EmTech

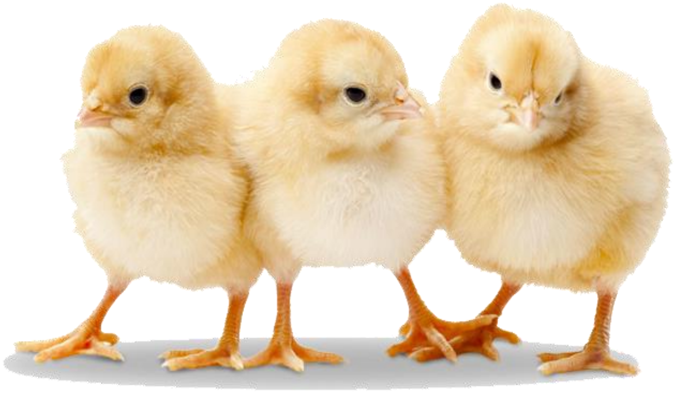
HATCHERY
SYSTEMS Ltd.

Incubation Technology and Development

Who are EmTech?

Incubation Technology and Development

- A highly experienced team with 25+ years of previous experience with Buckeye and Chick Master
- Responsible for the early development of today's single-stage systems and many of the control, monitoring and alarm systems found in today's hatcheries
- Developer of hatchery heat recovery technology and the new breed of stand-alone hatchery ventilation systems
- Developer of many of the new incubator innovations today such as the variable speed and forward/ reverse fan technology
- We are dedicated to our vision provide the best service to the hatchery sector of the poultry industry – Broiler, Layers Breeders and Game producers



Incubation Technology and Development

Who are EmTech?

- We are based in the South West of the UK at Lopen in Somerset – the same location where many of us began our career in the Poultry Industry with Buckeye Incubator Company
- This is our Head Office, Manufacturing, Training and Sales facility
- In House Manufacture for Quality Assurance



Our Vision

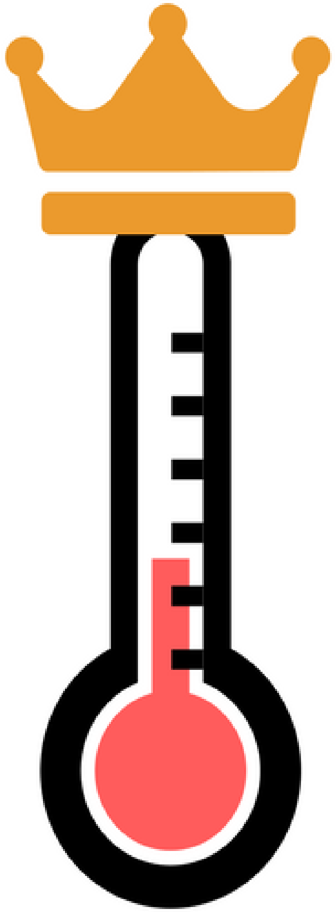
To provide hatcheries with the best performing equipment;

- To create the shortest possible hatch window
- To deliver healthy uniform chicks
- In an energy efficient way
- Using sustainable production methods
- With the highest level of bio security
- To be a leader, not a follower.
- To set new standards in expectations of quality, performance
- … in the simplest way possible, as nature intended.

Incubation Technology and Development

The Importance of Air Velocity for Heat Transfer and Successful Incubation

Temperature is King!



Is it possible create a near perfect environment for all eggs within the incubator?

- Yes it is, if we can thoroughly mix the air, control the parameters and ensure that it is evenly distributed throughout the incubator
- For successful incubation, eggshell temperatures should range between 37.8° C – 38.3°C. (100.04°F – 100.9 °F)
- AIR SPEED
- HEAT EXCHANGE
- COOLING / HEATING CAPACITY

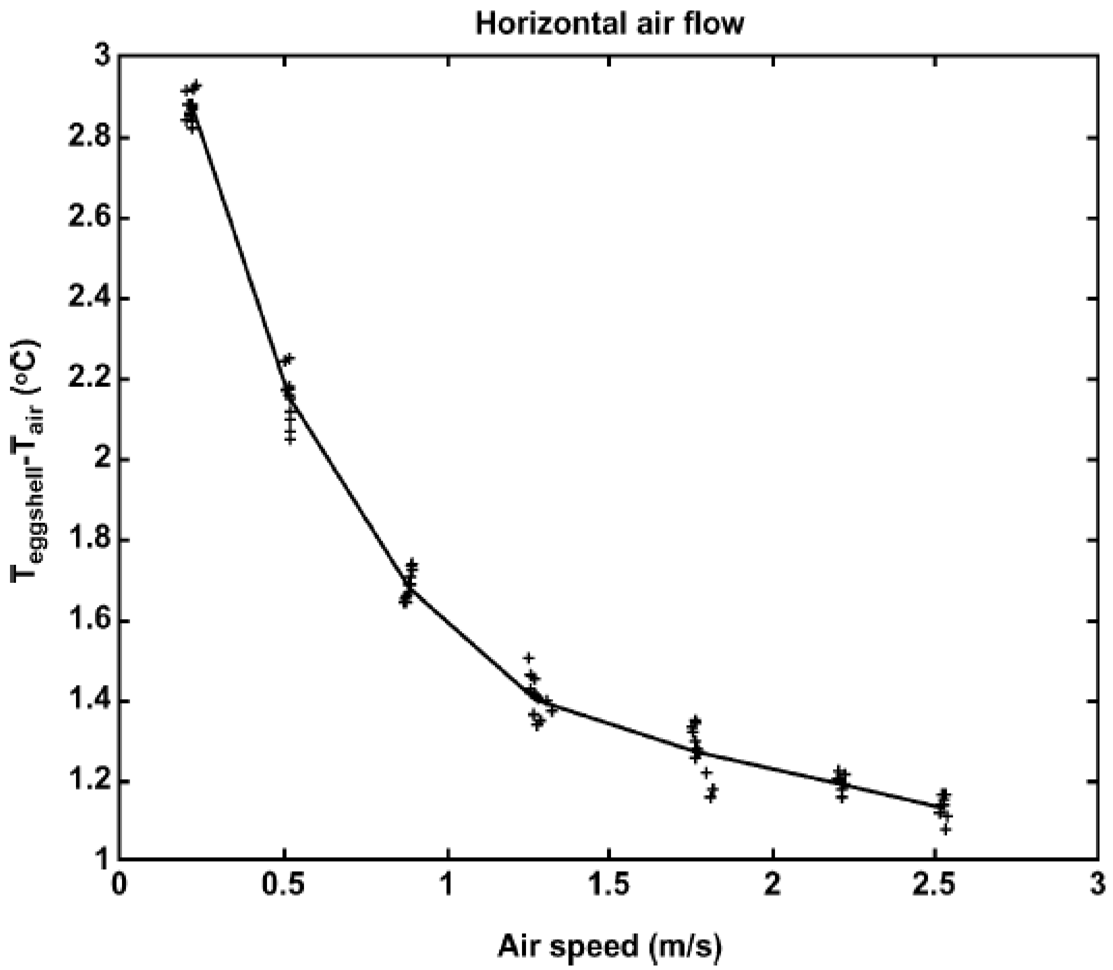


FIGURE 6. The temperature difference between the air and the egg-shell as a function of the air speed of a horizontal airflow at 285.6 mW of sensible heat production.

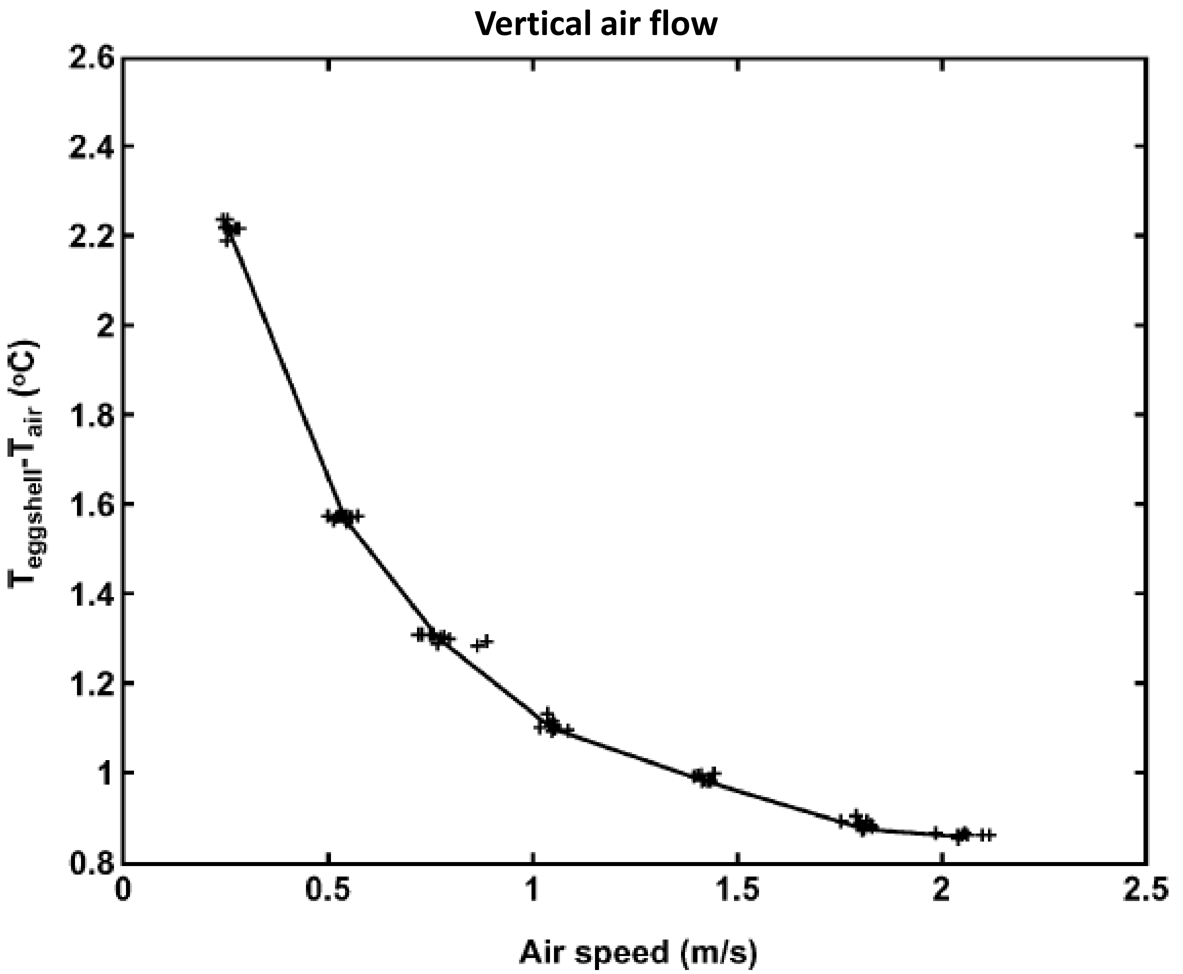


FIGURE 8. The temperature difference between the air and the egg-shell as a function of the air speed of a vertical airflow at 288.7 mW of sensible heat production.

A. Van Brecht,* H. Hens,† J.-L. Lemaire,* J. M. Aerts,* P. Degraeve,‡ and D. Berckmans*,[1]

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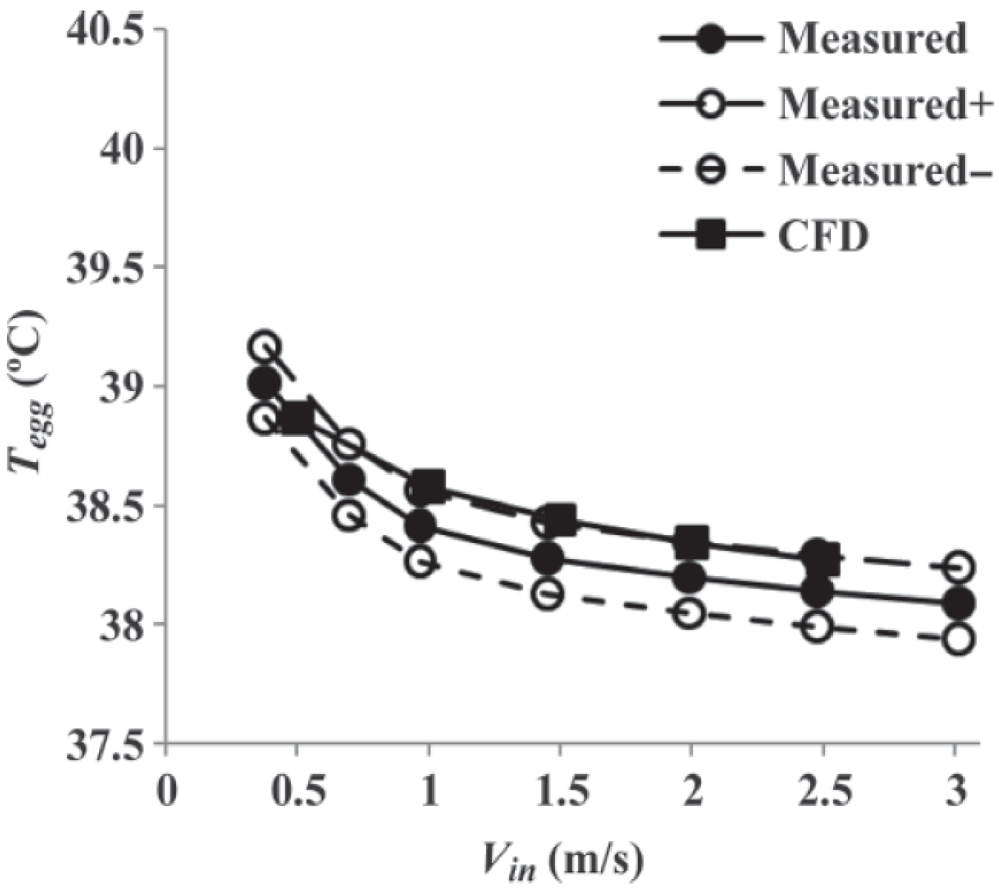

Figure 9. The average eggshell temperature, T_{egg}, versus inlet air velocity, V_{in}, for horizontal flow with an ambient temperature (T_{amb}) = 37.70°C and a heat production of the egg (Q_{egg}) = 148.5 mW, as simulated with computational fluid dynamics (CFD) and measured by Van Brecht (2004). Measured = average value; Measured± = average value ± accuracy of the thermocouple ± SD of measured values.

