



The Hatch Window

Presented on the XXII Latin American Poultry Congress June 2011, by Donna Hill, DVM, MAM, Dipl. ACPV

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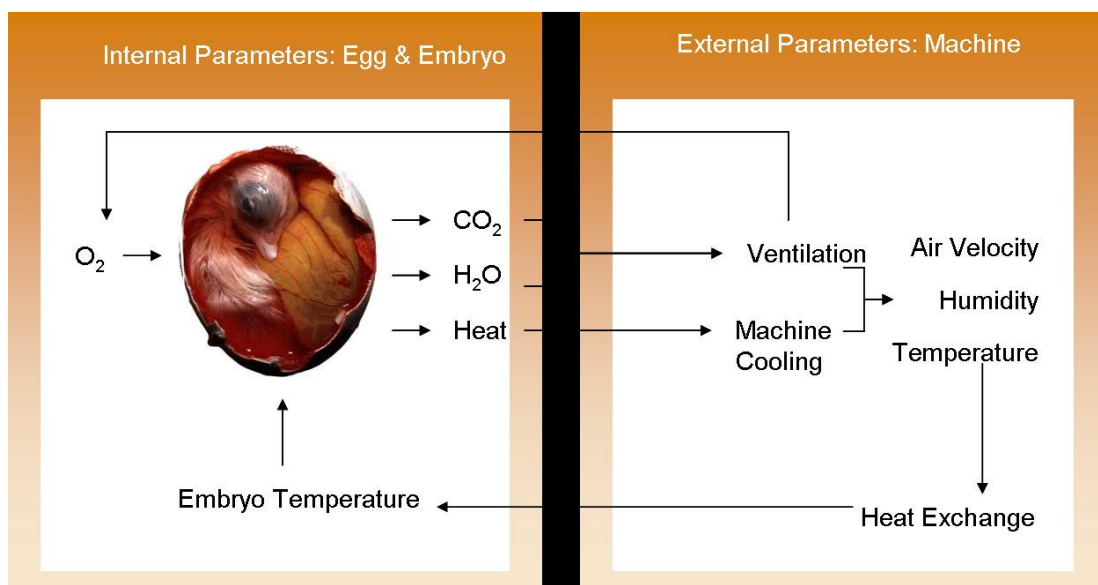
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Definition of “hatch window”

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

In any commercial incubation situation, the hatch window is influenced by the equipment design, operation and profile. All commercial incubation is the result of the embryo and machine interaction.

The picture below illustrates the interaction of the machine and the embryo.



The interpretation of the hatch window, long or short, is only relevant as it relates to the requirements of the production hatchery and the environment that the chicks are in after hatch. In other words, when does the hatchery need the chicks and does the hatcher maintain the chick in a thermo neutral state or not?

Impact of genetic selection and incubation on the hatch window

Today all commercial chicks and eggs are produced from parents that have been genetically selected. Genetic selection for breast meat yield or egg production influences not only the chick but also the egg quality and the embryo. How does this influence what the embryo needs for successful incubation and hatch? Genetic selection has:

1. Altered the heat production of the embryo. As embryo heat production increases, embryo temperature increases (in the same environment).
2. Selected for more altricial birds. Altricial birds have a higher growth rate but are less mature at hatch.
3. Decreased conductance of the egg shell. Conductance of the eggshell influences the total incubation time.

Characteristics of the egg and the embryo that impact the hatch window

Characteristics of the egg and the embryo that impact the hatch window are:

1. Conductance of the egg shell
2. Genetic line
3. Embryo heat production
4. Egg size
5. Egg selection practices
6. Sex: Male or female
7. Egg storage times
8. Breeder flock ages

While all of these factors influence the hatch window, they are only important in MIXED sets of eggs. If the egg sets are not mixed, these factors (especially conductance) determine the normal curve of the hatch window. In commercial incubation, the machine design, operation, and profiles have more impact on hatch window than the egg characteristics.

Machine design, operation, and profiles

Uniformity of the egg mass is the key to obtain the:

1. Most natural hatch window
2. Maximum hatchability
3. Optimum chick quality

In both multistage and single stage incubation, the machine design, operation, and profiles create the incubation conditions within the egg mass and therefore the relative humidity, temperature and airflow that creates the actual embryo temperatures. The actual embryo temperatures create the hatch window.

Uniformity of embryo temperatures (and the hatch window) is directly related to uniformity of relative humidity, air temperature and air velocity in the egg mass.

The influence of air speed on the embryo temperature is shown in the chart below. When air speed varies, embryo temperature varies.

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

As embryo heat production increases (with selection for yield), the variability in airflow and air temperature creates more variation in embryo temperatures.

Relative humidity functions as the heat transfer agent. The humidification system must create humidity that is uniform and has a very small droplet size (steam or ultrasonic) to prevent localized cooling during evaporation. When large droplets settle on an egg, evaporation cools the egg, which lowers the embryo temperature and impacts the hatch window.

Why is embryo temperature important?

