higher than setter air temperature

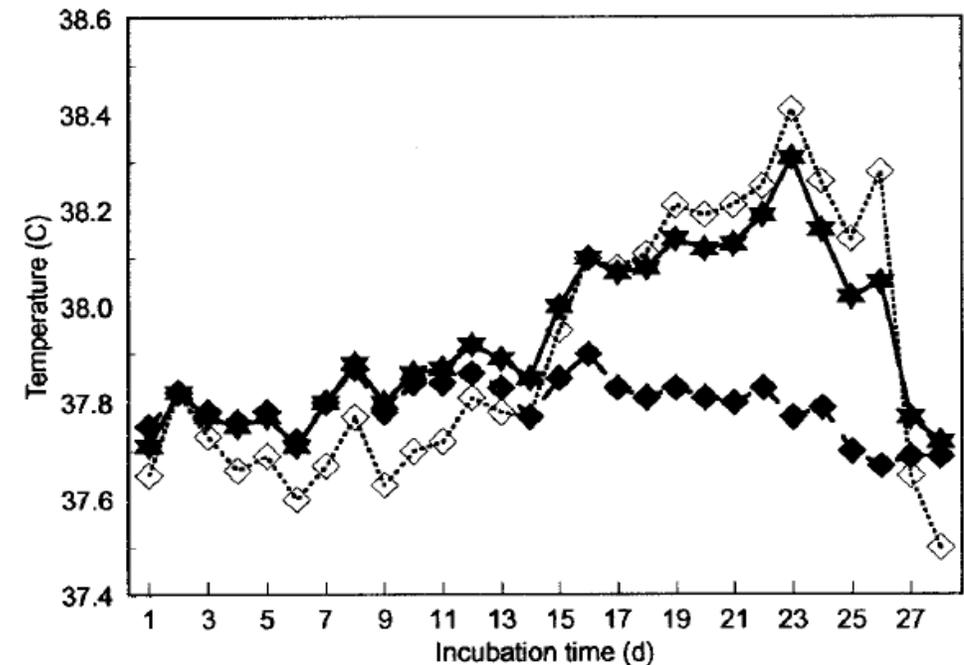


FIGURE 2. Temperature of a turkey egg incubated at 37.5 C; temperature measured inside the egg (◆), on the surface of the eggshell (★) and incubator air temperature approximately 10 mm from the egg (◆). The poult hatched on the 26th d of incubation. Data from French (unpublished observations).

French (1997)

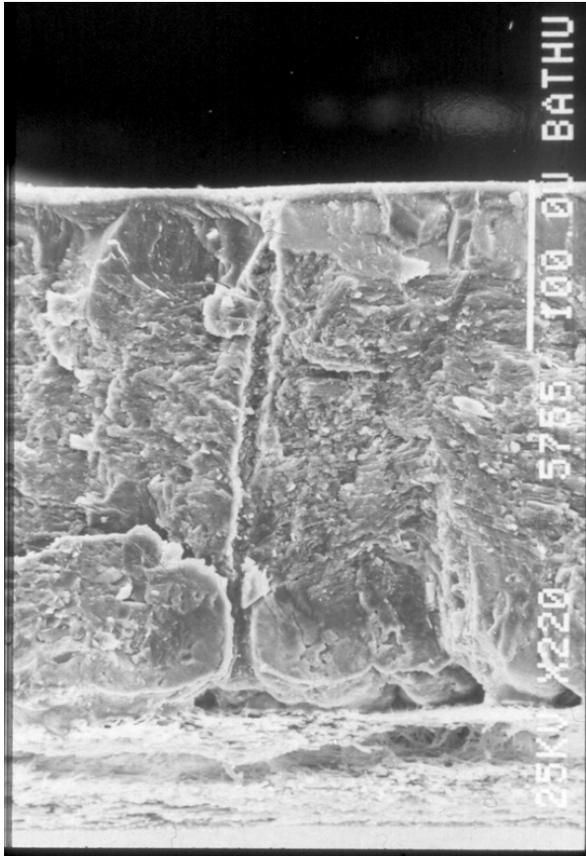
# OPTIMUM INCUBATION ENVIRONMENT

Three other factors also important:

- Humidity – controls egg water loss.
- Ventilation – provide oxygen, remove carbon dioxide, water vapour, heat.
- Egg turning – essential for proper embryo development.