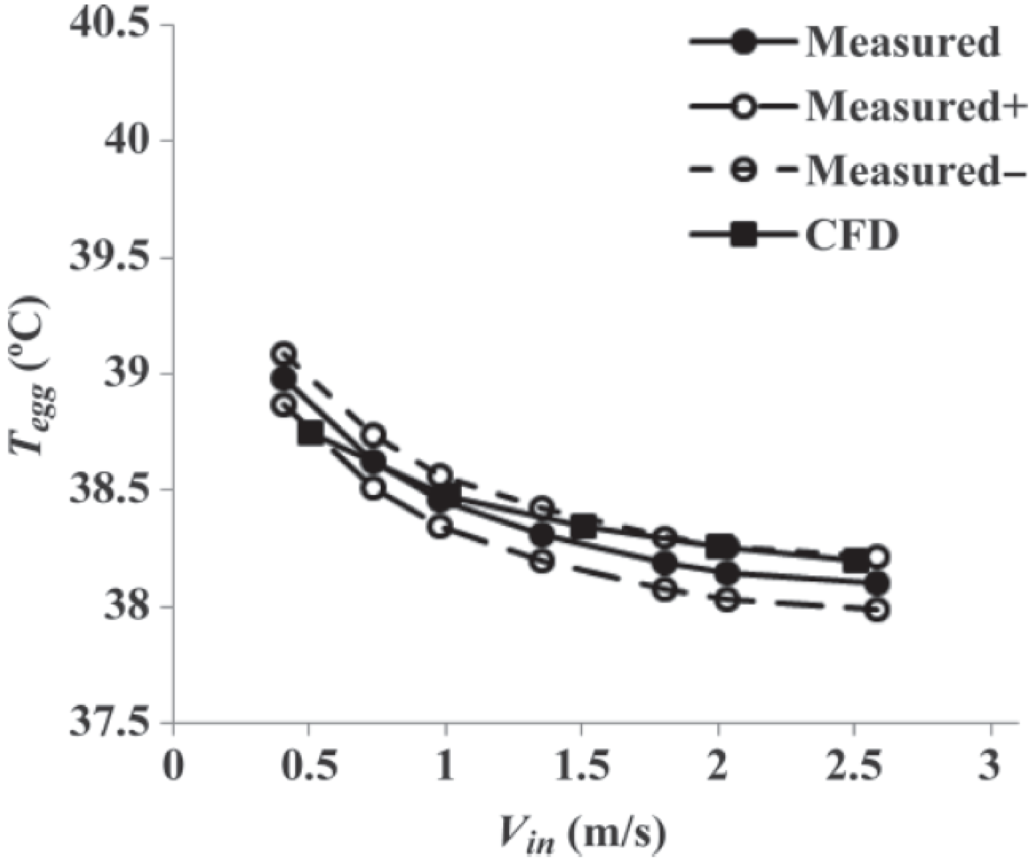

Figure 10. The average eggshell temperature, T_{egg}, versus inlet air velocity, V_{in}, for vertical flow with an ambient temperature (T_{amb}) = 37.80°C and a heat production of the egg (Q_{egg}) = 150.7 mW, as simulated with computational fluid dynamics (CFD) and measured by Van Brecht (2004). Measured = average value; Measured± = average value ± accuracy of the thermocouple ± SD of measured values.

S. Eren Özcan, S. Andriessens, and D. Berckmans[1]

Division of Measure, Model and Manage Bioresponses (M3-BIORES), Katholieke Universiteit Leuven, Kasteelpark Arenberg 30, B-3001 Leuven, Belgium

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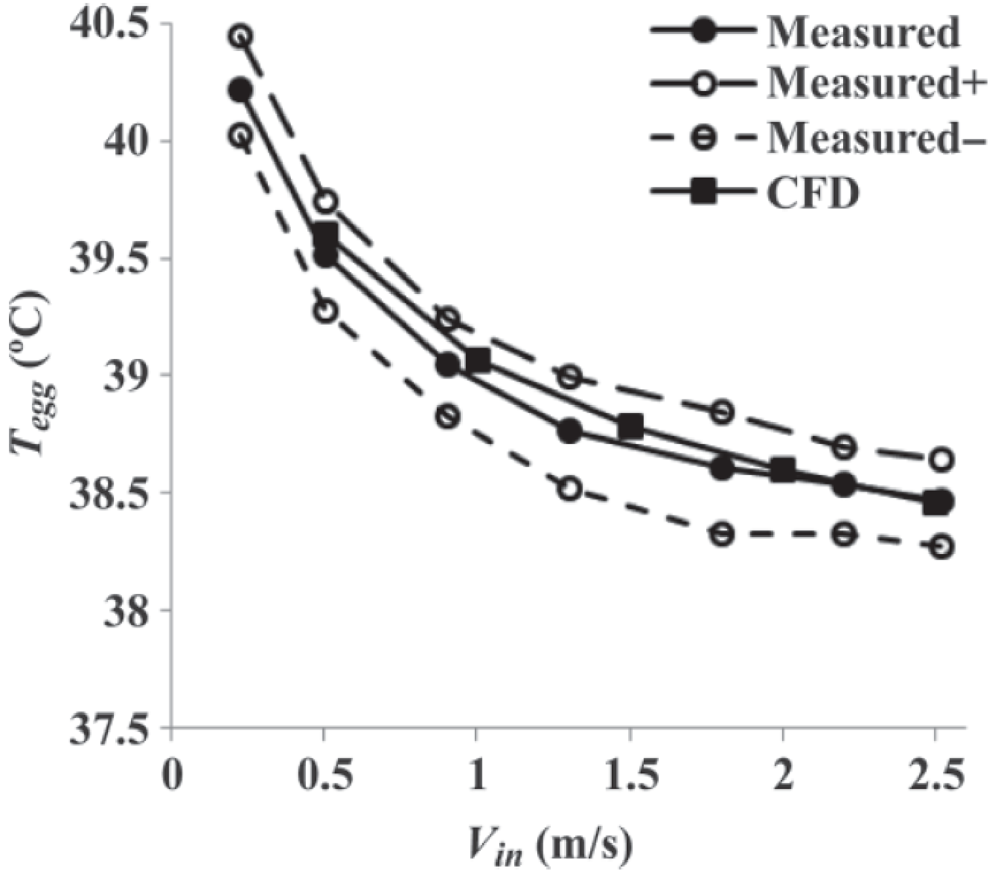

Figure 3. The average eggshell temperature, T_{egg}, versus inlet air velocity, V_{in}, for horizontal flow with an ambient temperature (T_{amb}) = 37.36°C and a heat production of the egg (Q_{egg}) = 285.6 mW, as simulated with computational fluid dynamics (CFD) and measured by Van Brecht et al. (2005). Measured = average value; Measured± = average value ± accuracy of the thermocouple ± SD of measured values.

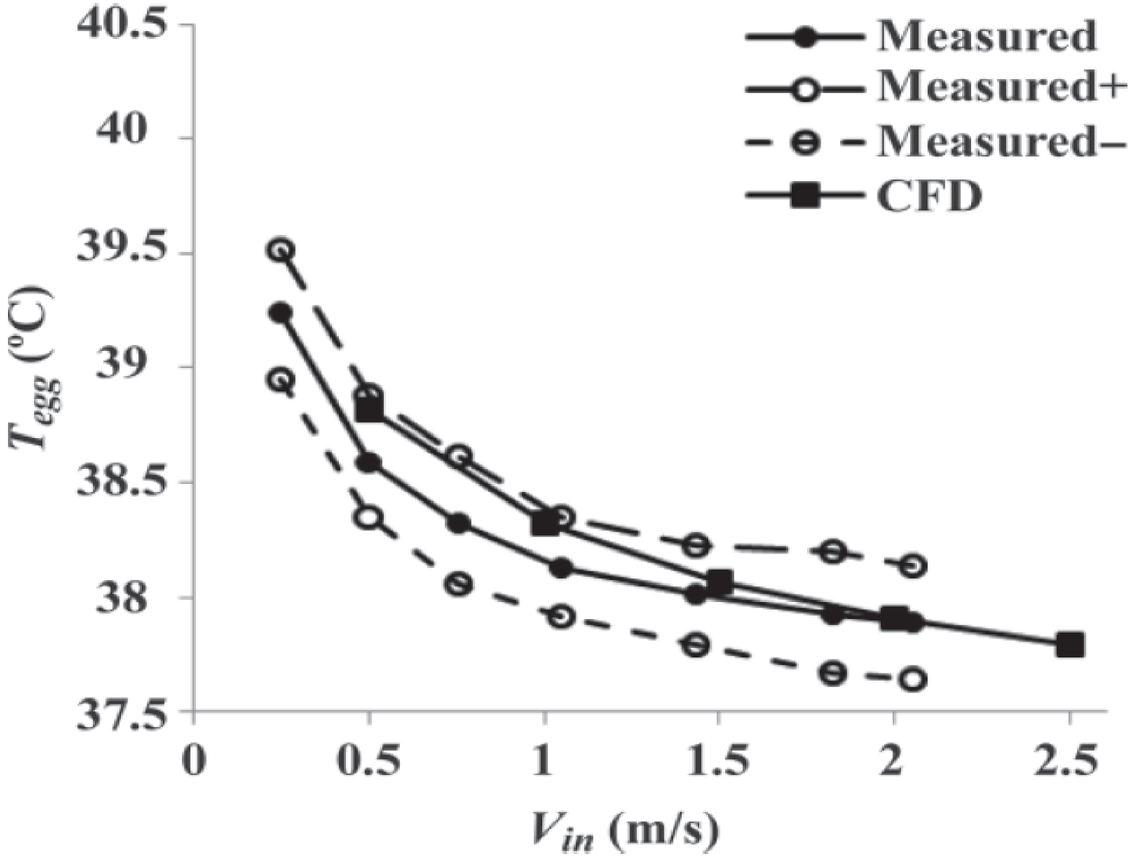

Figure 4. The average eggshell temperature, T_{egg}, versus inlet air velocity, V_{in}, for vertical flow with an ambient temperature (T_{amb}) = 37.06°C and a heat production of the egg (Q_{egg}) = 288.7 mW, as simulated with computational fluid dynamics (CFD) and measured by Van Brecht et al. (2005). Measured = average value; Measured± = average value ± accuracy of the thermocouple ± SD of measured values.

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Incubation Technology and Development

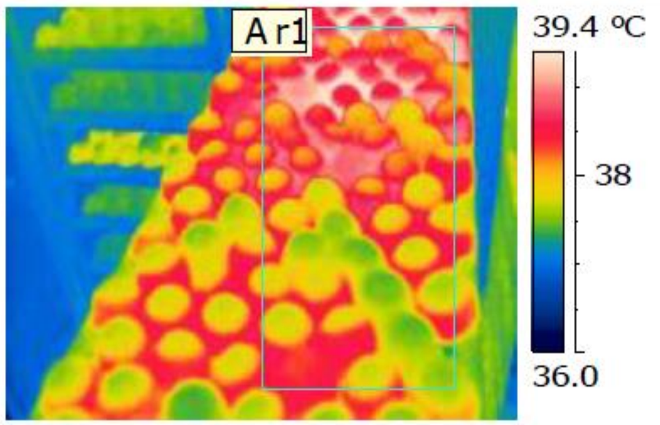
Multistage

NovaTech®
Trolley-based Incubation Systems

The Importance of Good Airflow and Heat Exchange in Multistage Setters

Buckeye Setter Trolley 1 Top, eggs at 18 days of Incubation

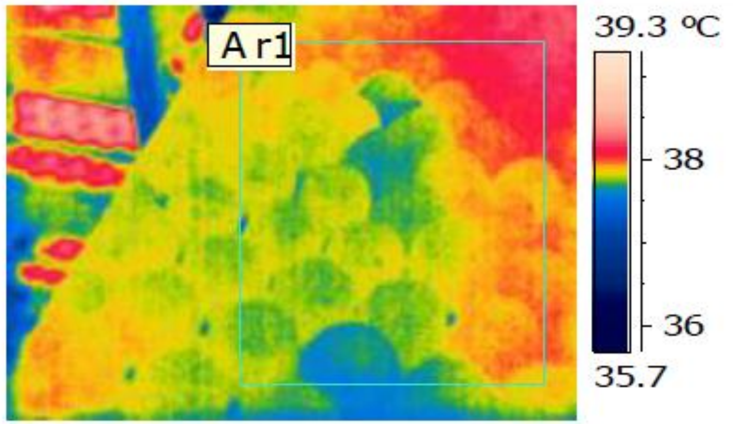
Ar1 Max. Temperature	39.5 °C
Ar1 Min. Temperature	37.0 °C
Ar1 Average Temperature	38.2 °C



Thermal Image of a tray of eggs showing the egg shell temperatures with embyros at 18 days of incubation from a 10 year old Buckeye Setter, from the top of Trolley 1 (first trolley from the front on the left). Note temperatures in excess of 39.4°C, which can be detrimental to chick quality. The lighter yellow and green are likely to be indicative of infertile eggs.

