HatchTech
INCUBATION TECHNOLOGY

Technical Information

A closer look through the Hatch Window

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Definition of “hatch window”

What is the “natural” hatch window for a set of eggs? The definition of the “natural” hatch window is the time that it takes to hatch all chicks in an ideal incubation environment. In reality, a natural hatch window can only occur when the hen incubates the eggs. Only in this “natural” situation can the hatch window be defined from the embryo perspective. In other words, there is no effect of the incubator on the hatch window.

In any commercial incubation situation, the hatch window is influenced by the interaction between incubator design, operation, profiles, the egg quality, and the embryo characteristics. All commercial incubation is the result of the embryo and equipment interaction.

Genetic selection and hatch window

Genetic selection for breast meat yield has changed the egg quality and embryo characteristics of broilers. How does this influence what the embryo needs for successful incubation and hatch? Genetic selection has:

1. Altered the heat production of the embryo. With no change in the temperature profile, as embryo heat production increases, embryo temperature also increases.
2. Decreased egg shell conductance. Egg shell conductance is a factor that determines total incubation time. Decreasing egg shell conductance, increases total incubation time.
3. Selected for more altricial birds. Altricial birds have a higher growth rate but are less mature at hatch.

Genetic selection and the following factors influence the hatch window:

- Genetic Line
- Breeder flock age
- Egg storage duration
- Egg size

Variation in embryo development at the start of incubation Incubator design, operation, and profiles.

Embryos of different genetic lines, breeder flock age, and egg storage durations differ in developmental rate. When eggs of different genetic lines, breeder flock age, or egg storage duration are set together in one incubator, the hatch window will increase.

If these three factors are not mixed, egg shell conductance, egg size, variation in embryo development at the start of incubation, and embryo heat production will determine the length of the hatch window.

In commercial incubation three very significant factors have to be added to these factors that affect the hatch window: the incubator design, operation, and profiles. The incubator design, operation, and profiles affect embryo temperatures and uniformity of embryo temperatures and have, therefore, more impact on the hatch window than individual egg quality and embryo characteristics.

Embryo temperatures create the hatch window

Uniform and optimal embryo temperatures throughout the egg mass are the key in obtaining the:

1. Most natural hatch window determined by egg quality and embryo characteristics
2. Maximum hatchability
3. Superior chick quality

In both multistage and single stage incubation, the incubator design, operation, and profiles determine the incubation conditions within the egg mass as defined by relative humidity, air temperature, airflow, and air velocity. These factors determine actual embryo temperatures, the variation in embryo temperature, and, therefore, also the hatch window. Uniformity of embryo temperatures (and the hatch window) is directly related to the uniformity of relative humidity, air temperature, air velocity, and air flow within the egg mass. An example of the influence of air velocity on embryo temperature is shown in the table below. High air velocity improves heat transfer from the eggs to the surrounding air and vice versa.

Air temperature	Air speed	Embryo temperature
99°F, 37.2°C	2.0 m/s	100°F, 37.8°C
99°F, 37.2°C	0.5 m/s	102°F, 38.9°C

In addition to air velocity, relative humidity influences the heat transfer capacity of the air. Humid air transfers heat better than dry air. In an incubator, the humidification system maintains the relative humidity at the profile set point. However, to create uniform humidification, the system must create moisture that has a very small droplet size (ultrasonic). Uniform small droplets prevent localized cooling of eggs due to evaporation of water droplets. When large moisture droplets settle on a group of eggs within the incubator, evaporation of the droplets cools this group of eggs. This lowers the embryo temperature of these eggs and creates variation in embryo temperatures within the incubator and increases the hatch window. Variation in embryo temperatures created by incubator design deficiencies has a significant impact on the hatch window. Embryos that are in cold areas of the egg

mass have a low embryo temperature and hatch later. Embryos that are in hot areas of the egg mass have a high embryo temperature and hatch earlier.

Impact of embryo temperature uniformity on hatchability and chick quality

Many studies have shown that embryo temperature affects hatchability and chick quality. When embryo temperature is 100°F, 37.8°C, throughout incubation the chick develops properly. This results in maximum hatchability and field performance potential. Several graphs throughout this article illustrate the effect of embryo temperature and embryo temperature uniformity on hatchability, chick quality, and hatch window.

