HATCHERY

The importance of air velocity in incubation

Embryos are quite able to withstand sub-optimal incubation conditions, but when high eggshell temperatures are being measured, hatchability will be decreased. Research has shown that air velocity is crucial in controlling the temperature of the embryos to acceptable levels.

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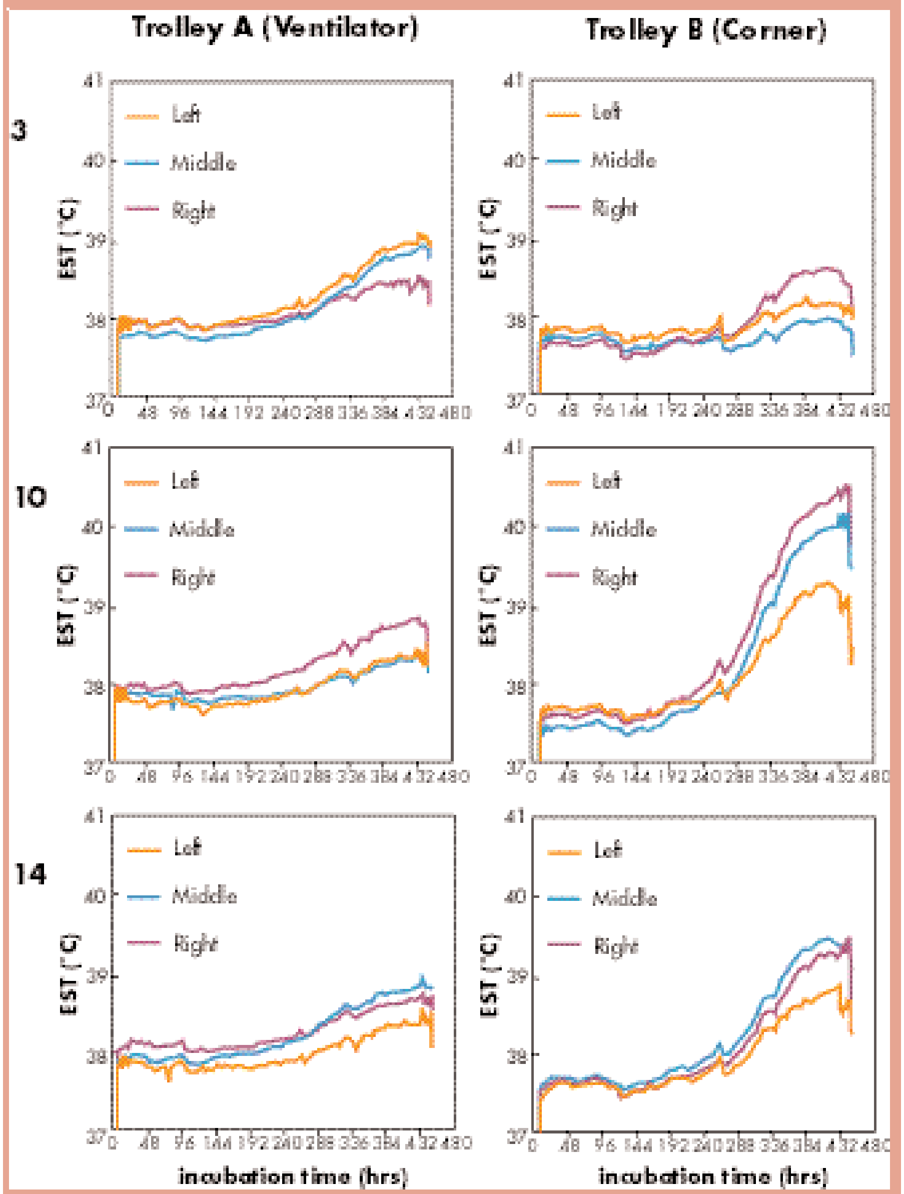
Temperature is commonly recognised as the most crucial environmental key factor in incubation. Many researchers already described the importance of maintaining optimal temperatures during incubation for best hatching results or chick quality. From their research, they concluded that temperature requirements and tolerance limits differ between layer and broiler strains, as well as between different lines and at different ages. The interpretation of incubation studies is difficult when incubator operation temperature is used as the temperature treatment applied to every single egg. Embryo temperature is by no means simply equal to machine temperature. At the onset of incubation, embryo temperature is lower than air temperature, as metabolic heat production is negligible and egg temperature is decreased by evaporative heat loss. Midway through incubation, embryonic heat production exceeds evaporative heat loss. During the third week of incubation, eggshell temperatures higher than 40˚C are being observed in commercial incubators at places where airflow between trays is less than 0.1 m/s. We tried to explain the variation in hatchability of individual trays to the variation of the Egg Shell Temperatures (EST). Air temperature and airflow across the trays at where we monitored EST were also monitored.

