



HATCHERY/BREEDER TIP ...

AIR REQUIREMENTS DURING INCUBATION

The main components of air are oxygen (O₂), nitrogen (N₂), carbon dioxide (CO₂), and water vapor (H₂O). The free movement of these molecules through the pores of the shell and the shell membranes is important because the developing embryo must receive a constant supply of oxygen and must eliminate carbon dioxide and moisture.

a. Oxygen in the Air

The oxygen content of the air at sea level is about 21%. It is impossible to increase the percentage appreciably in incubators unless pure oxygen is introduced. Generally, the oxygen content of the air in the setter remains at about 21%, but there may be some variation in the hatcher where large amounts of carbon dioxide are produced by the newly hatched chicks. The main danger in these cases, is that high levels of carbon dioxide become toxic. Hatchability will drop about 5% for each 1% that the oxygen content of the air drops below 21%.

As the embryo ages, its oxygen requirement increases and more carbon dioxide is given off. Each process is speeded up approximately 100 times between the first and 21st day of incubation, as shown in the table. Since 1,000 eggs require 143 ft³ of fresh air per day (oxygen in the air at 21%) on the 18th day of incubation, an incubator holding 40,000 eggs would need 5,720 ft³ of fresh air, or approximately 238 ft³ per hour. Therefore, it must be possible to change the air in the incubator about eight times a day or once every 3 hours. This rate of air exchange is the minimum required. Air exchange rates in most machines are usually more than adequate. In some cases, care must be taken to ensure that over-ventilation and a corresponding excessive loss of moisture does not become a problem.

Gaseous exchange during incubation

Day of Incubation	Absorption of Oxygen (ft ³)	Expulsion of Carbon Dioxide (ft ³)
1	0.50	0.29
5	1.17	0.58
10	3.79	1.92
15	22.70	11.50
18	30.00	15.40
21	45.40	23.00

Source: Romanov, A.L., 1930. *Journal of Morphology* 50:517-525.

PUTTING KNOWLEDGE TO WORK

b. Carbon Dioxide Tolerance

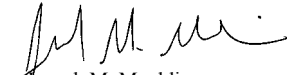
Carbon dioxide (CO₂) is a natural by-product of metabolic processes during embryonic development. In fact, CO₂ is released through the shell from the time the egg is laid. Carbon dioxide levels increase in the air within the setter and hatcher when there is insufficient air exchange. Younger embryos have a lower tolerance level to CO₂ than older ones. The tolerance level seems to be linear from the first day of incubation through the 21st day. During the first 4 days in the setter, the tolerance level to CO₂ is about 0.3%.

Carbon dioxide levels above 0.5% in the setter reduce hatchability, with significant reductions at 1.0%. Total embryo mortality occurs at 5.0% CO₂. Hatching chicks give off more CO₂ than embryos in eggs, and the tolerance level in the hatcher is about 0.75%. Recording devices are available for measuring the CO₂ content of the air, and some incubators have them as standard equipment. The best place to measure the CO₂ is in the exhaust duct coming out of the setter or hatcher. Measurements taken inside the machines are not as accurate because opening the doors will change the environment in the machine.

c. Airflow and Mixing

The most important aspect of airflow in an incubator is to ensure the proper mixing of temperature and humidity throughout the incubator cabinet while bringing in fresh air for oxygen and exhausting used air to reduce carbon dioxide, excess moisture, and temperature. Different incubator manufacturers have different means of circulating air: paddles, blades, and fans. In most cases, it is the pattern of airflow that is most important. Air, like water, follows the path of least resistance. An incompletely closed baffle door, a poor door seal, or a fan out of alignment will negatively affect airflow patterns. In a poorly maintained machine insufficient air is circulated through the mass of eggs resulting in hot and cold spots, which in turn creates slow hatches, reduced hatchability, and lower chick quality. Incubator maintenance is critical to achieve optimum air flow.

Ventilation of setter and hatcher rooms has a strong influence on the efficient operation of the machines and on subsequent hatchability and chick quality. An incubator will successfully incubate eggs even when it is placed outdoors. However, in this situation, it will neither operate efficiently nor economically, and the performance in hatchability and chick quality will be lower. For optimum performance, incubators need to be enclosed in a room where there is plenty of fresh air that has been preconditioned with temperature and humidity with a slightly positive air pressure differential between the incubator (setter or hatcher) room and adjacent rooms. Typically, hatcher and setter rooms have thermostats, humidistats, and pressure controls that are designed to create a good working environment for the machines. The acceptable ranges for setter and hatcher room temperature and humidity are between 75 and 80°F and 50 to 60% R.H. When these environmental parameters are outside the acceptable range, the incubators will compensate, but at an economic and efficiency cost. For example, when a setter room is too cool, the incubator will use additional heat to achieve the correct incubation temperature. However, heating the air with setter electric heating rods will be more than three times the cost of heating the room air with a gas furnace before it goes into the incubator. Further, when incubators have to work harder to create the correct incubation temperature, the temperature environment inside the mass of eggs is often not optimally uniform. This results in hot and cold spots within the machine, speeding the rate of development of some embryos while delaying the development of others. Similar non-optimum results occur when the humidity is outside the acceptable range. For example, when a setter room environment is too dry, the incubator will provide the additional humidity at the expense of economics and performance. Every time the incubation humidifier comes on, the mist creates evaporative cooling and the electric heating elements will respond (economic cost). Additionally, the evaporative cooling caused by the mist will signal the fresh air dampers to close more, which results in less oxygen, more carbon dioxide, and higher performance costs.


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****Consult with your poultry company representative before making management changes****