NovaTech Setter Trolley 1 Top, eggs at 18 days of incubation

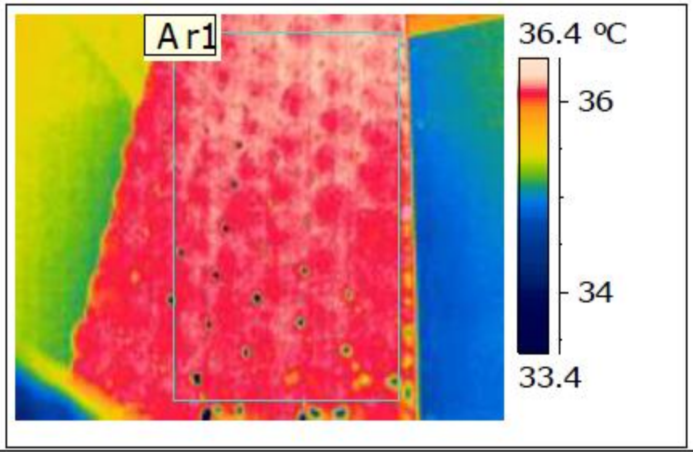
Ar1 Max. Temperature	38.3 °C
Ar1 Min. Temperature	37.3 °C
Ar1 Average Temperature	37.8 °C



Thermal Image of a tray of eggs showing the egg shell temperatures with embyros at 18 days of incubation from the new NovaTech Setter, same trolley and position – Trolley 1 – Top. Note that the temperatures are within the ideal range of between 37.8°C and 38.3°C. The blue colour would be indicative of infertile eggs

Buckeye Setter Trolley 24 Bottom, eggs at 1 day of incubation

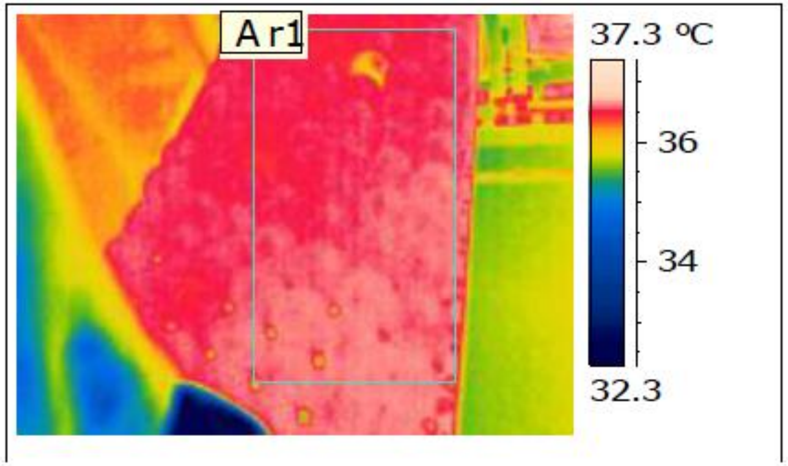
Ar1 Max. Temperature	36.3 °C
Ar1 Min. Temperature	31.4 °C
Ar1 Average Temperature	36.1 °C



Thermal image from a Buckeye Setter, trolley 24 bottom, looking at eggs freshly set and only 1 day into incubation, shows a minimum temperature of only 31.4°C and has an average temperature of 36.1°C with a maximum temperature of only 36.3°

NovaTech Setter Trolley 24 bottom, eggs at 1 day of incubation

Ar1 Max. Temperature	36.7 °C
Ar1 Min. Temperature	35.4 °C
Ar1 Average Temperature	36.5 °C



Thermal image from the NovaTech Setter trolley 24 bottom, note the much higher temperatures, showing a minimum temperature of 35.2°C, an average temperature of 36.5°C and a maximum temperature of 36.7°2

The thermal imaging is extremely conclusive. With the embryos at 18 days of the incubation, the Buckeye Setter shows maximum egg shell temperatures of 39.5°C and 39.3°C. For the NovaTech Setter, measurements from the same trolley and tray positions show maximum egg shell temperatures of 38.3°C and 38.2°C. That's 1.2°C cooler which ultimately produces better chick uniformity and chick quality.

At the opposite end of the scale, with the embryos at only 1 day of incubation, the Buckeye Setter shows average egg shell temperatures of 36.3°C and 36.6°C, while for the NovaTech Setter, measurements from the same trolley and tray positions show average egg shell temperatures of 36.7°C and 37.5°C. That's 1.1°C warmer which ultimately compresses the hatch window for improved chick uniformity and quality. The temperature set-point for both the Buckeye and NovaTech setters was 37.3°

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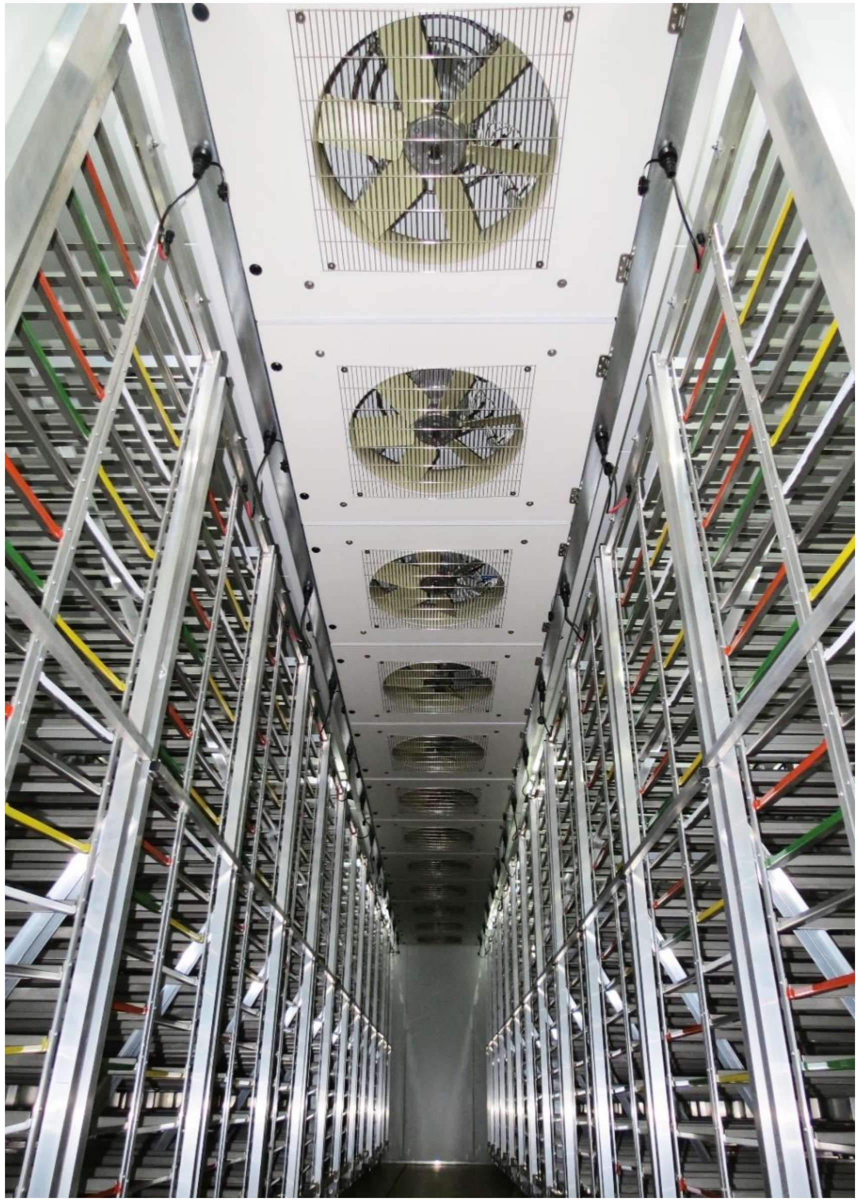
In **multi-stage systems**, highly efficient impeller fans and a redesigned fan-board now provides over 25% greater average air flow through the egg mass resulting in greater heat transfer and a tighter temperature bandwidth.

The improved airflow also creates a greater air pressure at the machine floor giving higher air velocities throughout the lower egg racks.