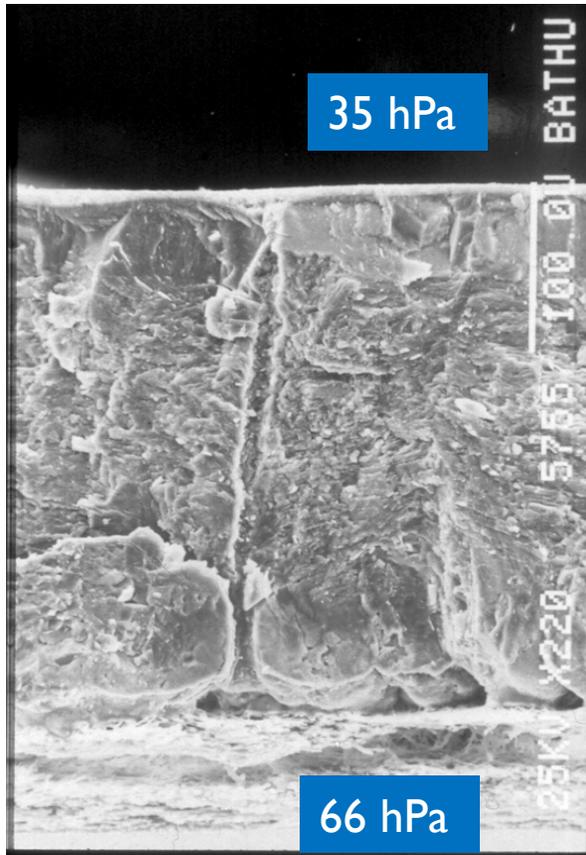
These three factors will also impact eggshell temperature

# WHY MUST EGGS LOSE WATER?



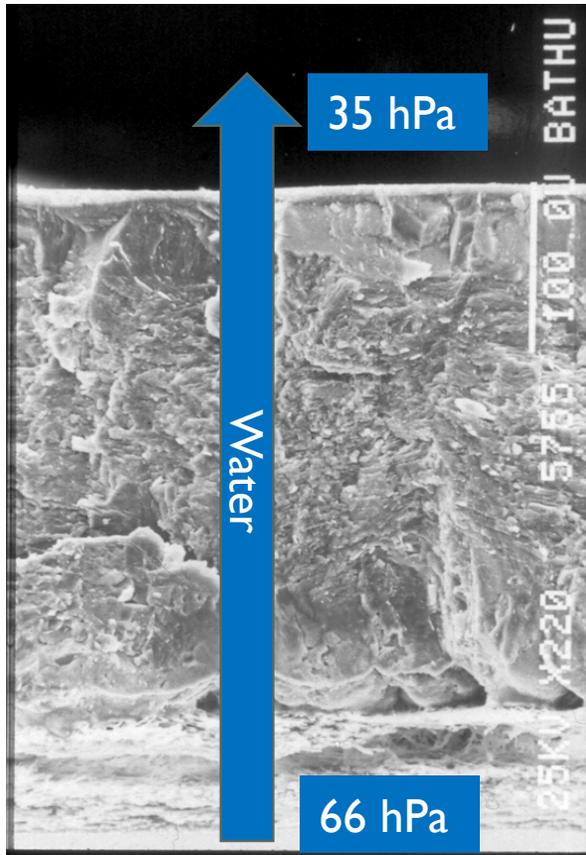
- Porous eggshell allows embryo to breathe.