Many current studies have shown the relationship between embryo temperature and hatchability and chick development. When embryo temperature is 100°F, 37.8°C, the chick develops properly. This results in maximum field performance potential and hatchability.

The most significant influence on the spread in hatch windows is the variation in embryo temperatures. 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 early.

Impact of embryo temperature uniformity on hatchability and chick quality

The following graphs illustrate the interaction of environmental uniformity, air temperature on hatchability and chick quality.

Figure I. Uniform airflow: all embryos are 100°F:

Optimum chick quality and hatchability, natural hatch window

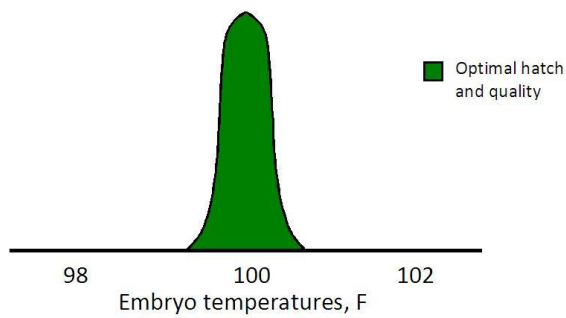


Figure II. Variation in airflow creates variable embryo temperatures:

Decreased chick quality and decreased hatchability, wider hatch window

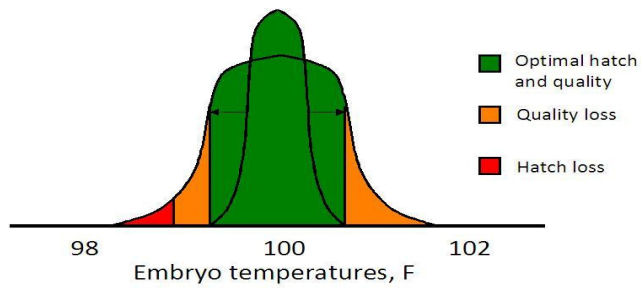


Figure III. To maintain hatchability with variability in the incubation environment (and embryo temperature), increase air temperature: Raises embryo temperature in all areas and improves hatch and BUT decreases chick quality

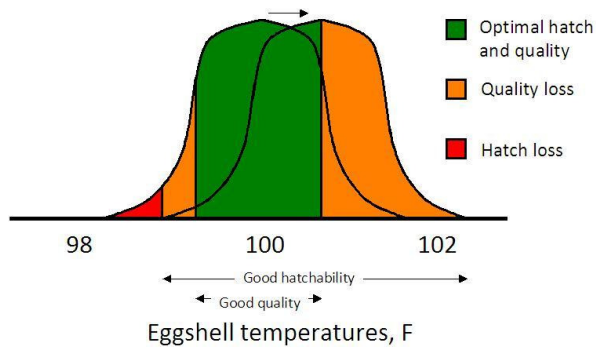
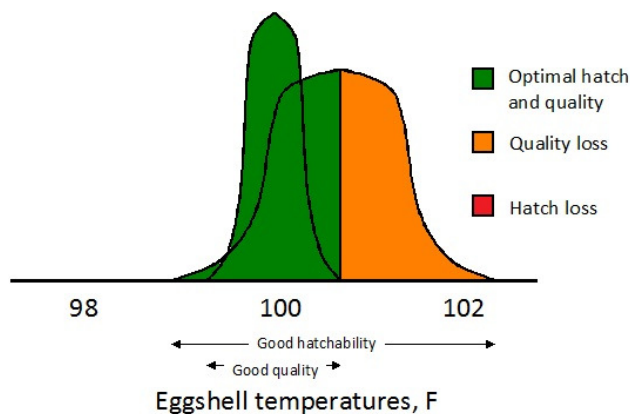


Figure IV. There are two practical outcomes in commercial incubation



Procedures to shorten (or manage) the hatch window

There are many different procedures in practice today that are designed to shorten the hatch window. Many of these procedures are actually detrimental to chick quality. They do not solve the underlying problem of variability in embryo temperatures during incubation, but they do shorten the hatch window.

Both high and low embryo temperatures create long hatch windows and chick quality problems. Low embryo temperatures create dramatic hatch loss. Most procedures are designed to stimulate the embryos that have been in the cold areas of the setter or hatcher to hatch.

Many of these procedures are incorrectly considered to be requirements of the embryo when in fact, they are done to correct for deficiencies in equipment design.

1. Transfer patterns: Transfer patterns that move embryos from specific locations in the setter to specific locations in the hatcher are simply moving eggs from the cold areas (cold embryo temperature) in the setter to the hot areas (high embryo temperature) in the hatcher. This improves the hatch window, but it cannot produce optimum chick quality.
 - a) Monitoring the hatcher and signs of hatch to change hatcher conditions: This is often done two ways:
 - a. Increase hatcher temperature: This increases embryo temperatures but decreases 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 ventilation. Since most machines use ventilation for cooling, this has the impact of increasing the embryo temperature and therefore “forcing” chicks to hatch.
3. Circadian incubation: Circadian incubation programs periodically increase the air temperature and therefore the embryo temperature. This increases the metabolism the embryo. Embryo development accelerates and consequently the chicks will hatch earlier. Embryos that were incubated in cold areas in the incubator will hatch on time instead of too late for normal chick harvest time.
4. Moving trolleys inside the incubator during incubation: Embryos are moved between relatively warm and cool areas of the egg mass to equalize hatch time. While this system will shorten the hatch window, it does not create consistent 100°F, 37.8°C embryo temperatures. It is not necessary if the egg mass/embryo temperatures are uniform.