NT24 NovaTech Setter



EmTech
HATCHERY SYSTEMS Ltd

Incubation Technology and Development

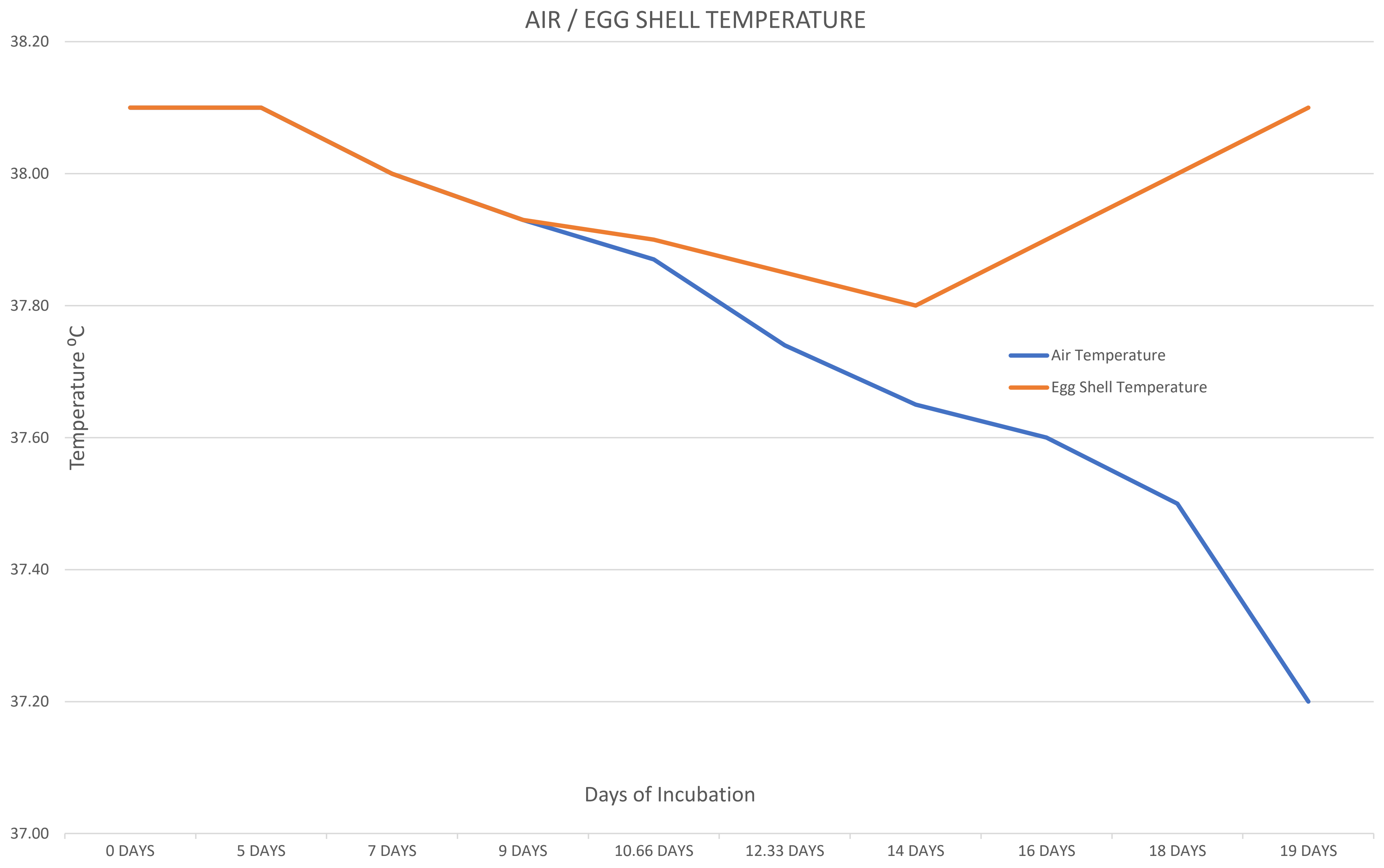
Single Stage

PrimoTech®
Single-Stage Incubation Systems

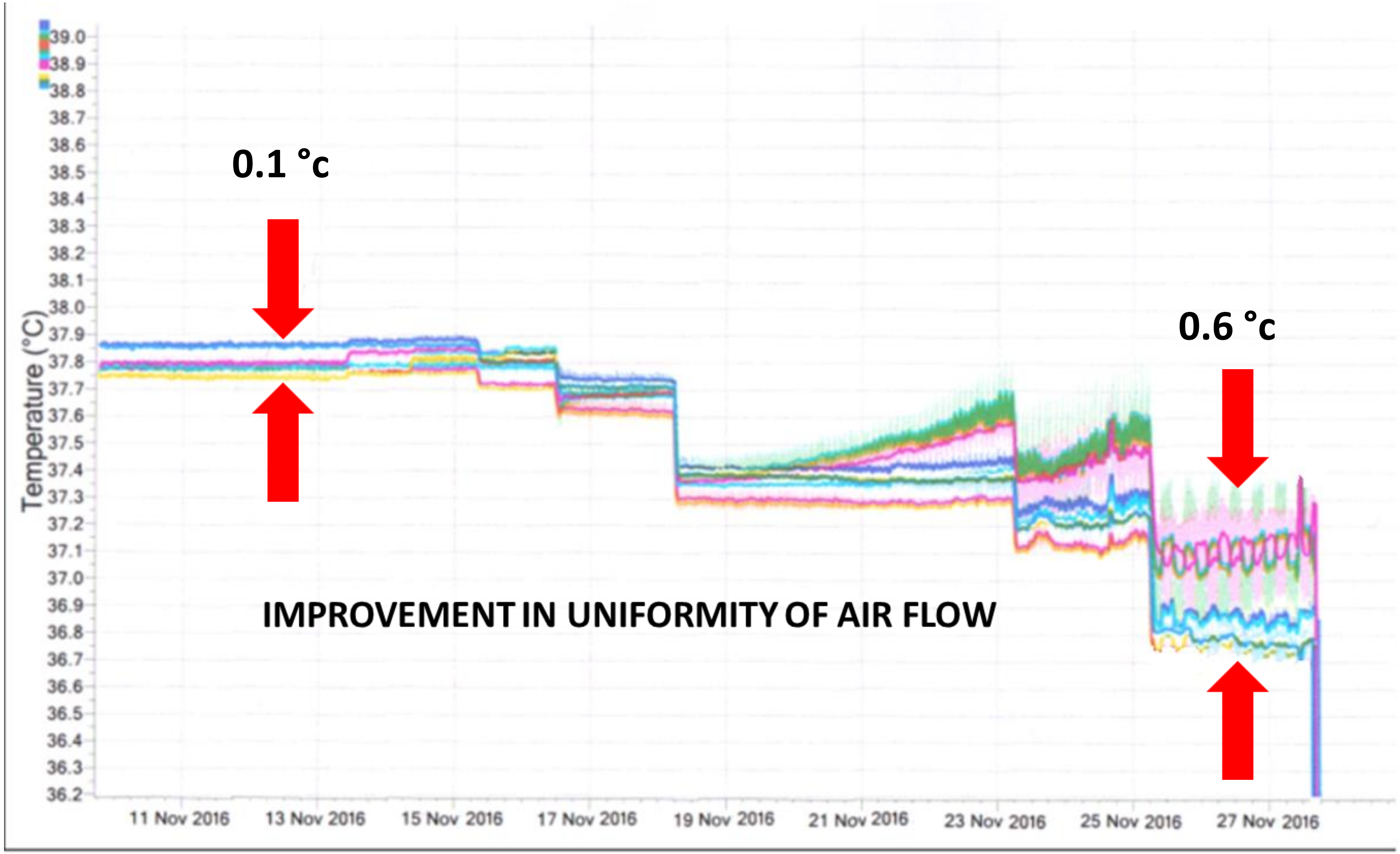
EmTech HATCHERY SYSTEMS Ltd

Incubation Technology and Development

PROGRAMME NAME	Setter - Deg C - 19 Days age				**FINAL STAGE**		11			14/03/2019		**Wieghted Avg Hum**
												Wieghted Avg Temp
STAGE NUMBER	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**(To 18.5 Days)**
Temperature Setpoint	**25.00**	**38.10**	**38.10**	**38.00**	**37.93**	**37.87**	**37.74**	**37.65**	**37.60**	**37.50**	**37.20**	**37.85**
Egg Shell Temperature	**25.00**	**38.10**	**38.10**	**38.00**	**37.93**	**37.90**	**37.85**	**37.80**	**37.90**	**38.00**	**38.10**	
Difference	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**-0.1**	**-0.1**	**-0.3**	**-0.5**	**-0.9**	
Temperature Spread- BandWidth	**0.10**	**0.10**	**0.10**	**0.10**	**0.10**	**0.15**	**0.20**	**0.40**	**0.50**	**0.55**	**0.60**	
Humidity Setpoint	30.0	30.0	80.0	75.0	60.0	45.0	40.0	40.0	35.0	30.0	30.0	**56.0**
Damper mode	MANUAL	MANUAL	Co2	HUMIDITY	HUMIDITY	HUMIDITY	HUMIDITY	Co2	Co2	Co2	Co2	
Minimum damper position %	15	0	0	5	10	15	20	50	50	50	50	
Maximum damper position %	0	50	50	100	100	100	100	100	100	100	100	
Turning mode	AUTO	AUTO	AUTO	AUTO	AUTO	AUTO	AUTO	AUTO	AUTO	AUTO	AUTO	
Turning tilt time (mins)	30	30	30	45	55	55	55	50	50	50	30	
Turning level time (mins)	0	0	0	5	5	5	5	10	10	10	30	
Fan speed control mode	AUTO	AUTO	AUTO	AUTO	AUTO	AUTO	AUTO	AUTO	AUTO	AUTO	AUTO	
Fan auto forward time (mins)	25	25	25	25	25	25	25	25	25	25	25	
Fan auto reverse time (mins)	5	5	5	5	5	5	5	5	5	5	5	
Fan forward/manual speed %	100	100	100	100	100	100	100	100	100	100	100	
Fan reverse speed %	75	75	75	75	75	75	75	75	75	75	75	
Co2 setpoint	1.200	1.200	1.200	1.200	0.500	0.450	0.400	0.350	0.300	0.300	0.350	
DAYS OF INCUBATION		**0 DAYS**	**5 DAYS**	**7 DAYS**	**9 DAYS**	**10.66 DAYS**	**12.33 DAYS**	**14 DAYS**	**16 DAYS**	**18 DAYS**	**19 DAYS**	
Hours for stage run	6	5	120	48	48	40	40	40	48	48	24	
		Egg Mass Heating	Co2% will increase - High Humidity	Begin Humidity Control - Start Weight	Co2 Damper to max 0.55% - Humidity decreasing	Humidity Reduction - co2% start down, temp	Eggs exthermic - co2% down again temp reduced	Increased heat output - co2% down,	Temperature Reduction- heat output radidly increasing	Maximum ventilation - Temp close to hatcher	Drop back to Hatcher Temp	
	Transfering on 20th Day with eggs at 19 days age											
	Warming	Incubation commences with a total period of 456 hours										


AIR / EGG SHELL TEMPERATURE
38.20
38.00
37.80
37.60
37.40
37.20
37.00
Temperature °C
Air Temperature
Egg Shell Temperature
Days of Incubation
0 DAYS
5 DAYS
7 DAYS
9 DAYS
10.66 DAYS
12.33 DAYS
14 DAYS
16 DAYS
18 DAYS
19 DAYS

Temperature Bandwidth



Incubation Technology and Development

What is the optimum?

- ✓ A highly **controlled incubator environment** ***providing the…***
- ✓ Tightest **hatch window,** ***resulting in…***
- ✓ Excellent **quality chicks, less stressed and ready for the farm**

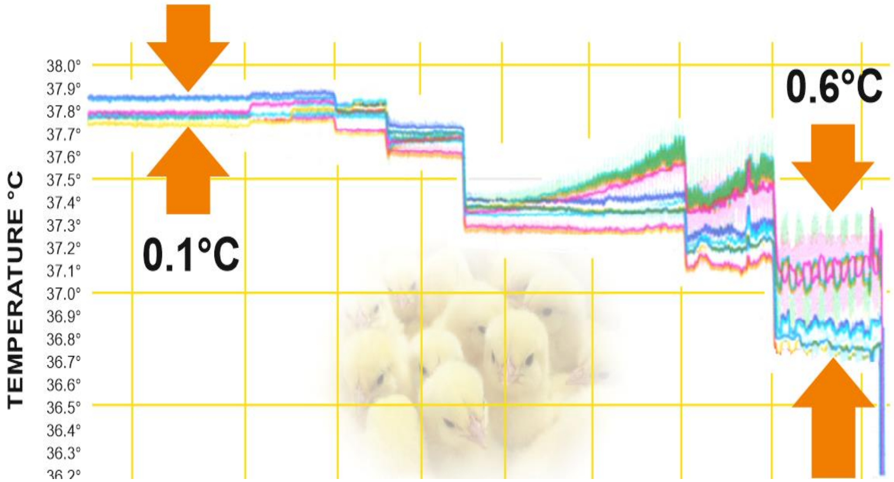
Optimising on Incubator Design

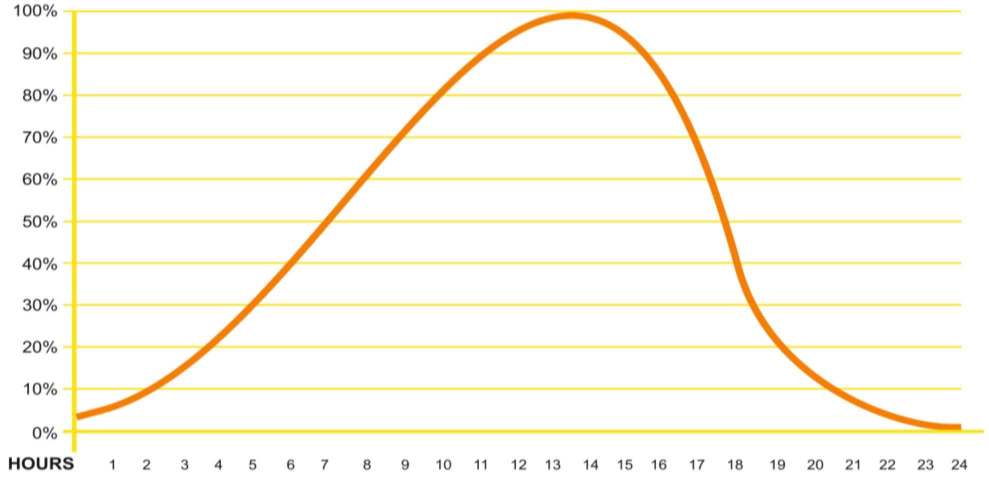
Innovative incubator **cabinet design and construction** for **optimum airflow** and **thermal control**

Perfect **air-flow** with only **one trolley positioned each side** of the **bi-directional fan**

Incubation Technology and Development

Optimum Results

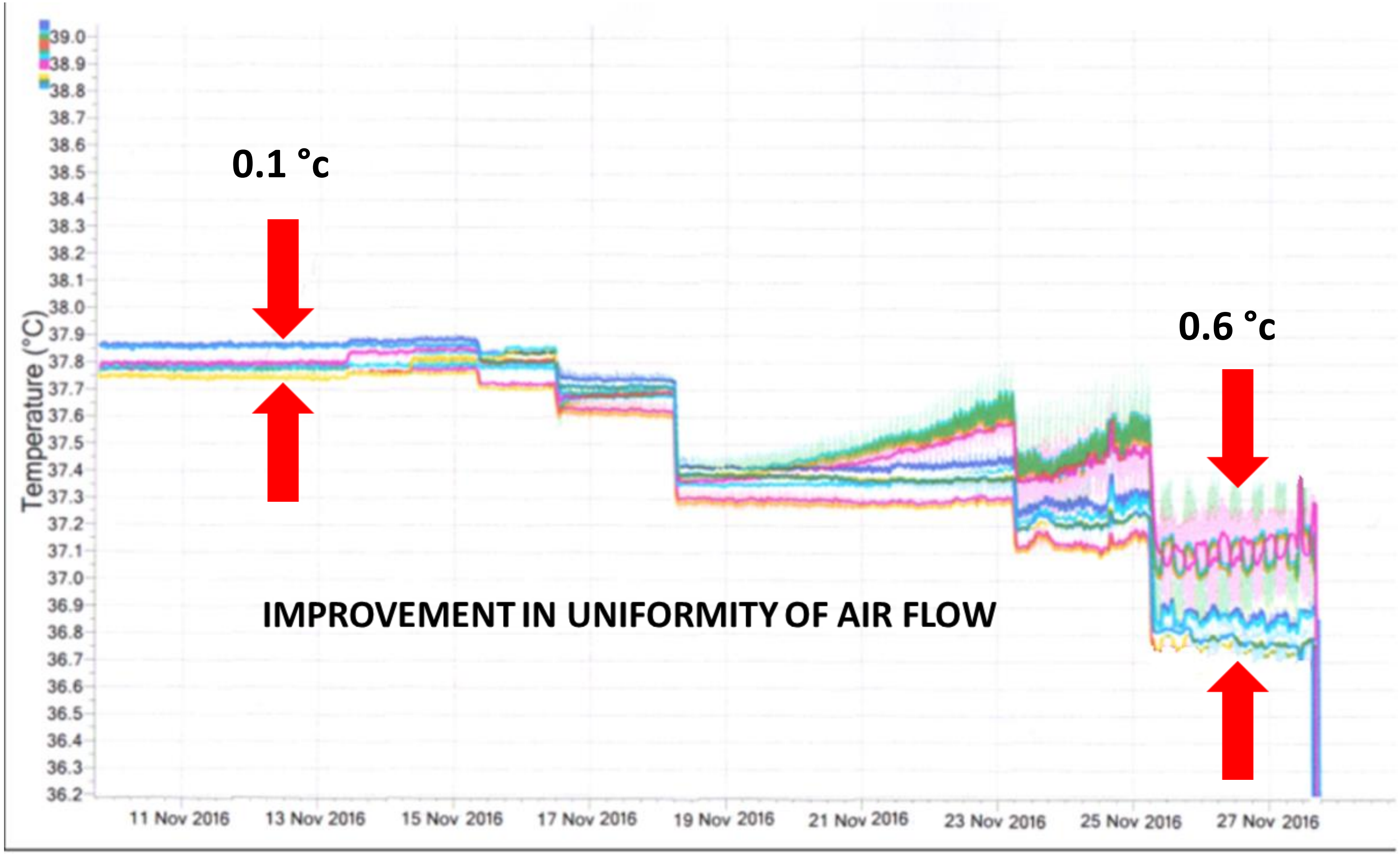




Maximum 0.6˚C bandwidth throughout the **entire egg pack**

The **tightest Hatch Window** for **more and better conditioned, farm ready chicks**

Why is Temperature Bandwidth so important?