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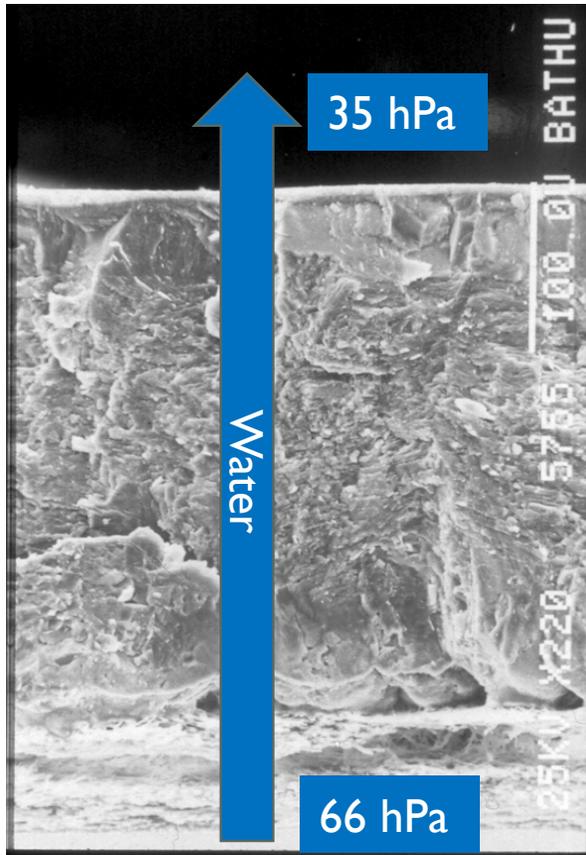
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- Water vapour pressure inside egg higher than incubator.

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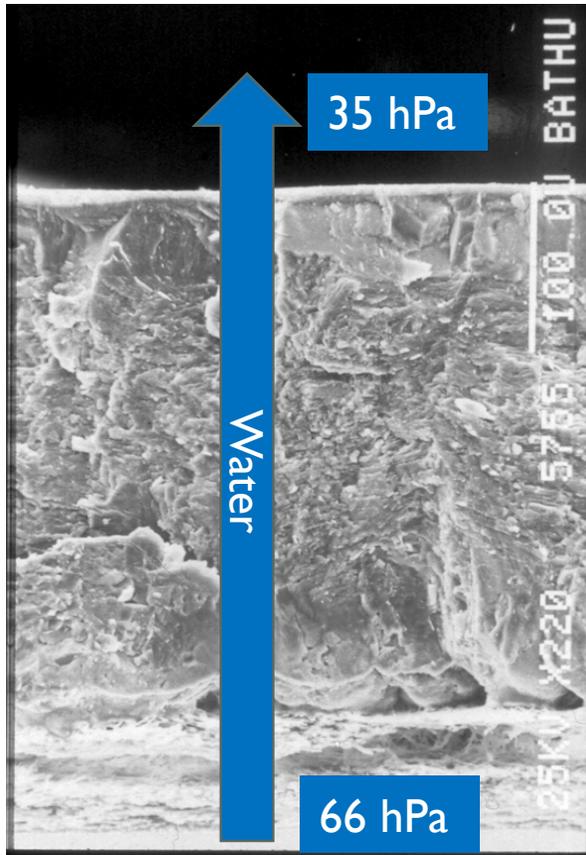
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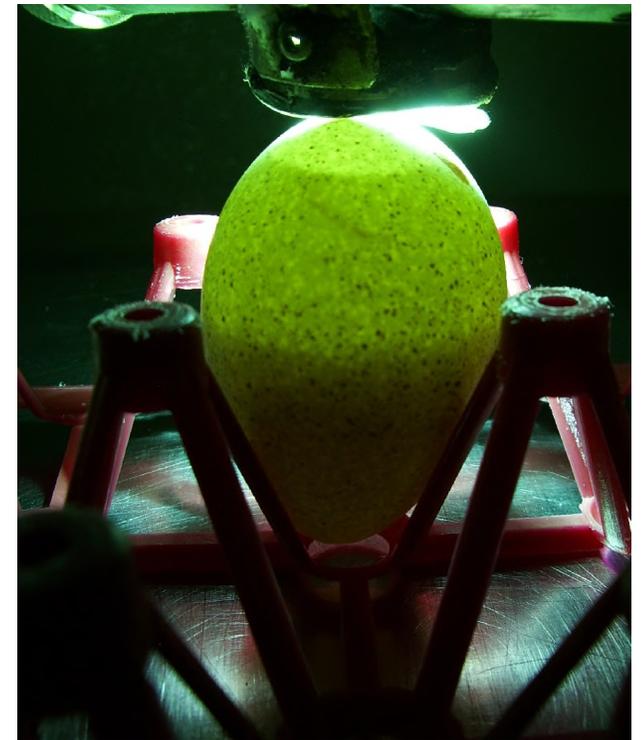


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- Embryo fat metabolism produces water which must be lost.
- Water loss allows an aircell to form  
– essential for embryo lung inflation just prior to hatch.