Figure 1. Eggshell temperature (EST) profiles in a single stage setter on a trolley in front of the ventilator (A) and in the corner (B) and at 3 different fertile eggs (left – middle – right) per tray at trays 3, 10 and 14



Eggshell temperature, air temperature and airflow

In this study, we measured the temperature of the eggs in a fully loaded single stage setter in a commercial hatchery. We used temperature probes, which we attached to the eggshells with sticky-tape in heat conducting paste. We measured EST at six different trays at two different trolleys. We placed one trolley (A) in front of the ventilator. The other trolley (B) was located in the corner as far away possible from the ventilator. Trays were numbered from 1 till 16, with tray 1 at the top of the trolley, tray 16 at the bottom. Per tray (tray 3, 10 and 14), we measured EST at three different eggs selected at strategic positions at the trays: at the left side, in the middle and at the right side of the tray. EST profiles in a single stage setter at six different trays are shown in *Figure 1.* Air temperature and airflow across these trays were measured at day 18 of incubation.

Break out analysis

For break out analysis, we selected 9 trays per trolley: trays 2,3,4; 9,10,11 and 13,14,15. Candled eggs and dead in shell from trolley

Figure 2. Hatchability of first grade chicks and culled chicks from fertile eggs, related to the maximum EST measured at day 18 of incubation (432 hrs)

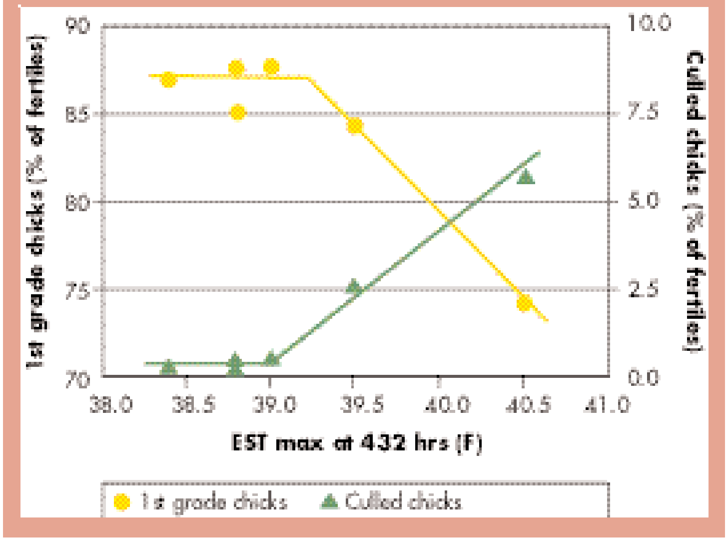


Figure 3. Air temperature and eggshell temperature in relation to air velocity at day 18 of incubation in a single stage setter