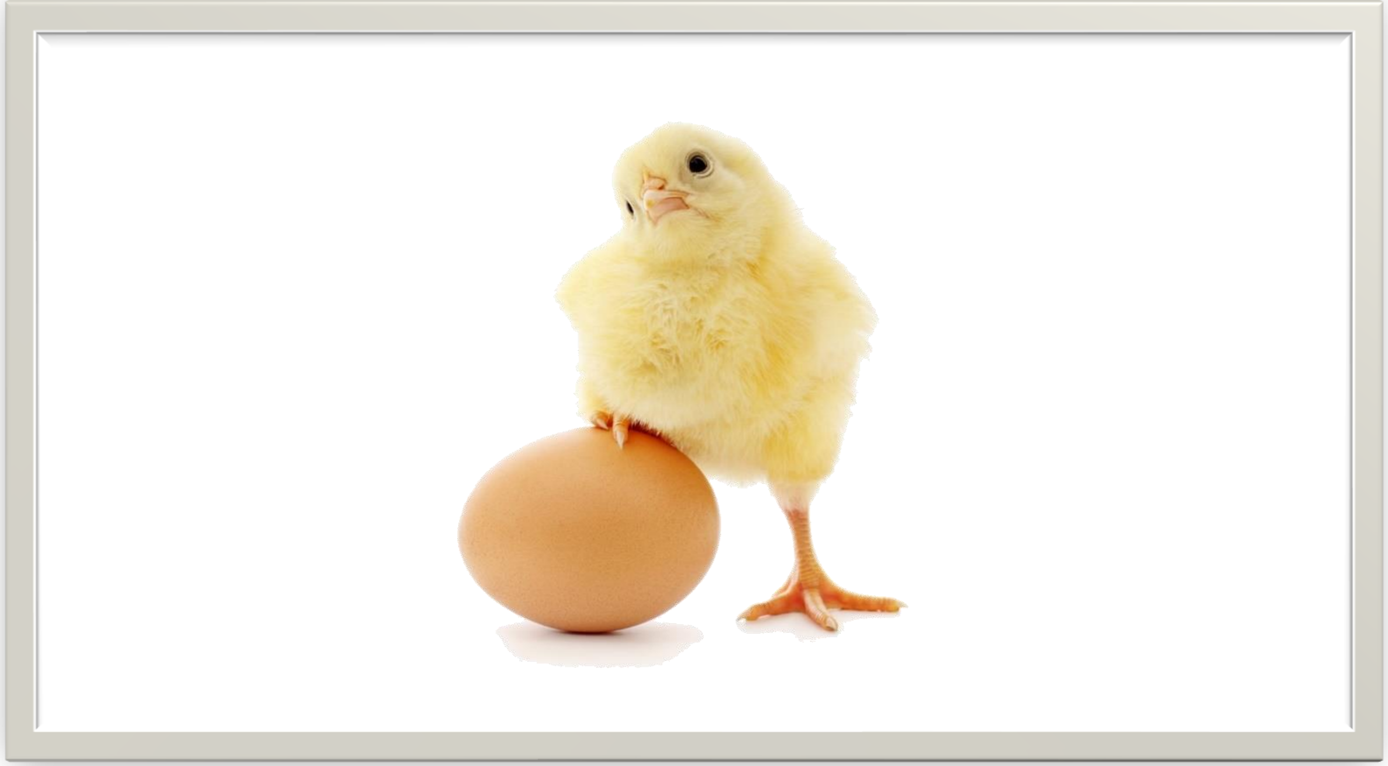
Incubation Technology and Development

Why >0.6°C< ?

By providing a near perfect temperature bandwidth of no greater than 0.6°C across the **entire** egg mass within the incubator, ensures that **all** the developing embryos experience exactly the same environmental conditioning, so that they all hatch within a very short hatch window.

A tight hatch window is the best indicator that you have got it right - ***simple as that***

So, how can we create the perfect environment within the incubator to ensure a tight Hatch Window?

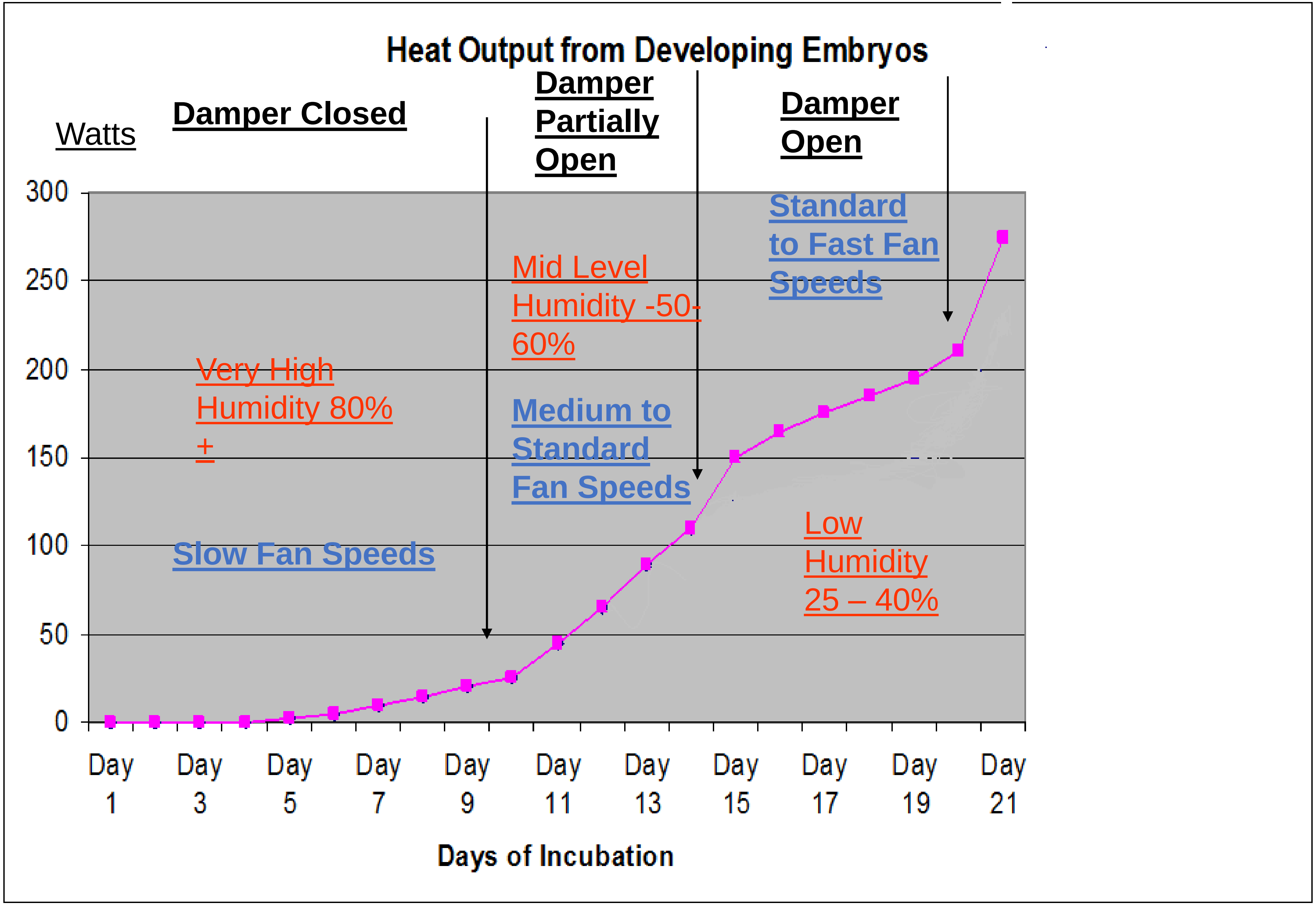


Temperature Bandwidth

What are the main factors that affect the Temperature Bandwidth within an incubator ?

- The stage of incubation
- The Incubator cabinet design
- Insulation and sealing of the cabinet
- Air flow and distribution
- Heating and Cooling
- Trolley orientation
- Trolleys and efficient turning angles
- Sectional egg mass control
- Measuring the temperature of egg mass
- Accuracy of Temperature control system
- Temperature Calibration

Incubation Technology and Development



Airflow, Moisture Content and Temperature Uniformity in a Single Stage Incubation Process

Day 1 – 7

- The thermal conductance of the air is very good due to the high moisture content, providing ideal conditions during this endothermic stage.
- While we are able to maintain this ideal environment, we are less reliant on the air velocity rate over the egg mass
- The uniformity of the temperature bandwidth is extremely good at this stage and can be as good as 0.1°C
- Slower fan speeds

Airflow, Moisture Content and Temperature Uniformity in a Single Stage Incubation Process

Day 8-13

- The developing embryos require greater intakes of air in the management of oxygen and co2
- The egg mass is becoming increasingly exothermic, requiring the need to remove heat. The air has much less moisture content and thus reduced thermal capacity
- Now more reliant on faster air velocity over the egg mass. The Environment is becoming increasingly more challenging
- Faster Air speeds required to keep the temperature distribution as tight as possible
- Altering the regularity of the airflow will help to remove heat
- Typical temperature bandwidth, would be 0.3°C

Airflow, Moisture Content and Temperature Uniformity in a Single Stage Incubation Process

Day 14-19

- Air intake now increasing to maximum damper opening in the run up to transfer and the management of Co2 to no greater than 0.4% The environment is now at its most challenging stage.
- Heat Output rate continues to accelerate and now is over 3 times greater than what it was at day 11
- The high rate of air exchange and the lower moisture content of the working air relates to lower thermal capacity and ability to conduct heat.
- Even Faster Air speeds will be required to keep the temperature distribution as tight as possible
- Typical temperature bandwidth just prior to transfer, 0.6°C at the point of transfer

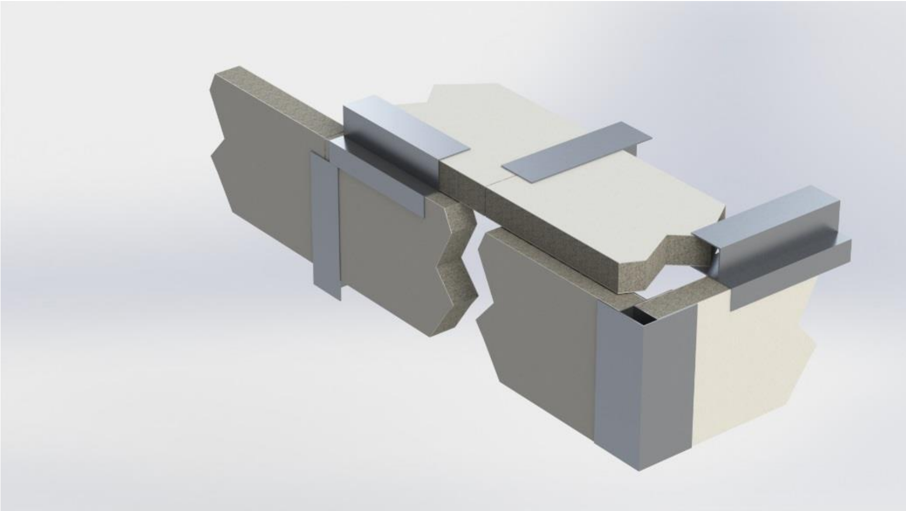
Incubation Technology and Development

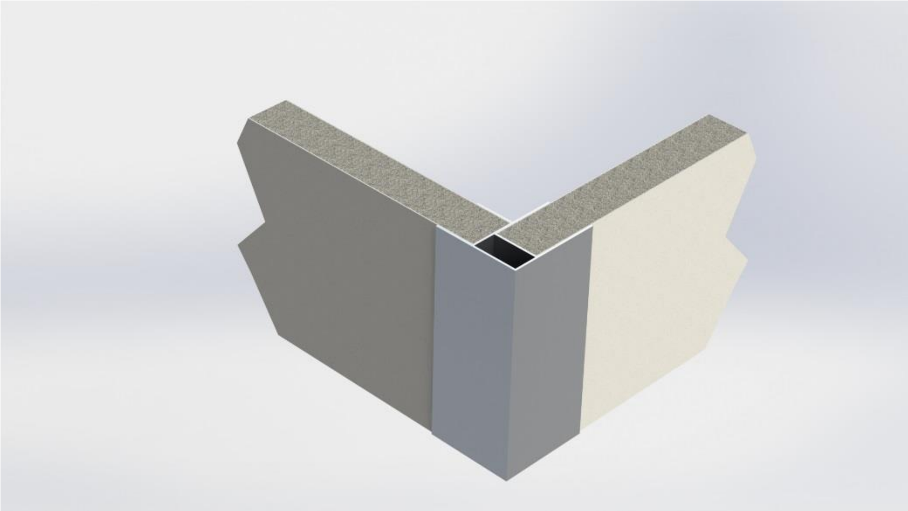
Temperature Bandwidth

The Incubator Cabinet Design and Construction

Aluminium framework?
This can act as a thermal bridge taking heat away from where it is needed and unbalancing the internal environment.

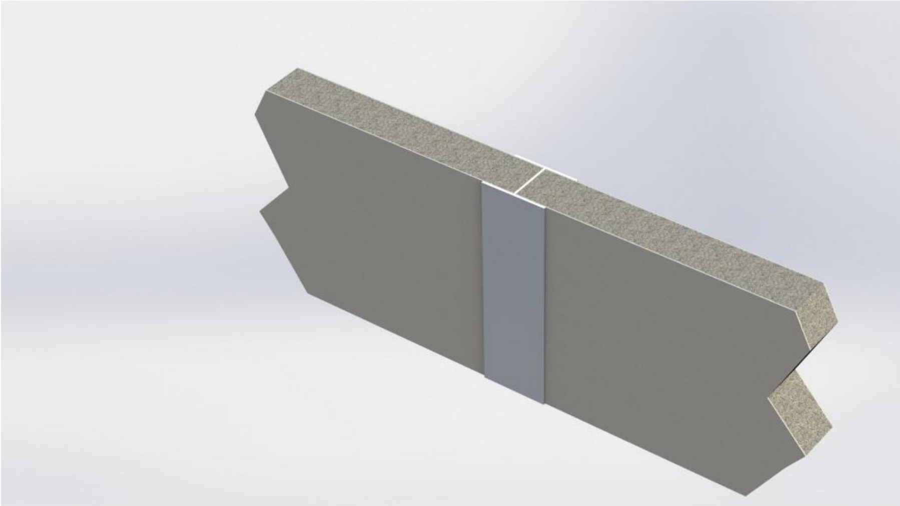
The Incubator Cabinet Design and Construction





Traditional Standard FRP incubator panelling

- Thermal bridging between all panels
- PU & EPS provide poor thermal insulation
- Not fire resistant
- Reduced strength
- Reduced longevity of panels



The Incubator Cabinet Design and Construction

In comparison, standard FRP incubator panel have:

