

# Technical Information

The decisive difference  
in chick length

cm

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## The impact of high egg shell temperatures during incubation

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Nowadays we realize more and more that not the temperature settings of the incubator, but the temperature that the embryo experiences is very important. Embryo temperature determines embryonic development and chick quality (Decuypere and Michels, 1992; Lourens, 2004; Meijerhof 2009), but is difficult to measure without killing the embryo. Therefore, eggshell temperature is used as an indicator for embryo temperature.

High eggshell temperatures (>102°F) are often observed in practice due to problems with cooling capacity or air velocity in the incubator (French, 1997; Hulet, 2007; Molenaar et al., 2009). Compared with normal eggshell temperatures (100°F), high eggshell temperatures reduce hatchability and chick quality (Lourens et al., 2007; Leksrisompong et al., 2007). The differences in hatchability and chick quality may be related to differences in nutrient use or the efficiency of nutrients absorbed from the egg.

The embryo develops from a nutrient supply that is fixed at lay. An egg contains water (73.6%), protein (12.8%), fat (11.8%), and a small amount of minerals (0.8%) and carbohydrates (1.0%) (Romanoff, 1960). Fat and carbohydrates are mainly used as an energy source and proteins are the building blocks during growth.

Nutrients that are not used for embryonic development are retracted in the body cavity before hatch. Differences in the amount of nutrients that are used for development as well as the efficiency in nutrient use from the egg may lead to differences in chick development and, consequently, chick quality. Lets take a closer look at the eggshell temperature because this influences chick quality.

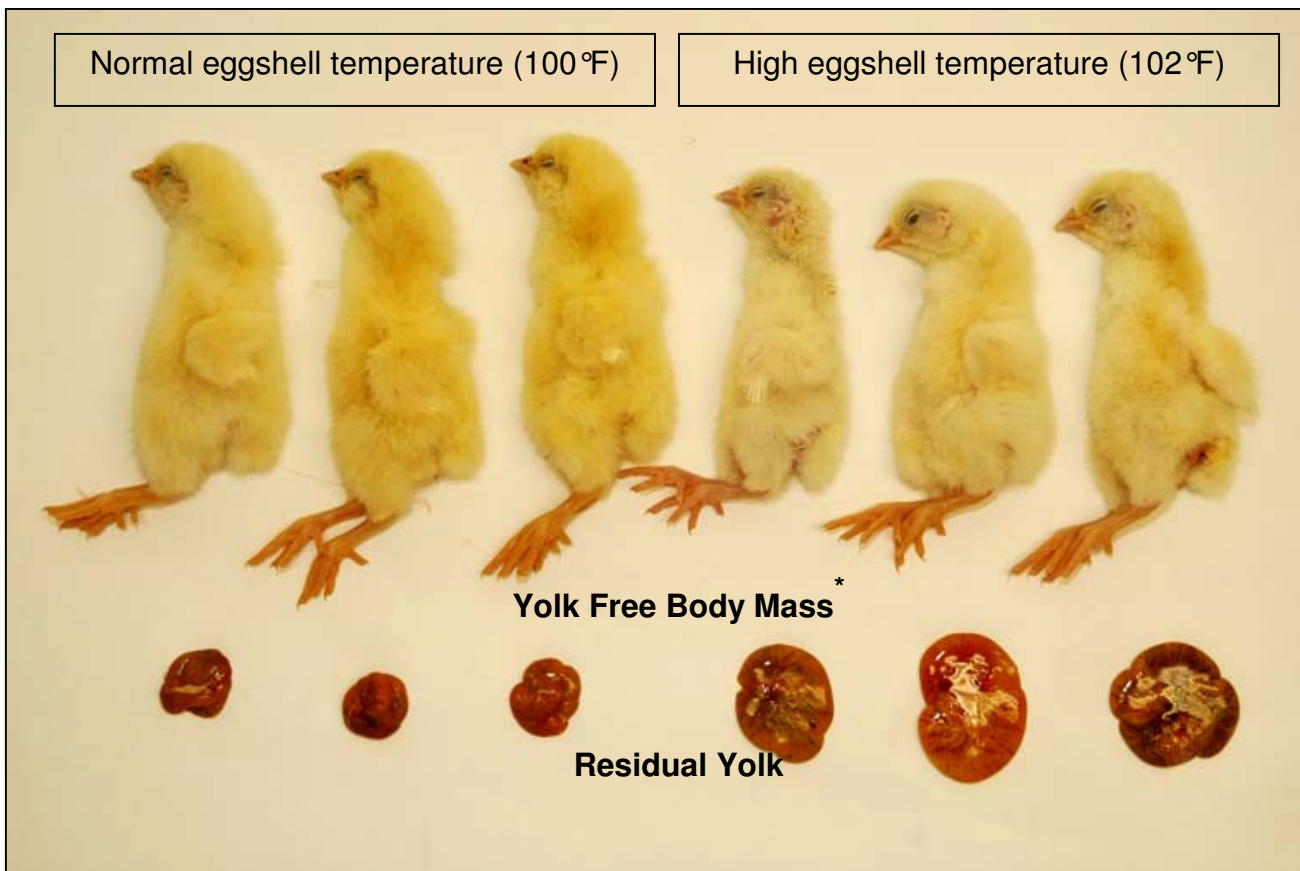
Several researchers investigated the effects of different eggshell temperatures on chick quality and found that an eggshell temperature of 100°F is optimal and results in the best chick quality (Lourens,