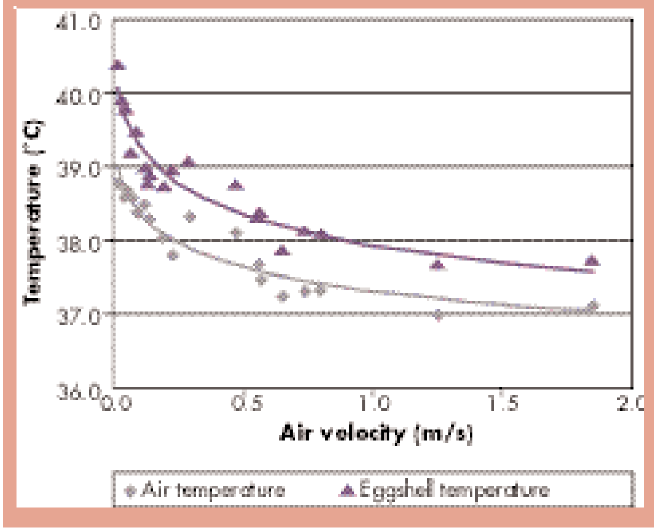


Table 1. Fertility, embryonic mortality (EM) and hatchability

	Trolley A (Ventilator)			*Trolley B (Corner)*		
Tray numbers	*2-3-4*	*9-10-11*	*13-14-15*	*2-3-4*	*9-10-11*	*13-14-15*
Fertility	92.4	91.1	93.6	91.6	93.6	94.2
EM week 1	3.4	5.9	5.7	5.1	5.2	5.4
EM week 2	0.2	0.2	0.2	0.5	0.9	0.5
EM Week 3	7.7 [a]	7.9 [a]	5.7 [a]	7.3 [a]	13.4 [b]	6.9 [a]
Culled chicks	0.5 [a]	0.2 [a]	0.5 [a]	0.2 [a]	5.7 [c]	2.6 [b]
1st grade chicks	87.7 [a]	85.1 [a]	87.6 [a]	86.9 [a]	74.3 [b]	84.4 [a]

Significant differences (P<0.05) are indicated by different letters.

Table 2. Minimum and maximum EST (oC) and temperature differences (DT) at 24 and 432 hrs of incubation at 3 different trays (3, 10 and 14) at two different trolleys A and B

		Trolley A (Ventilator)				*Trolley B (Corner)*			
		3	*10*	*14*	*ΔT (trolley)*	*3*	*10*	*14*	*ΔT (trolley)*
24 hrs	T_{min}	37.8	37.8	37.9	0.1	37.6	37.5	37.6	0.1
	T_{max}	38.0	38.0	38.1	0.1	37.8	37.7	37.7	0.1
	ΔT(tray)	0.2	0.2	0.2		0.2	0.2	0.1	
432 hrs	T_{min}	38.5	38.3	38.3	0.2	38.0	39.0	38.7	1.0
	T_{max}	39.0	38.8	38.8	0.2	38.4	40.5	39.5	2.1
	ΔT(tray)	0.5	0.5	0.5		0.4	1.5	0.8	

A and B were opened with forceps. Fertility and pattern of embryonic mortality was assigned by eye. We counted first and second grade chicks. Fertility was expressed as percentage fertile eggs of eggs set, embryonic mortality and hatchability as the percentage embryos or chicks of the fertile eggs. These results are listed in *Table 1*.

A decreased number of first grade chicks hatched from the fertile eggs that were placed at the trolley in the corner, especially from trays 9, 10 and 11. At those trays, we found more dead in shell (week 3 mortality) and culled chicks *(Table 1)*. From the EST profiles as shown in *figure 1*, we can clearly see the difference in EST in the first days of incubation. After one day of incubation, EST at the trolley in front of the ventilator was on average 0.3˚C higher than EST at the trolley in the corner *(Table 2)*. Eggs in front of the ventilator reached this constant temperature about 5 hours sooner than eggs in the corner (after respectively 7 and 12 hours).

More pronounced differences in EST are found after 10 days of incubation. At day 18, the highest EST was found on the trolley in the corner at tray 10 (40.5˚C). This is 2.7˚C higher than what is assumed to be the optimal incubation temperature of 37.8˚C. At 18 days of incubation, this "optimum" incubation temperature was not recorded at all, all EST were above 38.0˚C *(Figure 1, Table 2)*.

We related data from *Table 1 and Table 2* in *Figure 2*. The percentage hatchability of first grade chicks and the percentage of culled chicks were plotted against the maximum EST measured at day 18 of incubation. The figure clearly illustrates that when EST is observed higher than 39.5˚C, hatchability is decreased and the number of culled chicks steadily increased with EST higher than 39.0˚C. Decreased hatchability at higher EST is not only due to a higher percentage cull chicks, we also found a higher incidence of late embryonic mortality *(see Table 1)*.

On day 18 of incubation, we measured air temperature (˚C) and air velocity (m/s) between the trays at where we also measured EST. These results are shown in *Figure 3*. This figure shows the relation between air temperature and EST at different air velocities. The highest EST were found at places where air velocity was lower than 0.1 m/s.

Optimal conditions

EST profiles varied largely between eggs located at different places in the incubator. Highest EST was observed at places where air velocity was lowest. Hatchability at those trays decreased significantly, due to a higher incidence of late embryonic mortality as well to a higher percentage culled chicks. Embryos are quite able to withstand sub-optimal incubation conditions, but when eggshell temperatures are being measured higher than 39˚C, hatchability will be decreased. An air velocity of at least 0.25 m/s is required to control the temperature of the embryos to acceptable levels. h