# CONTROLLING EGG WATER LOSS

- Too much water loss – embryo desiccation (often early embryo mortality)
- Too little water loss – too small aircell (late embryo mortality)
- Too low incubator humidity – too high water loss
- Too high incubator humidity – too low water loss
- We can measure water loss by weighing eggs
- Optimum water loss – eggs lose 11 – 12% of their fresh egg weight by 25 days of incubation

# IMPACT OF EGG WATER LOSS AND HUMIDITY ON EGG TEMPERATURE

Water evaporation requires energy = heat loss

1 gram of water evaporation = 28 mW of heat loss

## Egg Water Loss

- An 80g turkey egg loses approx 0.4g/d
- This equal 11.2 mW/d of egg cooling
- Egg temperature at start of incubation slightly lower than air temperature

## Humidification

- Evaporating water into the incubator to control humidity will also cool the air
- Can result in cool spots within incubator

# HUMIDIFIER DANGER

- Humidifiers can wet eggs / floors / walls
- Result - localized cooling
- Good maintenance of humidifiers essential
- Minimising humidification can result in better temperature control
- However, in some machine designs humidifier cooling prevents overheating!



# VENTILATION

- Ventilation requirement will very much depend on setter design
- Air cool only setter: ventilation is based on heat removal requirement
- Water cooled setter: ventilation is based on CO<sub>2</sub> removal
- Target 4000ppm CO<sub>2</sub>
- CO<sub>2</sub> easier to measure than O<sub>2</sub> and also higher ventilation requirement

Day 25 of incubation ventilation requirement:  
Single stage setter containing 10,000 80g turkey eggs

	Ventilation (m <sup>2</sup> /hr)
Heat Removal	162.0
Carbon Dioxide Removal <sup>a</sup>	63.0
Water Vapour Removal	13.7

<sup>a</sup> maintain setter carbon dioxide level at 4000ppm

# VENTILATION DANGER

## Over-ventilation

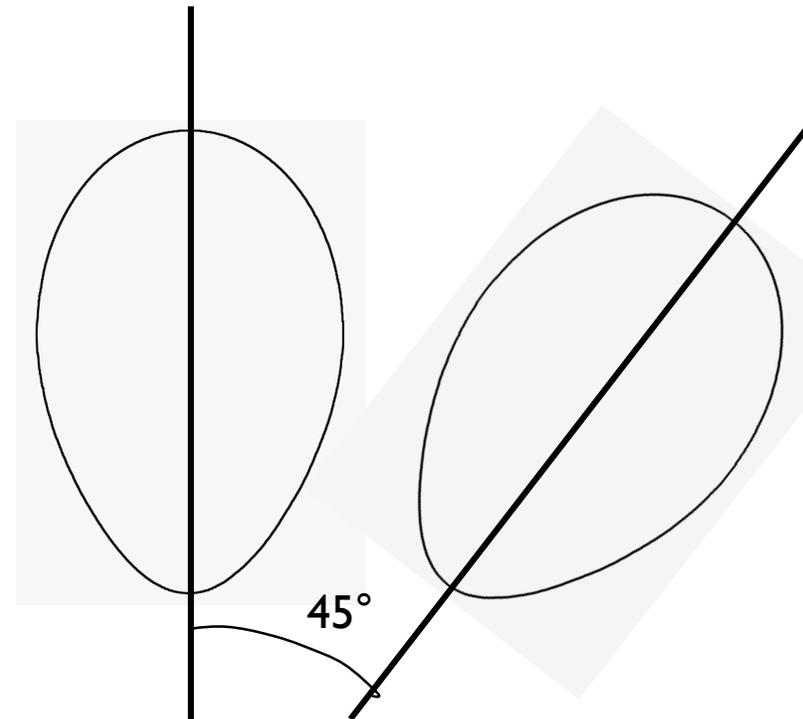
- Over-ventilation is a common problem in water cooled setters
- Bringing cool, dry air into the setter risks:
  - Cold spots near air entry
  - Cold spots due to humidifier operation
- Water cooled setters keep CO<sub>2</sub> below 4000ppm

