

Cooling by spraying

By Ron Meijerhof

When working in incubation, we often find that we can control the temperature in setters and hatchers better if the machines ask for a certain amount of spraying, especially if the cooling capacity of the machines is (too) limited. Some machines don't even have any other cooling possibilities than exchanging air and spraying. When the machines spray and evaporate water, we see that they hold their temperature better and don't get overheated so easily.

At first sight, this seems logical. Evaporation of water costs energy and therefore has a cooling effect. Evaporative cooling systems are based on this effect, and everybody who has ever walked in the rain will agree with it. Spraying of water will reduce the temperature and therefore cool the egg mass in a machine, and if overheating problems occur in a machine an increase in spraying of water by changing the humidity settings will bring the temperature down.

However, if we do some calculations and look at the total system we might have to add some remarks to these conclusions.

How much water is needed for effective cooling?

If we have a machine of 100.000 eggs of 60 grams, we are dealing with egg mass of about 6000 kg. The specific heat of eggs is approximately 3.5 kJ per °C per kg. This means that if we want to cool the egg mass in the machine 1°C, we need to extract $6000 \times 3.5 = 21.000$ kJ or about 5000 kcal of energy from this egg mass.

Evaporation of water costs energy. To evaporate one litre of water, 2260 kJ of energy is needed. If we have a 100% effective system, so all energy used to evaporate water is coming from the eggs, we need to evaporate almost 10 litre of water to cool the eggs with 1 °C.

Although this doesn't seem to be a large quantity, a machine has to spray quite frequently to use 10 litre, as the amount of water used by the sprayer is not that big. However, it shows that the machine can cool quite substantially if it sprays a lot of water. But will all eggs in the machine be cooled evenly?

What is the effect on temperature distribution?

If we spray water in the machine, not all eggs provide the same amount of energy for evaporation and are cooled to the same level. The sprayer is often located close to the ventilator, so that the high air velocity takes away the water rapidly. This means that the water is sprayed on the eggs within that high air velocity, and they will provide the energy for evaporation and will be cooled the most. Eggs away from that air velocity will benefit much less, or not at all. The eggs in the high air velocity already lose a lot of heat through the wind chill effect of air velocity. This means that these eggs were already cool, and will get even colder if the sprayer comes on. Eggs away from the air velocity were relatively warm, and will stay warm.

Fooling the sensors

The temperature sensor in a machine is normally located in an area with high air velocity. This is by itself correct, as the sensor will pick up temperature differences rapidly. However, if the machine sprays so much water that it isn't all evaporated before it hits the sensor, the sensor will be cooled by the water, the machine will think the temperature drops and in extreme situations will even start heating. Although we often think that the water is evaporated if we don't see droplets anymore, we have to realise that the water first needs to pick up energy before it can evaporate, and if it didn't pass enough eggs before it hits the

sensor, the sensor will be cooled. But the eggs away from the air velocity and the water spray will still be warm, and will even get warmer as the machine starts heating. It is as if we put the thermometer in a room in a glass of cold water when we feel hot..

Spraying of water in machines helps to bring down the temperature, but we have to realise it brings down especially the temperature reading on the display, not so much the temperature of the eggs. Spraying a lot of water will often increase the spread in temperature experienced by the eggs in the machine, and sometimes will even increase the temperature in the hot places.