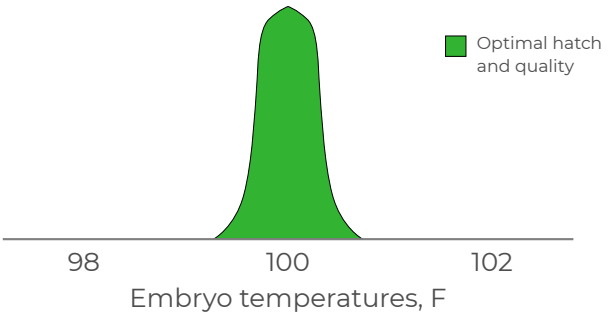

Figure I. *Uniform airflow: all embryo temperatures are close to 100°F: Maximum hatchability and chick quality and a natural hatch window (determined by egg quality and embryo characteristics)*

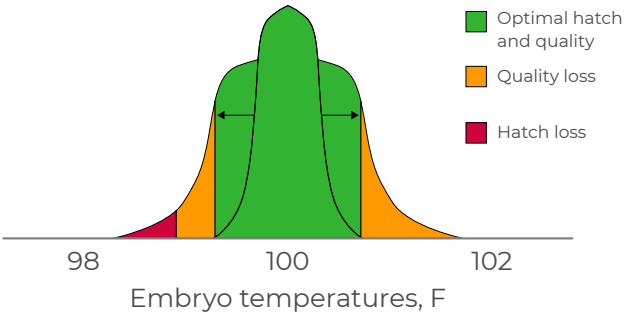

Figure II. *Variation in airflow and air velocity creates variable embryo temperatures: Decreased hatchability and chick quality with a wider hatch window (determined by cold and hot spots in the incubator)*

Management procedures to shorten the hatch window

Both high (>100°F) and low (<100°F) embryo temperatures within one incubator increase the hatch window and decrease chick quality. Most procedures to shorten the hatch window are designed to accelerate the embryos that have been in the cold areas of the incubator and/or to slow down the embryos that have been in the hot areas of the incubator. Many of these procedures do not meet the requirements of the embryo, but are used to correct for improper incubator design. The following management procedures are used in the field to reduce the hatch window:

1. Transfer patterns that move embryos from specific locations in the setter to specific locations in the hatcher. Eggs from the cold areas (cold embryo temperature) in the setter are moved to the hot areas (high embryo temperature) in the hatcher. The development of embryos that originate from the cold areas in the setter is accelerated and the development of embryos that originate from the hot areas is retarded. This may shorten the hatch window, but negatively affects chick quality because embryo temperatures are not consistently 100°F, 37.8°C.

2. Change the air temperature or carbon dioxide levels of the hatcher when the first signs of hatching chicks are detected.
   a. Increase air temperature in the hatcher. This increases embryo temperatures. The purpose is to accelerate the development of the slowest embryos, which may shorten the hatch window. However, this is not guaranteed because the effect of increasing the temperature on the hatch window depends on the timing of the procedure. The increase in embryo temperature negatively affects chick quality.

b. Increase carbon dioxide levels. Higher carbon dioxide levels are often used to "stimulate" the chicks to hatch. In reality, high carbon dioxide levels decrease the inlet of fresh air (ventilation). Because most incubators use fresh air for cooling, a reduction in the ventilation rate impacts embryo temperatures. Raising the embryo temperature accelerates the development of the slowest embryos, which may shorten the hatch window. However, this is not guaranteed because the effect of increasing the temperature on the hatch window depends on the timing of the procedure. The increase in embryo temperature negatively affects chick quality.

3. Moving trolleys inside the incubator during incubation. Embryos are moved between relatively warm and cool areas of the egg mass to equalize hatch time. This may shorten the hatch window, but negatively affects chick quality because embryo temperatures are not consistently 100°F, 37.8°C. If the embryo temperatures are uniform throughout the incubator, moving trolleys inside the incubator is not necessary.

As described above, the goal of most procedures to shorten the hatch window is to accelerate the embryos that have been in the cold areas of the incubator and/or to slow down the embryos that have been in the hot areas of the incubator. For optimum chick quality, hatchability, and a natural hatch window in any group of eggs, it is more important to ensure optimal and uniform embryo temperatures throughout the complete incubation process.