2004; Lourens et al., 2005; Leksrisonpong et al., 2007). An eggshell temperature of 102°F, especially in the second half of incubation, decreased chick quality, expressed by a shorter chick length, a lower yolk free body mass, and a poorer navel quality (Picture 1; Lourens et al., 2007; Leksrisonpong et al., 2007). In summary, embryos incubated at high eggshell temperatures were less developed at hatch.

One of the reasons of the reduced development with a high eggshell temperature is the shorter incubation time, which reduces the time for nutrient use from the egg and embryonic development. The question remains: Do embryos incubated at high eggshell temperatures also change the efficiency of their nutrient use?

To answer this question, we calculated the efficiency in nutrient use for growing embryos. The FCR (Feed Conversion Ratio) in the growout period expresses the kg of feed that a bird consumes to gain 1 kg in weight. Using this concept, we can calculate a similar ratio for growing embryos and call this ratio the egg conversion ratio (ECR). The ECR expresses how efficiently nutrients are used during incubation for chick development. The ECR is calculated by dividing the total energy use during incubation by the total energy content of the yolk free body mass (Figure 1). The yolk free body mass is the hatchling without the residual yolk and is therefore the true development of the bird during incubation. The lower the value of ECR (or FCR), the more efficient the bird is in utilizing the available nutrients for growth.

Picture 1. Yolk free body mass and residual yolk of embryos incubated at a normal or a high eggshell temperature



\* Yolk Free Body Mass = Body weight – Residual Yolk

HatchTech Research department performed an experiment to calculate the ECR of two eggshell temperatures. Eggs were incubated from day 7 till hatch at a normal (100°F) or a high (102°F) eggshell temperature. The ECR was 1.62 for the normal eggshell temperature embryos and 1.74 for the high eggshell temperature embryos (Table 1). The high ECR of 1.74 demonstrated that the high eggshell temperature embryos used more nutrients for their growth and were less efficient than the normal eggshell temperature embryos, which is comparable with a higher FCR in growing animals.

Embryos incubated at a high compared with a normal eggshell temperature, are less developed and have a poorer chick quality at hatch. This might be caused by a