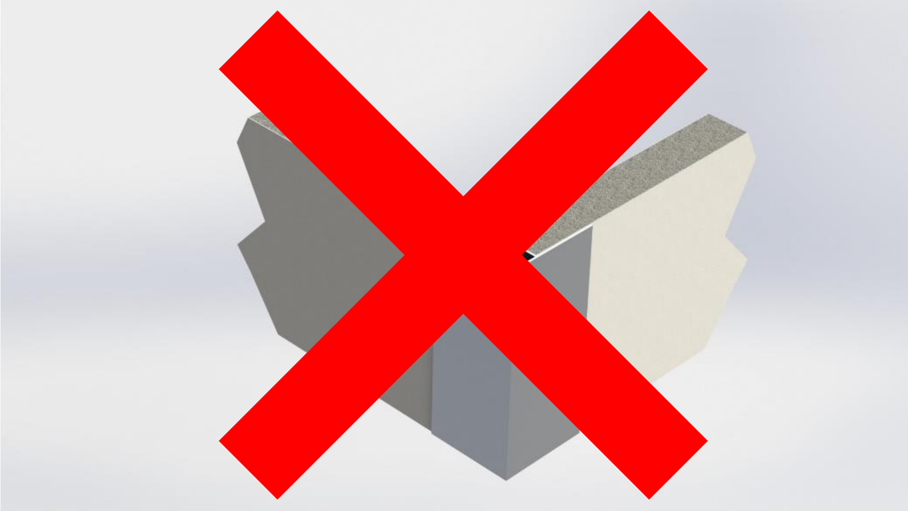
Thermal bridging between ALL panels

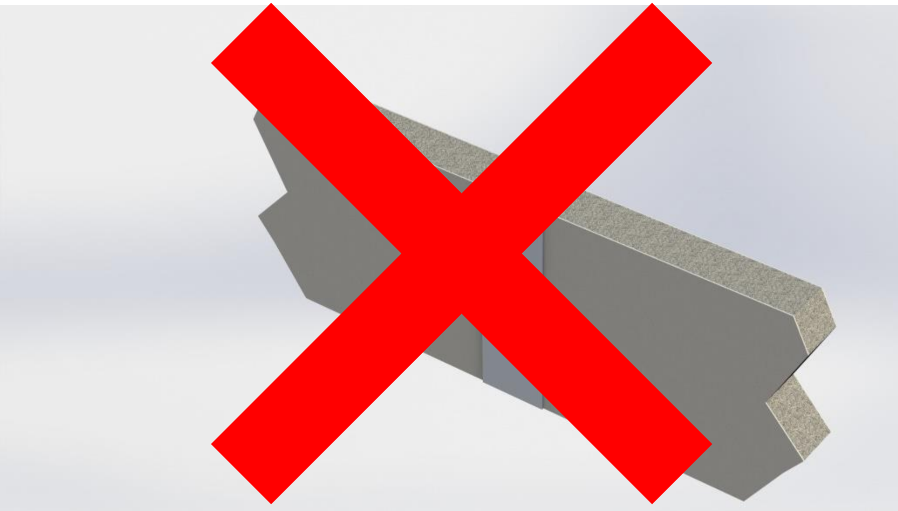
30% less thermal insulation

Virtually NO fire resistance

Reduced strength

Reduced longevity

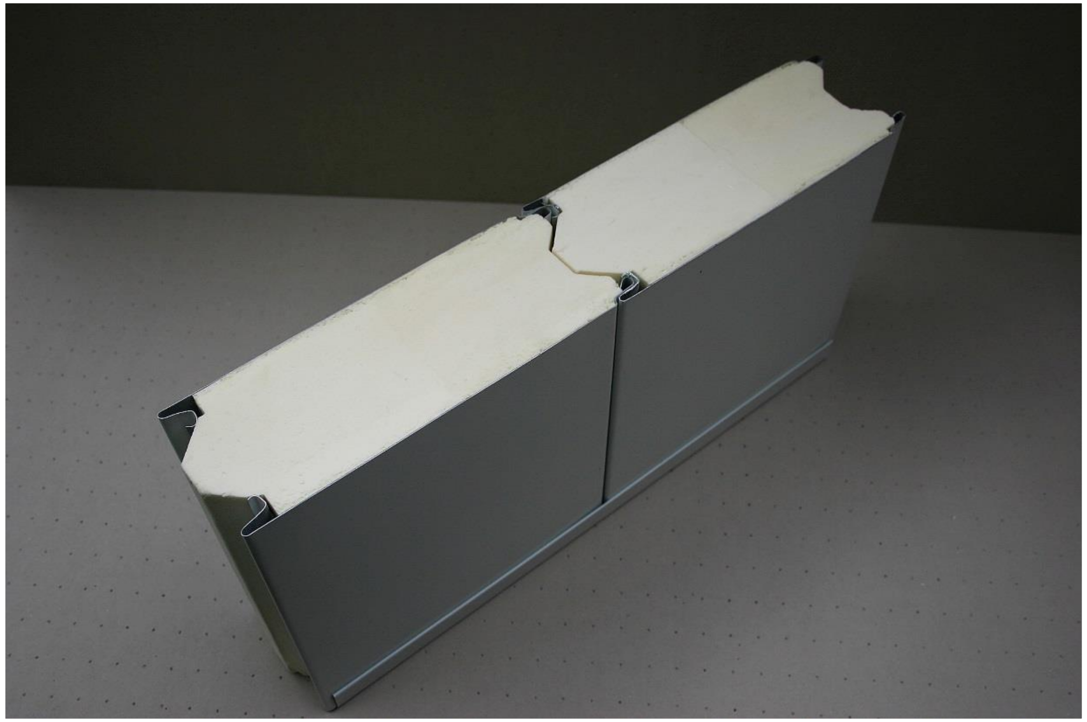




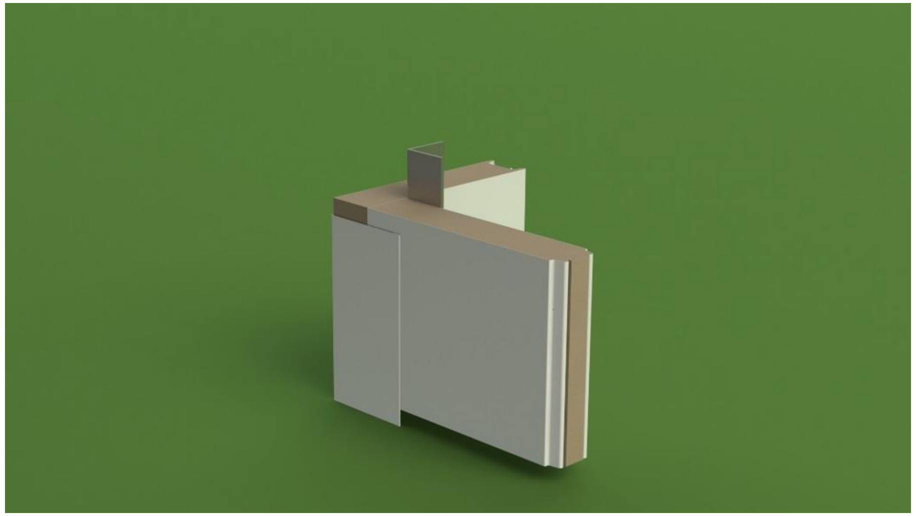
Incubation Technology and Development

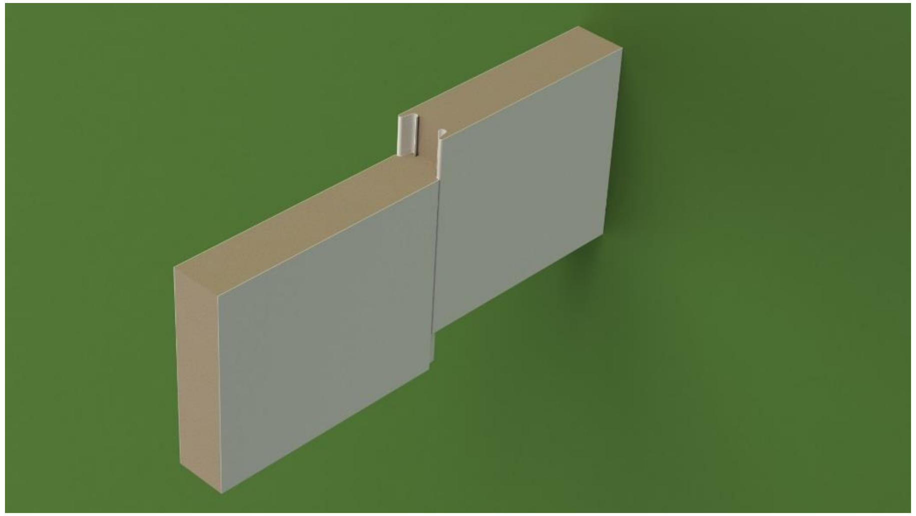
Cabinet Construction:

- Interlocking 51mm ***PIR***; (Polyisocyanurate) Fire retardant panels
- Eliminates thermal losses
- 30% better thermal insulation
- No steel framework that can cause thermal bridging
- Reduced cold air pockets and condensation
- ***Reduced insurance premiums***



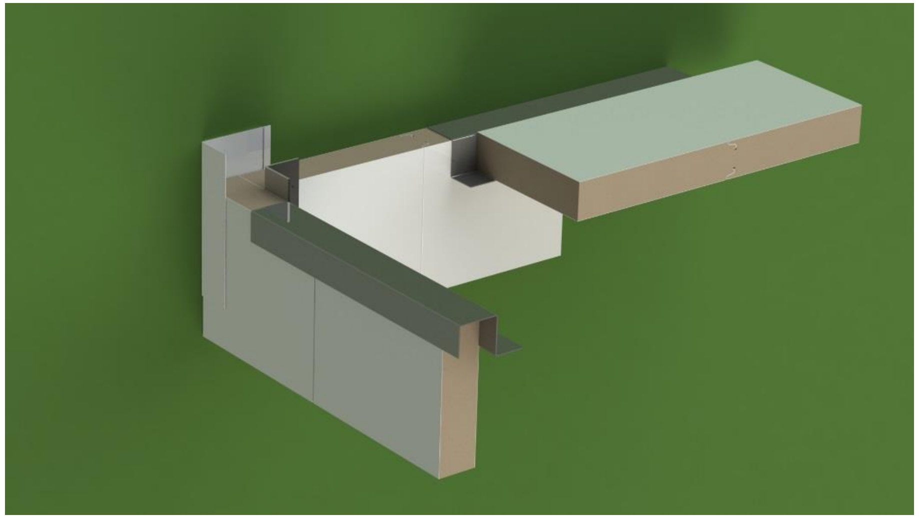
Cabinet Construction:





EmTech cabinet panelling and locking mechanism

- Thermal bridging reduced to a minimum
- Fully interlocking PIR panels
- Fire resistant
- More………



Insulation & Sealing Of the Cabinet

- Fully sealed cabinet and dampers
- Easy clean and removable door seals
- 1.2% CO_2 at 6/7 days
- Promotes high moisture levels within the cabinet

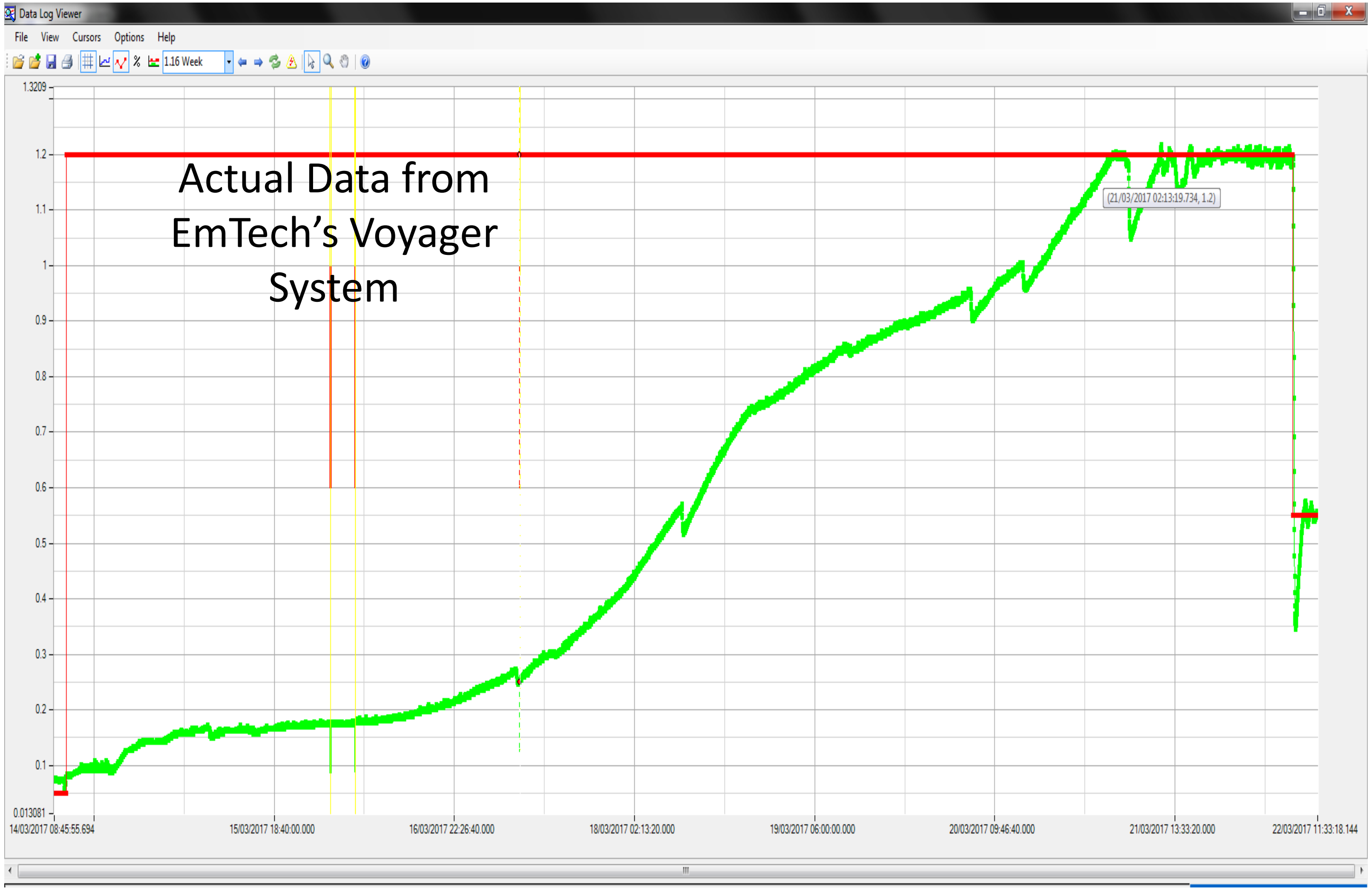
Door Seals

Incubation Technology and Development

- Removable seals
- Easy clean
- Biosecurity

Why Cabinet Design is So Critical

- CO_2 reaches **1.2% by day 6**
- Evidence of an extremely well sealed incubator