## Under-ventilation

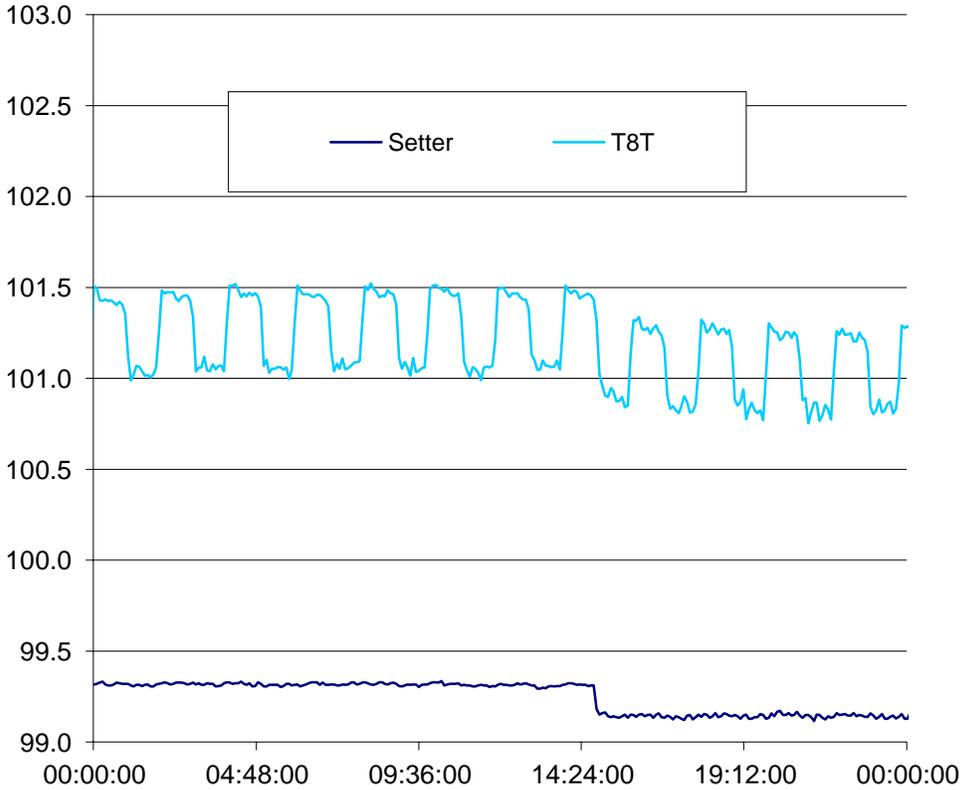
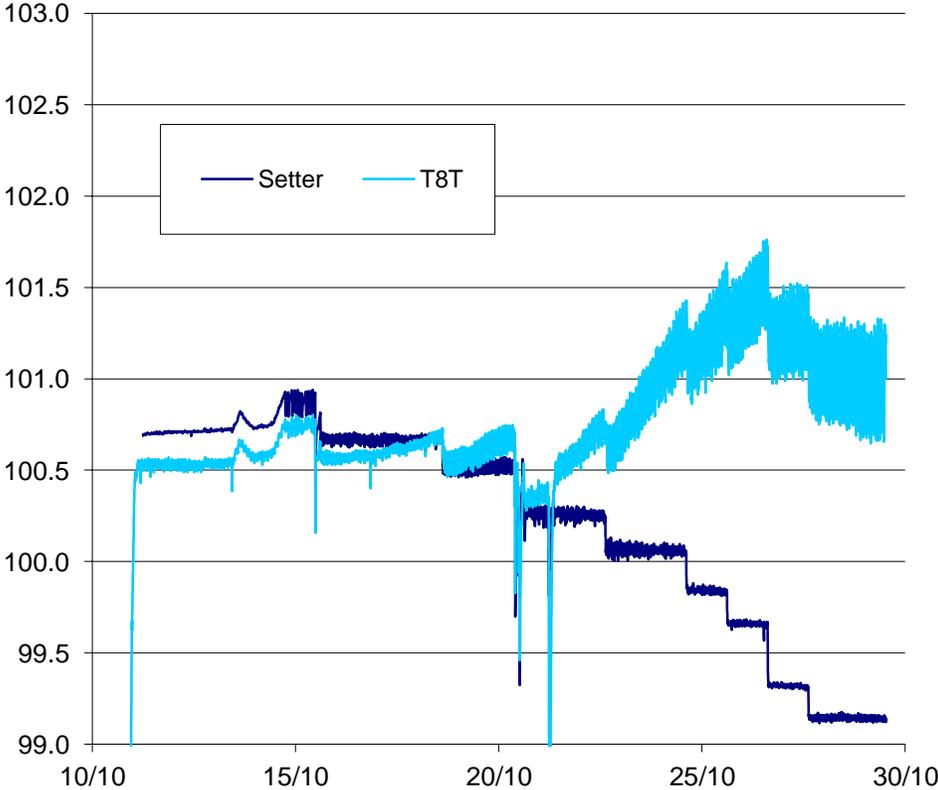
- Under-ventilation a common problem in air cooled machines
- Ensure the correct static air pressure gradient is maintained
- Humidifiers often provide an important contribution to cooling