1. Shorter incubation time,
2. Lower efficiency in nutrient use.

ECR =

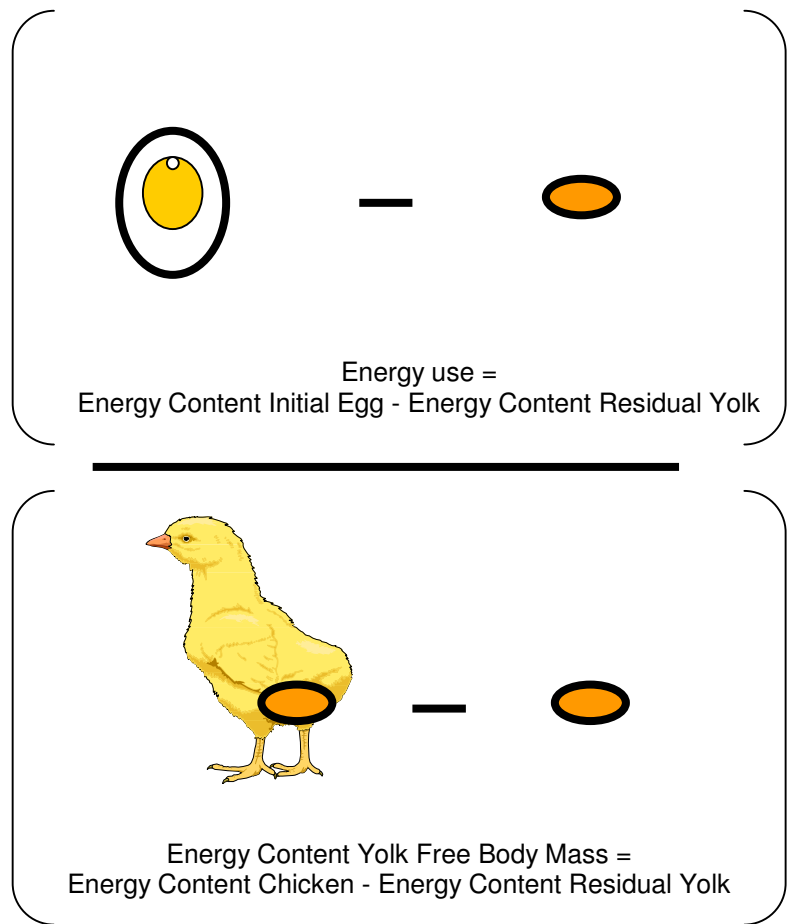


Figure 1. ECR = Egg Conversion Ratio

The results of higher eggshell temperatures during incubation are not only seen at hatch. The impact of high eggshell temperatures can also be seen in a decrease in development and feed efficiency in chickens at slaughter age (Hulet et al., 2007). This is expressed by a lower slaughter weight and a higher FCR.

In conclusion, high eggshell temperatures during incubation can negatively affect body development and nutrient efficiency of broiler chickens. Therefore, ECR during incubation should be optimized by controlling the eggshell temperature to obtain the highest nutrient efficiency of broiler chickens from the start of incubation.

Table 1. Energy content of egg and chickens incubated at a normal (100°F) or a high (102°F) eggshell temperature (EST) from day 7 until hatch.

	Energy content, kJ	
	Normal EST	High EST
Total egg, start incubation	374	374
Yolk free body mass*	208	187
Residual yolk*	38	49
Energy loss*	128	138
ECR**	1.62	1.74

\*12 h after emerging from the eggshell

\*\*Egg Conversion Ratio = Energy use during incubation (kJ)/ Energy content yolk free body mass (kJ); Figure 1

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## References

- Decuyper, E., and H. Michels. 1992. Incubation temperature as a management tool: a review. *Worlds. Poult. Sci. J.* 48:28-38.
- French, N. A. 1997. Modeling incubation temperature: The effects of incubator design, embryonic development, and egg size. *Poult. Sci.* 76:124-133.
- Hulet, R. 2007. Symposium: Managing the embryo for performance. *Managing incubation: Where are we and why?* *Poult. Sci.* 86:1017-1019.
- Hulet, R., G. Gladys, D. Hill, R. Meijerhof, and T. El-Shiekh. 2007. Influence of egg shell embryonic incubation temperature and broiler breeder flock age on posthatch growth performance and carcass characteristics. *Poult. Sci.* 86:408-412.
- Leksrisompong, N., H. Romero-Sanchez, P. W. Plumstead, K. E. Brannan, and J. Brake. 2007. Broiler incubation. 1. Effect of elevated temperature during late incubation on body weight and organs of chicks. *Poult. Sci.* 86:2685-2691.
- Lourens, A. 2004. Embryo development and chick temperature. *Avian Poult. Biol. Rev.* 15:226-227.
- Lourens, A., H. Van den Brand, R. Meijerhof, and B. Kemp. 2005. Effect of eggshell temperature during incubation on embryo development, hatchability, and posthatch development. *Poult. Sci.* 84:914-920.
- Lourens, A., H. Van den Brand, M. J. W. Heetkamp, R. Meijerhof, and B. Kemp. 2007. Effects of eggshell temperature and oxygen concentration on embryo growth and metabolism during incubation. *Poult. Sci.* 86:2194-2199.
- Meijerhof, R. 2009. Incubation principles: What does the embryo expect from us? *Proc. 20<sup>th</sup> Aust. Poult. Sci. Symp.*, Sydney, New South Wales, Australia.
- Molenaar, R., R. Meijerhof, B. Kemp, R. Hulet., and H. Van den Brand. 2009. High eggshell temperatures: A matter of life and death importance? *Proc. IFRG meeting*, Norwich, Norfolk, UK.
- Romanoff, A. L. 1960. *The avian embryo*. The Macmillan company, New York, NY.