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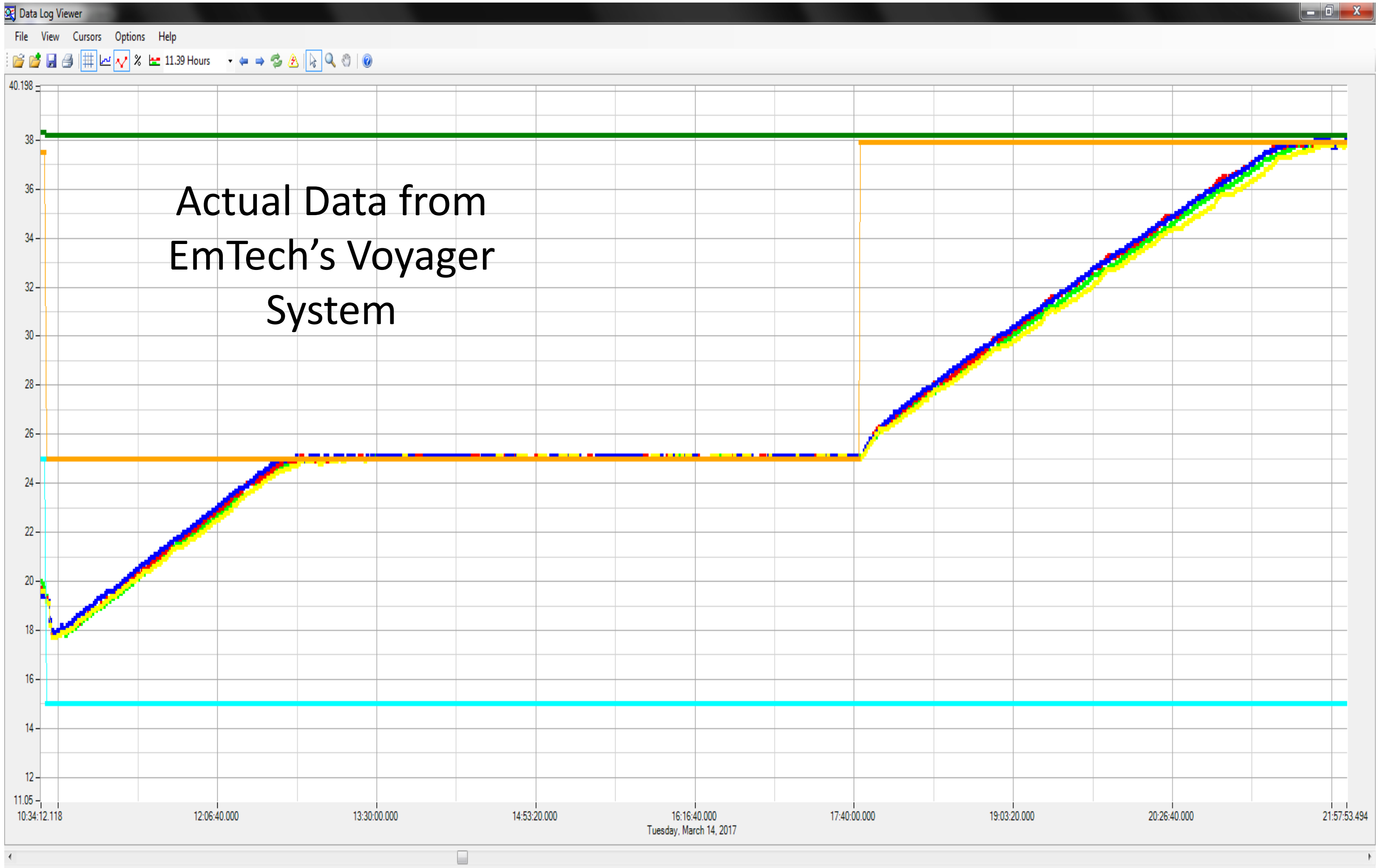
Why Cabinet Design is So Critical

- From 18°C to Incubation Temperature in **6.25 hours!**
- Evidence of an extremely well sealed incubator



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Why Cabinet Design is So Critical

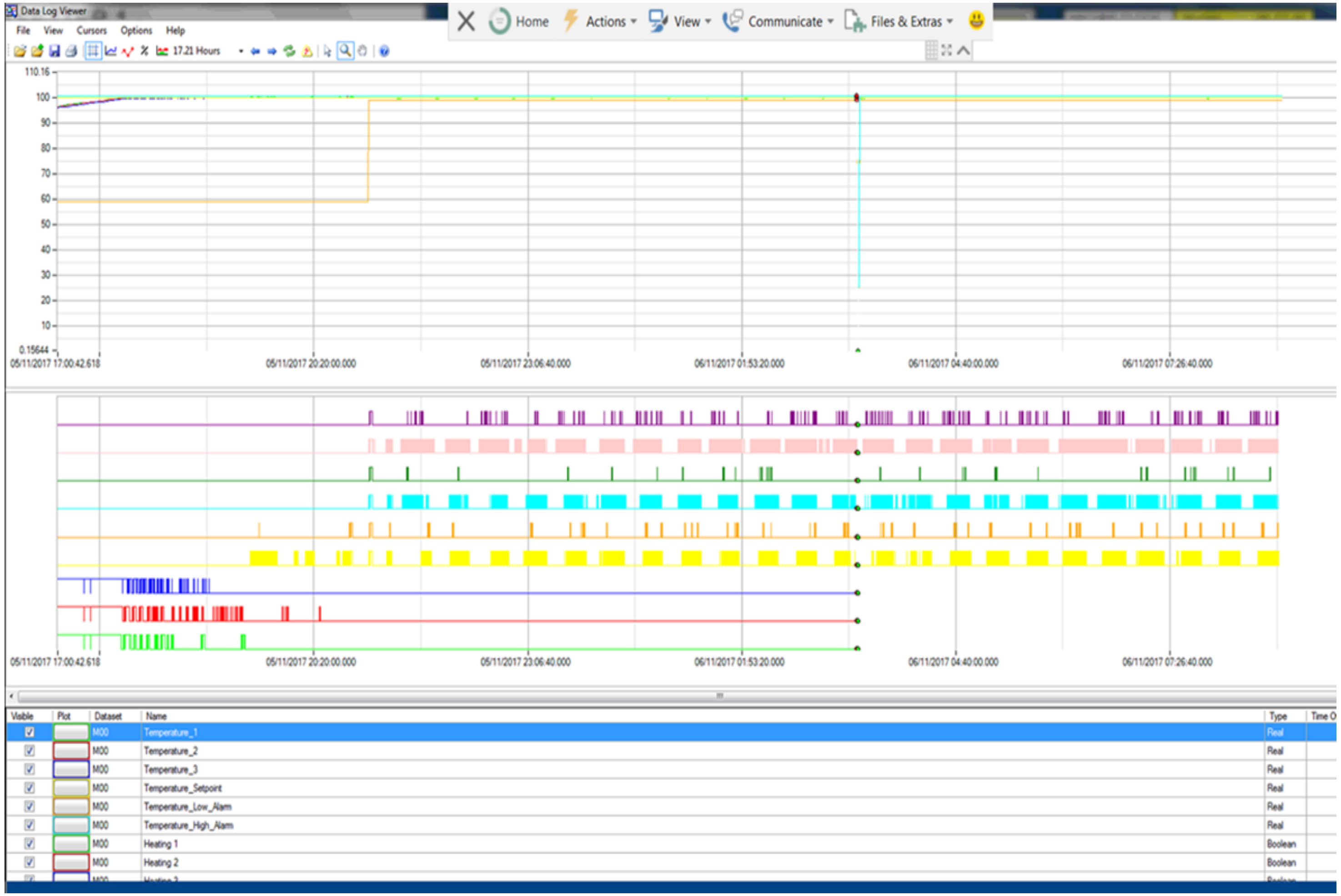
But there are still 17 days left?

Surely, there's more heating to come?

Actually, there isn't.

As you can see, this graph shows that once the setter had reached temperature, within 3 hours all heating had stopped.

This means, that the EmTech PrimoTech single stage setter only used 1.21 Kwh/1000 eggs of heating!



Data from Avi-Bio Hatchery, Poland

The Importance of Air Flow

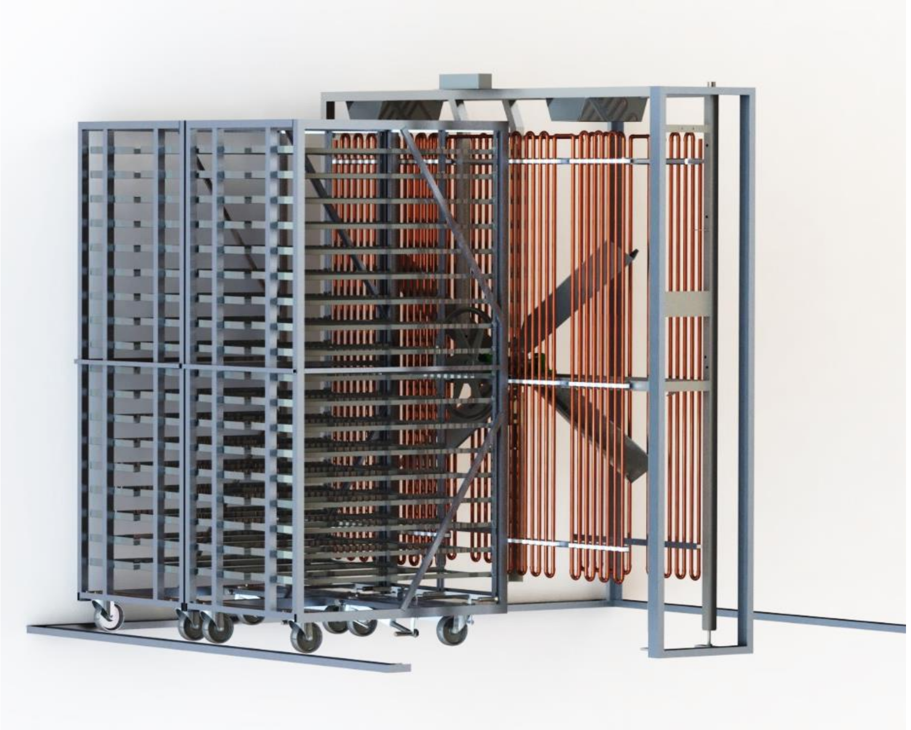
Incubation Technology and Development

Air Flow and Distribution

Effective air distribution

- Floor to ceiling fan support frame assembly
- Bi-directional 6 blade paddle with a unique tapered design which significantly improves the ‘air-off’ pressure and subsequently air velocities through the egg mass.
- The ability to change direction and vary the speed of the fan is significant to ensure that air reaches every corner of the egg pack.

Trolley Orientation



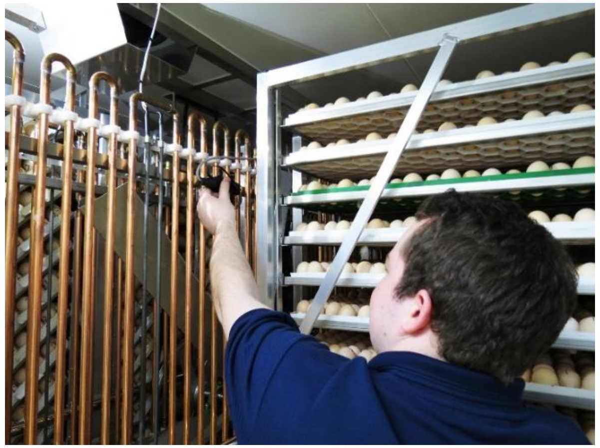
Trolleys orientated to allow efficient airflow through eggs

Incubation Technology and Development

Turning

Trolleys and Efficient Turning Angles

- Fully welded aluminium frame, easy to move.
- Stainless steel turning components with “Igus” non metallic bearings
- Individual industrial IP66 24v dc electric actuator
- Consistent turning angles regardless of floor quality