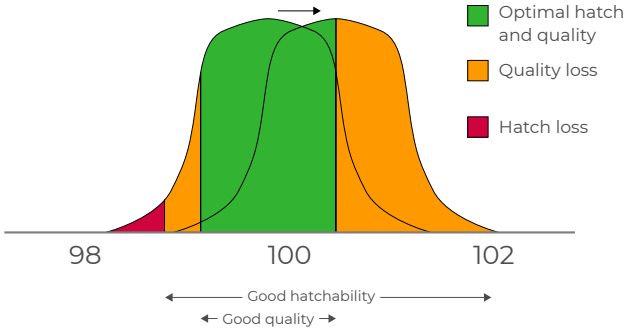

Figure III. *To maintain hatchability with non uniform embryo temperatures by increased air temperature: ALL embryo temperatures rise. This will improve hatchability in comparison to Figure II, BUT chick quality decreases and hatch window is still as wide as in Figure II*

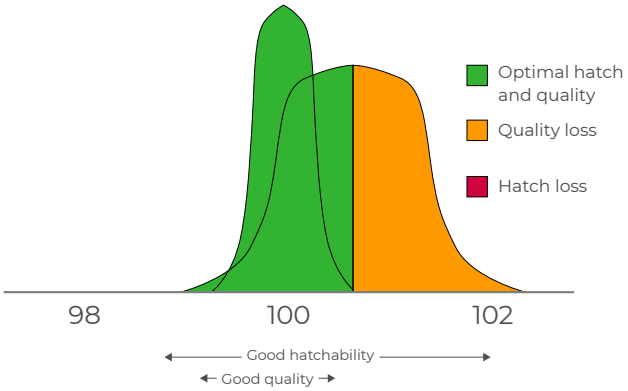

Figure IV. *There are two practical outcomes in commercial incubation:*

1. *Uniform and optimal embryo temperatures (approximately 100°F): maximum hatchability and chick quality and a natural hatch window determined by egg quality and embryo characteristics.*
2. *Non uniform embryo temperatures: Maximum hatchability BUT decreased chick quality with a wide hatch window due non uniform embryo temperatures.*

Is a short hatch window desirable?

After hatch, chicks are at risk for dehydration because they have no immediate access to water. For this reason it is crucial that chicks are held at the correct body temperature. Chicks that are comfortable, i.e. in their thermo neutral zone have a rectal temperature between 40.0 - 40.6°C, 104 - 105°F. Comfortable chicks lose 1 - 2 grams of moisture per 24 hours and will not dehydrate during their stay in the hatcher, or during

chick handling and transport. Chicks that are overheated (rectal temperature over 106°F, 41.1°C) lose 5 - 10 grams of moisture per 24 hours and are at risk for dehydration.

If chicks are overheated in the hatcher after hatch, they must be pulled as early as possible to prevent dehydration. This is a reason to monitor the hatch window. However, when chicks are not overheated, early hatched chicks are not dehydrated by leaving them in the hatcher until the last chicks are hatched.

The only valid reason (that is not related to incubator design) to monitor the hatch window is to minimize the time from hatch to feed consumption. Early feed consumption stimulates intestinal development and improves field performance. It is questionable whether the positive effect of early feeding exceeds the negative impact on chick quality that management procedures to shorten the hatch window create.

In conclusion

The “hatch window” is influenced by several factors. The uniformity of embryo temperatures that is created by the incubator design, operation, and profiles has the most significant impact on the hatch window. Because of existing deficiencies in incubator design, many believe that it is beneficial to use management procedures to shorten the hatch window to prevent dehydration of the chicks. It is, however, important to realize that the management

procedure that is used to shorten the hatch window will negatively impact chick quality and performance potential. To create a commercial “natural” hatch window, chicks must hatch “naturally” as determined by their individual egg quality and embryo characteristics. As in all populations, there is a natural curve. To hatch chicks with a “natural” hatch window in a commercial situation, the incubator design must create a uniform and optimal environment in the egg mass (air temperature, air flow, air velocity, and relative humidity). This environment must maintain the chicks in their comfort zone after hatch as defined by dry chick rectal temperatures of 40.0 - 40.6°C or 104 - 105°F. If the incubator can meet these standards, the chicks will not dehydrate after hatch and it is NOT necessary to manage or shorten the hatch window.

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