Temperature timing in incubation

By Ron Meijerhof

Incubation is extremely sensitive for temperature. Relatively small changes can result in substantial losses. But embryos are not equally sensitive for temperature changes in every stage of the process. We can already conclude this from the behavior of mother hen. During the first days of natural incubation, it is very difficult to force a hen to leave the nest, where at the end of incubation she easily leaves the eggs for a longer time span.

The first days: keep them warm

Embryonic development starts if the temperature gets above the so-called physiological zero (26-27^{o}C), but the optimal incubation temperature is about 37,8^{o}C, or 100^{o}F, measured as temperature of the shell. In the first days of the incubation process, embryos are very sensitive for temperature, both high but especially low. High temperatures result in abnormalities as double spines and heads, brain hernias, posterior duplication etc, where low temperatures effectively kill the embryos. Once the incubation process has started and the embryo is fully developing, the process should not be stopped or slowed down for at least the first 5-6 days. Cooling the eggs in this period leads to high early embryonic mortality.

An embryo doesn't know if it is in the incubator or not, it just recognizes the temperature change. If the temperature during storage or transportation of the eggs gets for some hours above 26-27oC, the embryo considers incubation to have started. But if the storage temperature then is dropped again, several embryos will not survive. This results in very early mortality which can only be detected when eggs are opened. It is often classified as poor fertility, where in reality it is very early embryonic death caused by poor temperature control during egg collection, storage or transportation or even in the pre-incubation period in the hatchery.

A temperature drops in the machine during the first days can also have detrimental effects. In multi stage machines with rack-setting, fresh eggs are set twice a week. This means that twice a week one sixth of the eggs is replaced by relatively cold eggs, which will have a cooling effect on the other eggs. That is no problem for the eggs already in the machine for a longer period, but eggs that were placed 3-4 days before will be cooled as well. These eggs were just getting on temperature and started to develop, and now suffer from a temperature drop due to the fact that fresh, cold eggs are brought in. To avoid this cold shock, it is very important in this situation that the fresh eggs are pre-warmed to 26-27oC. Pre-warming to higher temperatures is not advisable, because then the embryos start to consider the incubation to have started during the pre-warming process, and will suffer from the temperature drop between pre-warming and setting.

In multistage machines with trolley setting, this effect is much less as the whole trolley with fresh eggs will be warmed by the forced air flow coming from the trolleys with further developed eggs. In this situation, pre-warming is much less critical. This is also why we normally see slightly reduced early embryonic mortality in multi stage machines with trolley setting when compared with machines with rack setting.

In single stage machines, we do not have the problem of bringing cold eggs in with eggs that just have started their development. But not all single stage machines have enough heating capacity to warm up the eggs quick enough. After all, if we have to warm up a machine with 100.000 eggs of 60 gram, we are warming up 6000 kg of egg mass. As eggs have the thermal properties of water, it is as if we warm up a small swimming pool containing 6 m3 of water. As the embryo benefits if the warming process goes relatively quick, pre-warming the eggs will help, as it requires less energy and therefore less time to warm up the eggs from 26oC to incubation temperature than from 18oC to incubation temperature.

The last days

Later in incubation, cooling the eggs is no problem. In the third week of incubation we can take the eggs out of the machines for periods of 24 hours and even 48 hours. If we put them back after this period, their hatch time will obviously be delayed, but the hatch results are still good. In this period, the big risk is overheating, also because of the metabolic heat production, but not under cooling.

This also means that we have to take the moment of incubation in account if a machine breaks down. If it happens early in incubation, we want to keep the eggs as warm as possible, so preferably we repair the machine as quick as possible with the eggs still in and the doors closed. In the middle period, it depends on the time that is needed to get the machine fixed if we keep the eggs in or out. But in the later part of incubation, breaking down of a machine means that the eggs has to be taken out as quick as possible, to avoid the metabolic heat production to overheat them.