# EGG TURNING

- Turkey eggs need turning for first 18 days of incubation
- In artificial incubators normally turned by tilting setter trays  $45^{\circ}$  to left for 1 hour and the to the right for the next hour
- Best results when angle of turn is  $38 - 45^{\circ}$  from vertical once per hour
- Insufficient turning results in poor hatchability



# EFFECT OF EGG TURNING ON INCUBATION TEMPERATURE

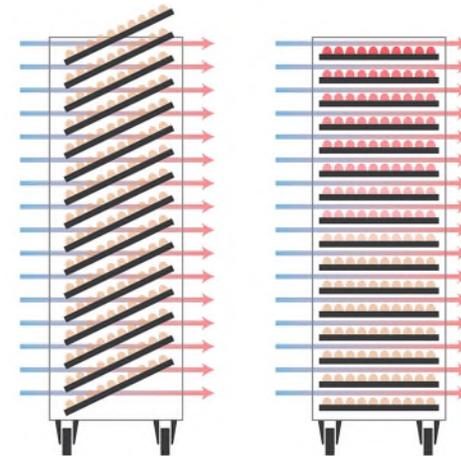


# IMPORTANCE OF AIRFLOW OVER THE EGGS

- Good airflow over the eggs is very important for cooling the eggs in the second half of incubation
- The smaller the space between trays the more restricted the airflow
- When eggs are turned there is less space between trays
- Leveling eggs after 18d can be beneficial in some machine designs

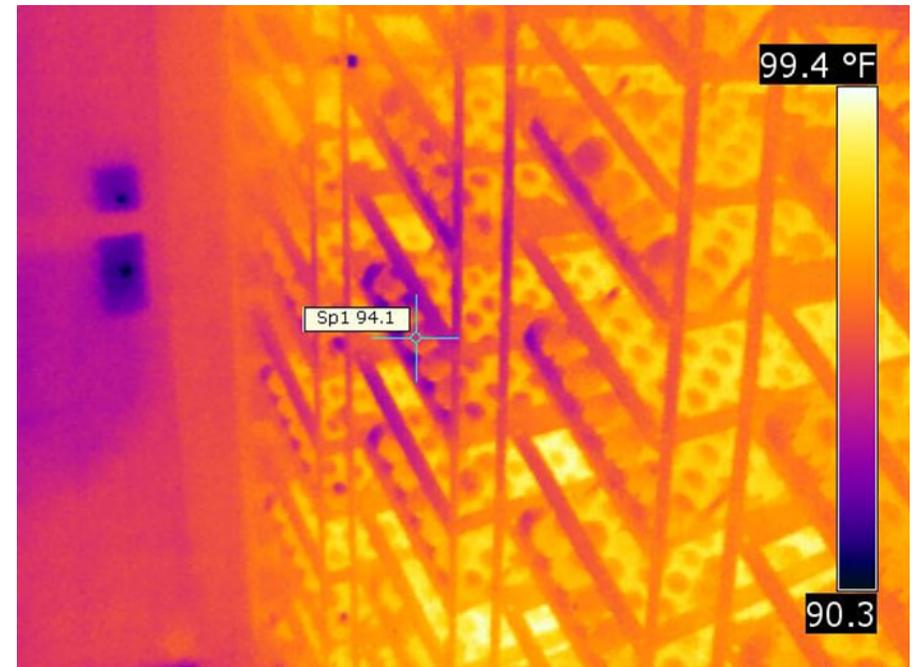


From Petersime.com



# TOOLS REQUIRED

- Need to be able monitor the incubation environment
- Modern incubators have sensors to measure air temperature, humidity, CO<sub>2</sub> and frequency of egg turning
- For temperature and humidity need to measure eggshell temperature and egg water loss.