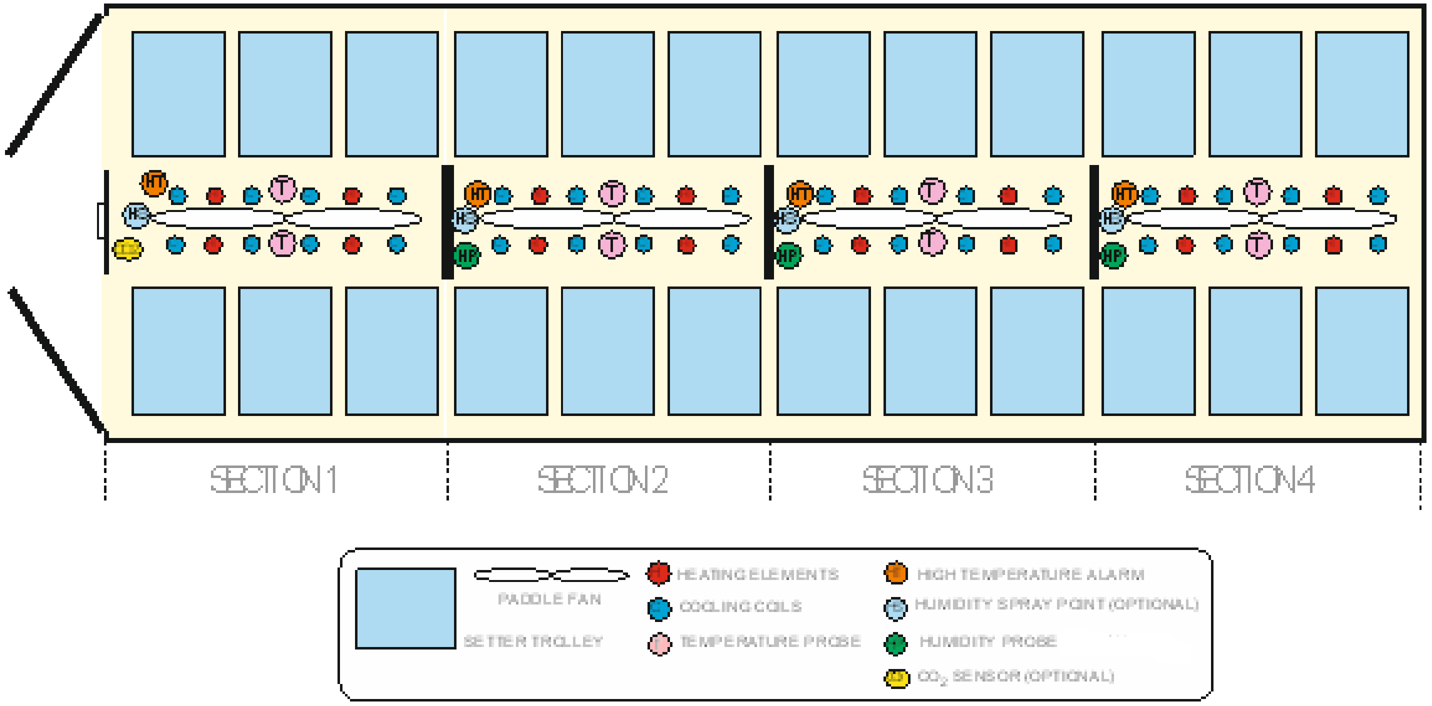
Sectional Control

Each section has it own air conditioning paddle fan system with the following features:

- 6 trolleys per section
- maximum capacity of 33,456 eggs
- Two temperature sensors
- Independent high temperature alarm
- Individual heating and cooling

PT24-165 Single-Stage Setter

Internal Layout



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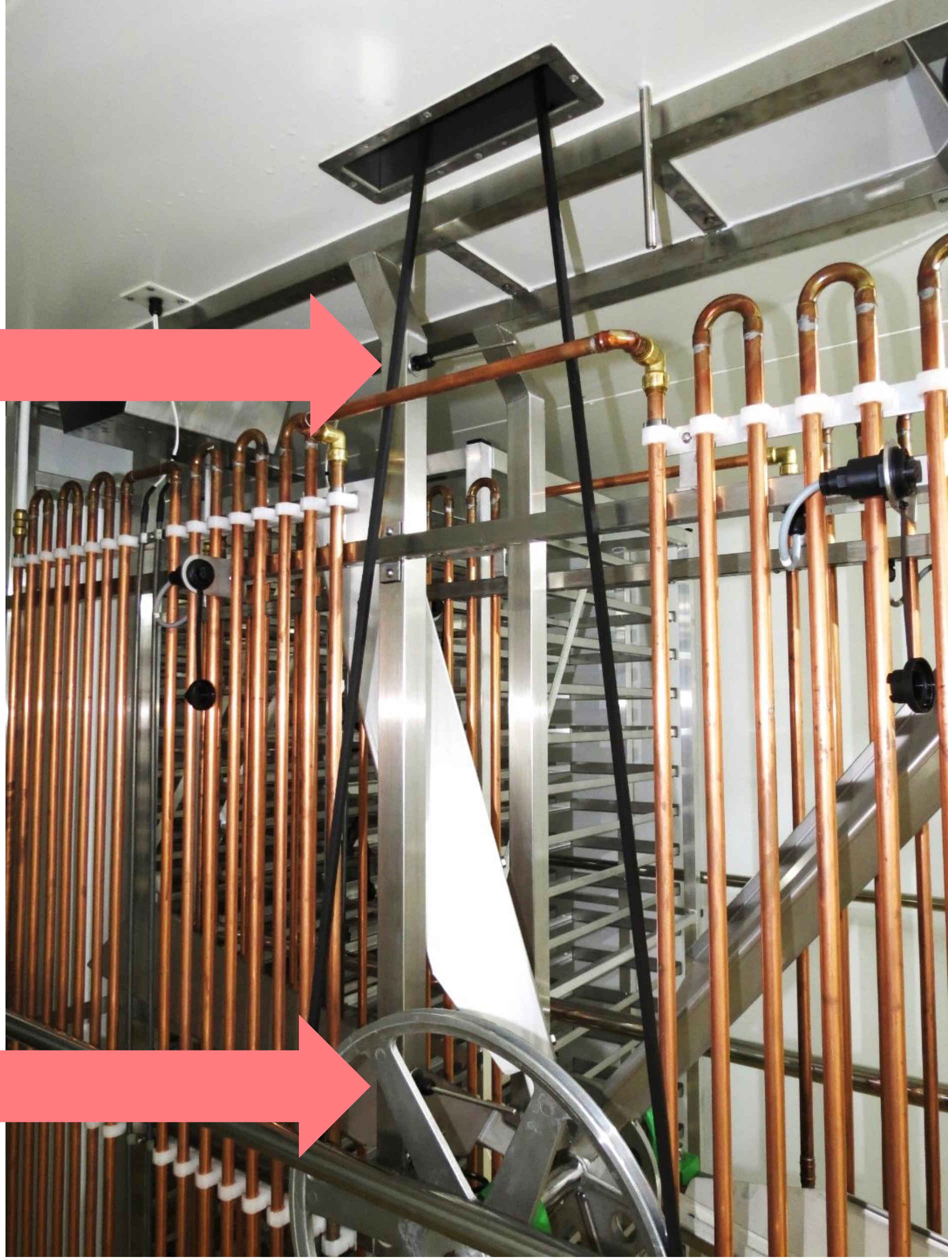
Positioning of the Temperature Sensors

Two sensors per paddle Fan

- Sensor 1 is the primary temperature control, indicative of the return air temperature from the egg mass
- Sensor 2 measures the “Air-off” temperature from the paddle fan air conditioning system
- Two sensors provide valuable information to the PLC system for the accurate and precise control of the incubation process



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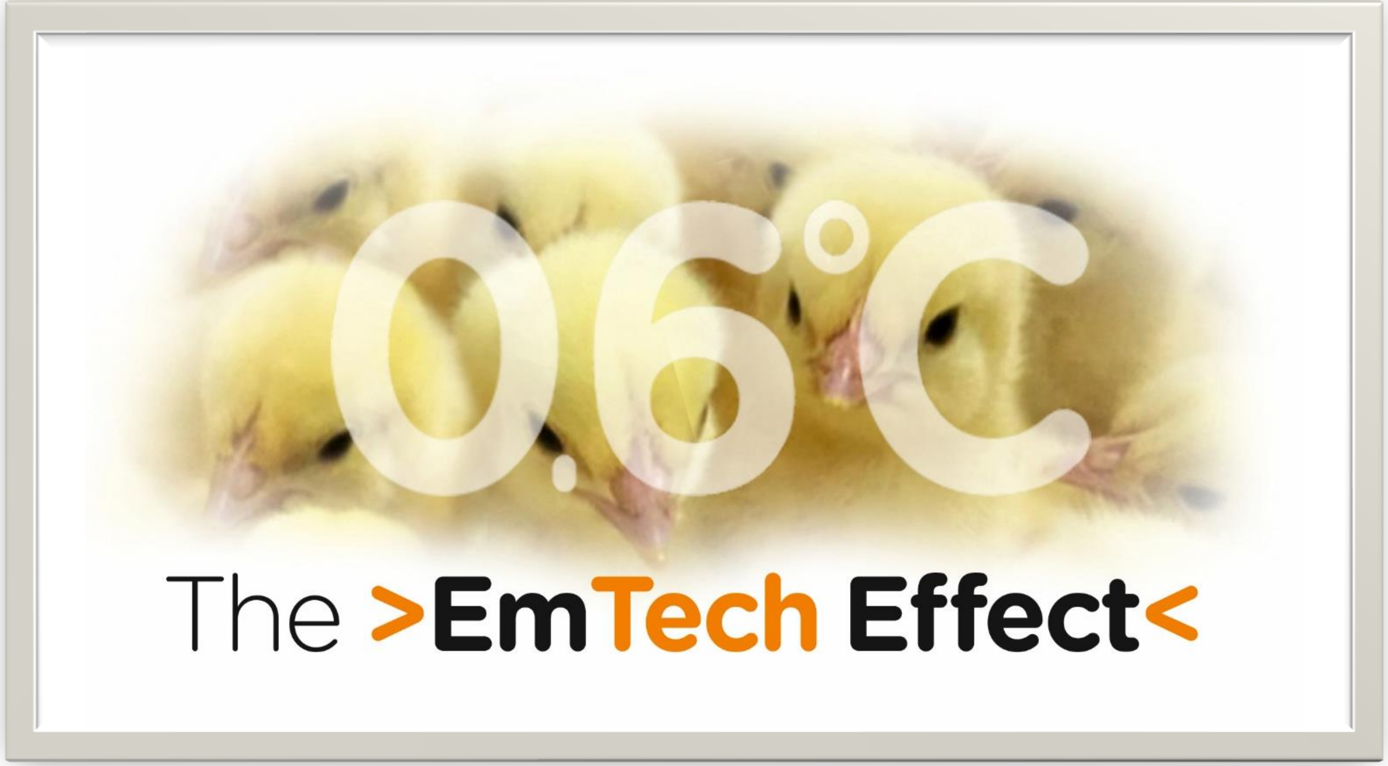
With the well sealed cabinet offering superior thermal insulation properties, a unique paddle fan design and optimum trolley orientation, creates the foundation for the optimisation of heat transfer and temperature bandwidth within the egg pack.

All achieved by good old fashioned engineering principals.

Creating as near as perfect environment within the incubator to ensure the tightest possible Hatch Window



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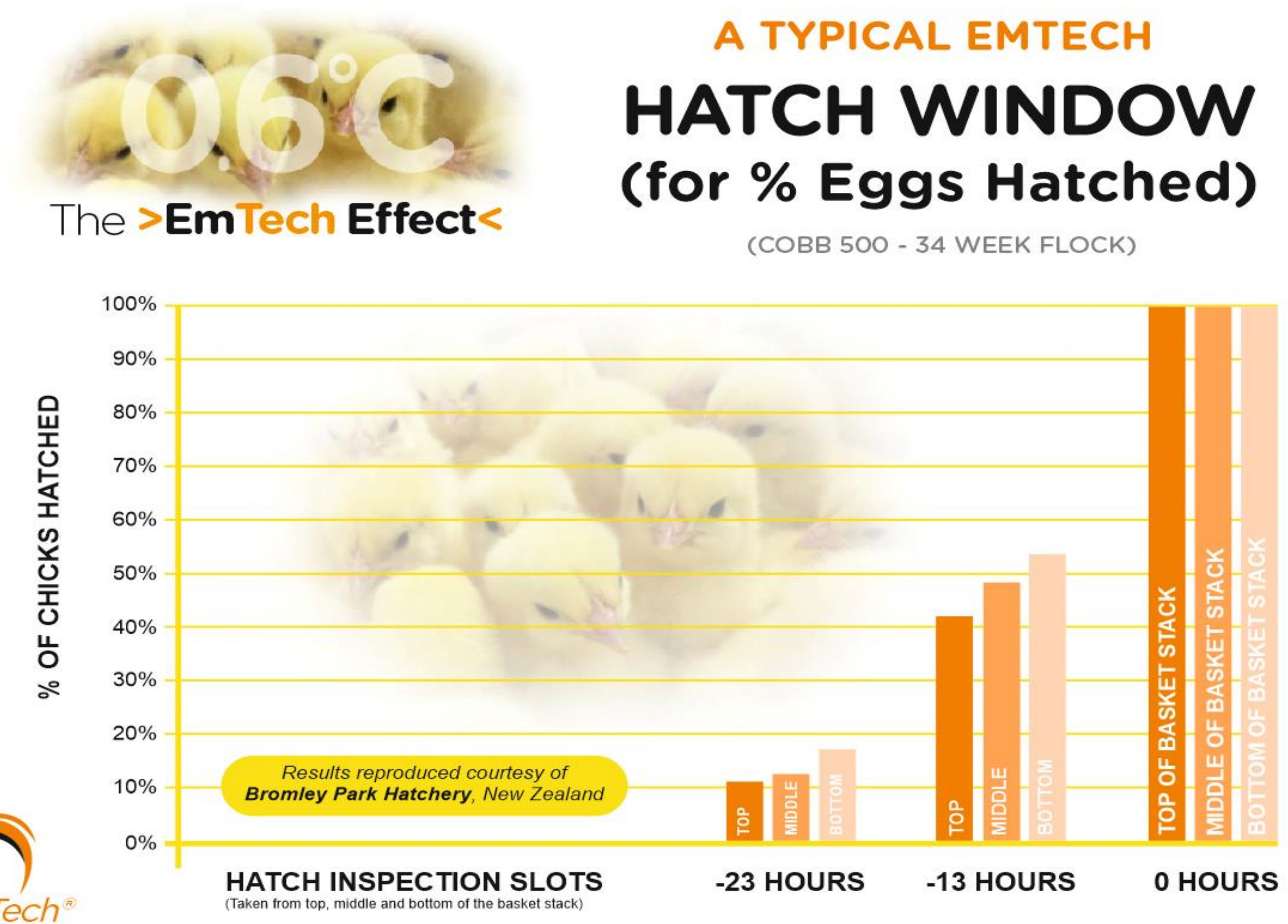

Our Vision

To provide hatcheries with the best performing equipment;

- To create the shortest possible hatch window
- To continue to improve on the temperature bandwidth
- To deliver healthy uniform chicks
- In an energy efficient way
- Using sustainable production methods
- With the highest level of bio security
- To be a leader, not a follower.
- To set new standards in expectations of quality, performance

… in the simplest way possible, as nature intended.

Incubation Technology and Development

Nature made it simple, so why make life complicated?

www.emtech-systems.com

EmTech

HATCHERY
SYSTEMS Ltd.