Gildetrom 25 | P.O. Box 256 | NL-3900 AG Veenendaal | The Netherlands | T +31 (0)318 512511 | F +31 (0)318 517487 | info@hatchtech.nl | www.hatchtech.nl

Laminar Airflow: The Crucial Basis of Good Incubator Design

Dr. Inge van Roovert-Reijrink and Dr. Donna Hill

To optimize hatchability and chick quality, embryo temperature control is crucial. Research has shown that an embryo temperature of 37.8°C throughout incubation results in optimal hatchability and chick quality. In the last decade, incubator manufacturers have increased the size of their incubators to decrease the cost price. As incubator size increases, it is more difficult to maintain the optimal 37.8°C embryo temperatures uniformly throughout the egg mass. The environment must be uniform to ensure uniform embryo temperatures. This article discusses the factors that create the incubation environment and why uniform airflow, i.e. laminar airflow, is the crucial basis of a good incubator design.

Embryo Temperature

The embryo temperature is a result of the embryonic heat production (A) and heat transfer capacity of the environment surrounding the embryo (B).

A. Embryonic Heat Production

Embryonic heat production is dependent on the breed, the breeder flock age, and the stage of incubation. The first few days of incubation, the embryonic heat production is very low. After 9 days of incubation, the embryonic heat production increases exponentially.

B. Heat Transfer Capacity of the Environment Surrounding the Embryo

Heat transfer is the transition of thermal energy from a relatively warmer to a relatively cooler object. How successful heat is transferred to or from the eggs is dependent on air temperature (1), air velocity (2), and relative humidity (3). Laminar airflow ensures that the environment is delivered uniformly through the egg mass.

1. Air Temperature

In the first 9 days of incubation, the embryonic heat production is very low and the eggs are losing water. Evaporation of water consumes energy and cools the embryo. For these reasons, the air temperature must be higher than 37.8℃ to transfer heat to the embryos during this time. After 9 days of incubation, the embryonic heat production increases exponentially. At this point, the embryos require cooling to remove the embryo heat and the air temperature must be lower than 37.8℃ to maintain an embryo temperature of 37.8℃.

2. Air Velocity

Uniform air velocity is important to maintain uniform embryo temperatures. When air velocity is low, the air moves slowly across the eggs. Consequently, the air has more time to absorb heat from the eggs. The downstream eggs are not cooled as much as the upstream eggs because warmer air has less cooling capacity than cooler air. The lower the air velocity, the more variation that there is in embryo temperatures. When the air velocity is 0.5 m/s, the difference in embryo temperature between eggs (over a distance of 0.5 meter) is 1.5℃. When the air velocity is 2 m/s the difference in embryo temperature between eggs is only 0.2℃.

3. Relative Humidity

Relative humidity is also a very important component of heat transfer. Humid air transfers heat better than dry air. It would be ideal to maintain a high relative humidity during the whole incubation process, but egg weight loss must also be considered. Egg weight loss should be at least 10% at 18 days of incubation. A balance must be found between relative humidity to control heat transfer and relative humidity to control egg weight loss.

The quality of the relative humidity in the air is important. Humid air that contains moisture naturally derived from the eggs has an excellent heat transfer quality and is uniformly spread throughout the incubator. In contrast to relative humidity naturally derived from the eggs, relative humidity created by a spray nozzle does not have the same quality. The larger droplet size creates areas of evaporative cooling in the egg mass.

Unfortunately the moisture supply of the eggs itself is not adequate to supply the minimum relative humidity levels throughout the incubation process. At the end of incubation, ventilation increases to supply the oxygen demand of the embryos and to remove carbon dioxide. Consequently, moisture is also removed from the incubator and must be increased by a humidification system to maintain the minimum relative humidity necessary to create a uniform environment. A spray nozzle will cool the embryos with evaporative cooling and is detrimental for the uniformity of the environment in the incubator. To maintain uniformity of the environment, the droplet size must be small enough to be uniformly distributed throughout the egg mass so that the water droplets evaporate equally on all eggs instead of on a few eggs. To meet these demands, HatchTech Incubation Technology designed the HatchTech U-Vaporator which

delivers a 1 micron droplet size to effectively and uniformly provide humidification to the egg mass.

Laminar Airflow: the Crucial Basis of Good Incubator Design

HatchTech Incubation Technology has created the ideal incubation environment. Air velocity, air temperature, and relative humidity are controlled to meet the embryo requirements at each stage of incubation. To deliver this environment to the egg mass in the large commercial sized machines of today, laminar airflow is necessary. Laminar airflow ensures that the incubation environment and therefore embryo temperatures are uniform.

In the HatchTech incubator and hatcher, the air flows from the right to the left side in parallel layers. This is also known as a “streamline airflow” or “laminar airflow”. The laminar airflow is created by pressure differentials within the environment and the perforated radiators that are located upstream before and after every setter trolley.

The laminar airflow in the HatchTech incubator and hatcher eliminates variations in embryo temperatures. This results in positive returns on your investment as hatch losses are often caused by variations in embryo temperatures. In a hatchery that produces 800,000 chicks per week and has a day-old chick cost of € 0,30, a hatch loss of 2%, means a loss of € 250,000 per year. In reality, the loss of money will be higher because variation in embryo temperatures will also cause higher mortality and diminished performance during the growing period.

In conclusion, laminar airflow ensures uniformity of airflow in the HatchTech incubator and hatcher. The uniform airflow guarantees that the optimal combination of air temperature, air velocity, and relative humidity reaches every egg in the incubator. This makes it possible to maintain optimal hatchability and chick quality on a year round basis, year after year.