# CHECKING EGGSHELL TEMPERATURE

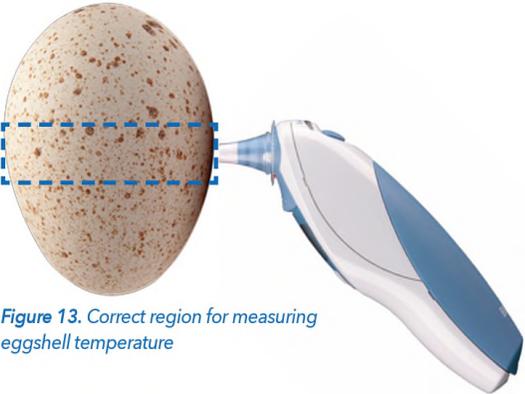
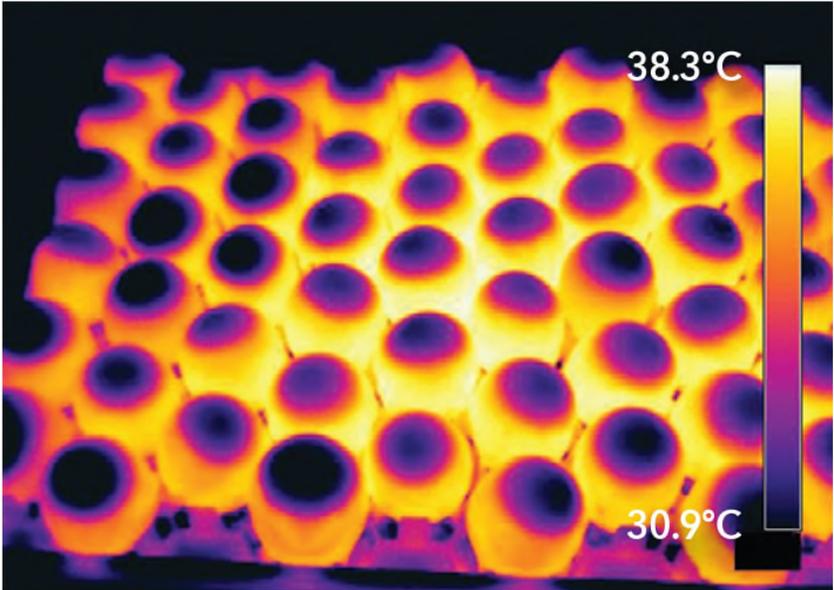
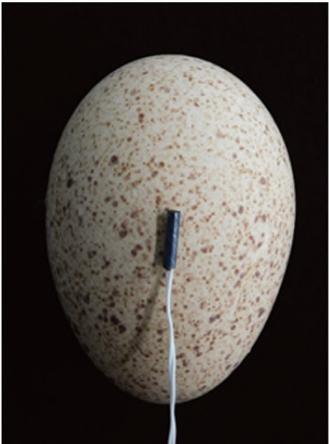


Figure 13. Correct region for measuring eggshell temperature



# MEASURING EGG WATER LOSS



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## Measuring Egg Water Loss

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### Definition

Egg water loss is the amount of water that is lost by diffusion through pores in the eggshell during the incubation process. The rate of egg water loss is controlled by the humidity of the incubator and the conductance (porosity) of the eggshell.