The impact of hatcher changes to “shorten” the hatch window on the embryos and chicks

Most changes to shorten the hatch window in the hatcher involve raising the air temperature. This means that the actual embryo temperature increases. Higher embryo temperatures create a cascade of physiological changes in the embryo during the crucial hatch period.

When the air/embryo temperature increases:

1. The embryonic metabolic oxygen demands increase, but the conductivity of the shell limits the amount of oxygen that can be transferred to the embryo.
2. When oxygen is available, the embryo uses aerobic metabolism. The yolk is the energy source.
3. When oxygen is no longer available, the embryo changes from aerobic to anaerobic metabolism for energy.
4. Anaerobic metabolism uses the limited glycogen stores from the heart, liver, and kidney to supply energy. When glycogen is used for energy, lactic acid is produced. The chicks that hatch are lethargic, exhausted, and do not eat or drink readily. In the field, there are increased starve outs and one week mortality.
5. Since oxygen is not available, the yolk is not utilized for immune function and long bone development, the navel does not heal properly, and weight loss decreases

Genetic selection for breast meat yield compounds this problem since conductivity of the shell decreases and embryo heat increases.

Recent research by Oviedo-Rondon has shown the relationship between high temperature incubation conditions on the end of incubation and leg problems in the field, especially splayed legs. High embryo temperatures impact bone, tendon, and thyroid development. 3-4 days before hatch, the long bones have the fastest elongation rate. High embryo temperatures impact the factors that control ossification of the long bones primarily during the plateau stage of oxygen consumption. Lipids, trace minerals, and vitamins in the yolk are used in bone modeling and remodeling. If the yolk is not used properly, the bones will not receive nutrients critical for their early development.

Why is a short hatch window desirable? Or is it?

After hatch, chicks are in the same developmental stage that they are in transport. Therefore, the environmental conditions necessary to maintain comfortable chicks should be the same.

Chicks that are comfortable, i.e. in their thermo neutral zone (rectal temperature 40-40.6°C, 104-105°F) lose 1-2 grams of moisture per 24 hours. Chicks that are overheated (rectal temperature over 106°F, 41.1°C) lose 5-10 grams of moisture per 24 hours. This is true in any situation where the chicks have no access to water, whether the chicks are in the hatcher or in transport to the farm.

If time after hatch was the only reason for chicks to lose moisture, it would not be possible to transport chicks. But it is possible to transport chicks as long as they are in their thermal comfort zone. The same is true of the time after hatch in the hatcher. If chicks are in their thermal comfort zone in the hatcher, they are not dehydrated. If they are above their thermal comfort zone (hot), then they are quickly dehydrated and it is necessary to monitor hatch window and pull immediately after hatch. Only chicks that are overheated dehydrate rapidly after hatch.

The one valid reason (that is not related to machine design) to monitor the hatch window is minimize the time from hatch to feed consumption. Intestinal development begins 24 hours after the chicks first consume feed. Early feed consumption is correlated with good intestinal development and field performance.

In conclusion

The “hatch window” is influenced by many factors. The most important influence on the hatch window is the uniformity of embryo temperature that is created by the machine design, profiles, and operation. Because of existing equipment design deficiencies, many will continue to find it necessary to “manage by the hatch window to prevent dehydration”. In this situation, it is important to understand the underlying factors that make this management practice necessary. It is better to solve the underlying problem than to manage around the problem.

In the poultry industry today, it is common to accept that a short hatch window is beneficial and that management practices to shorten the hatch window are necessary and beneficial. These practices are not done because of embryo requirements. They are done because of deficiencies in equipment design. These practices may improve hatch, but they influence the embryo and do not necessarily create the best chick quality. A “forced” short hatch window is not a “natural” hatch window.

To create a commercial “natural” hatch window, chicks must hatch “naturally” as determined by their individual egg characteristics. As in all populations, there is a natural curve. This “natural” hatch window will not be shorter than the hatch window created by overheating the embryos. But it will produce the best quality chicks and maximum hatchability.

To hatch chicks with a “natural” hatch window in a commercial situation, the equipment design must create a uniform environment in the egg mass. This environment must maintain the chicks in their comfort zone after hatch as defined by dry chick rectal temperatures of 40-40.6°C or 104-105°F. If the equipment can meet these standards, the chicks will not dehydrate after hatch and it is NOT necessary to manage or shorten the hatch window.

References

Oviedo-Rondon, E. O., M. J. Wineland. Incubation distress easily leads to splayed legs. World Poultry 2011, August 23, p. 24-25

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