### Objectives/ Discussion

To determine the correct humidity for maximum hatchability and poult quality by measuring the egg water loss. Typically a turkey egg will lose between 11 – 12% of its fresh egg weight through water loss by the 25th day of incubation. Too much water loss and the egg will become desiccated and too little water loss will result in too small an air cell at hatch, which will stop the embryo fully inflating its lungs. Low incubator humidity will increase egg weight (water) loss and high incubator humidity will decrease egg weight loss. The weight loss targets for turkey eggs depend on the age of the breeder flock see Table 1 below:

Table 1. Weight loss targets for turkey eggs

Flock Age (wks)	Egg Weight Loss Target
1 – 3	9 - 10 %
4 – 15	11 – 12 %
> 16	13 – 14 %

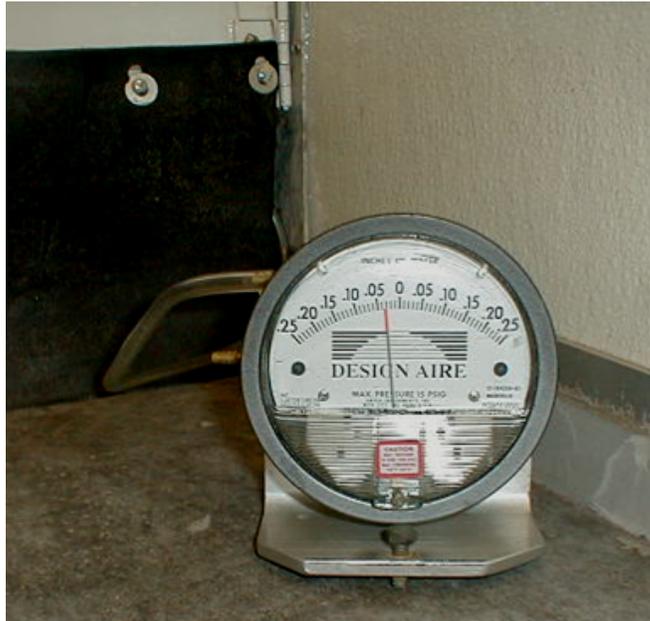
### Procedures

Although it is possible to weigh individual eggs this is very time consuming and in most cases not necessary. It is normally simpler just to weigh whole trays of eggs. It is possible to combine this procedure with a measurement of poult yield

1. You will require a weighing balance that can weigh a whole tray of eggs with a readability of at least 5g



# CHECKING VENTILATION



Static pressure meter

Anemometer



Carbon dioxide meter

# CHECKING TURNING



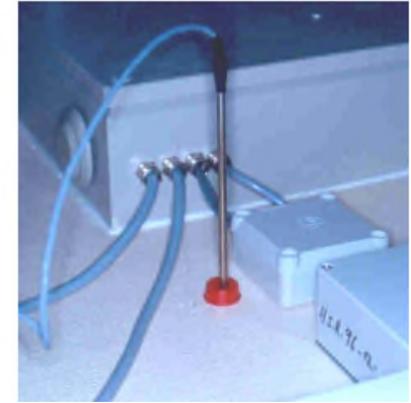
# OBSERVE HOW SETTERS AND HATCHERS OPERATE



- Spend time watching how the machines operate
- How frequently heaters, coolers, humidifiers come on and off?
- How much are the vents opening?
- Is the machine cycling? Example:
  - Vents open → humidifiers come on → heaters come on → vents close → humidifiers go off → heaters go off → vents open
- Ideally machines should be doing as little as possible

# CALIBRATION AND MAINTENANCE

- Hatchery calibration and maintenance essential for good performance
- All control sensors should be calibrated regularly
- Planned maintenance
- Cleanliness is next to godliness



# SUMMARY

- Eggshell temperature: 37.8–38.1°C (100 – 100.6°F)
- Setter humidity to achieve 11 – 12% egg weight loss @ 25d of incubation
- Ventilation in air cooled machines to achieve eggshell temperature target
- Ventilation in water cooled machines to achieve <4000ppm carbon dioxide
- Turn eggs hourly at least 38 - 45° from vertical for first 18d
- Be aware of how humidity, ventilation and turning impact shell temperature
- Routinely monitor, calibrate and maintain

A large colony of King penguins is shown on a snowy beach. The penguins are densely packed, extending from the foreground into the distance. They have dark feathers with a characteristic yellow patch on their necks. The background shows a vast expanse of snow and a clear sky. The overall scene is a naturalistic depiction of a penguin colony.

THANK YOU AND ANY QUESTIONS