Factors affecting incubation in high humidity regions

Moisture loss during incubation is critical for embryo development and to ensure good chick quality. The environment has a large impact on moisture loss; it is greater in dry air as the moisture is removed quickly from the egg.

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However, in a high humidity environment, the difference between the internal and external environments of the egg is small, making it more difficult for moisture to leave the egg.

If weight loss is marginally too low, the first solution is to reduce the humidity. For example, a humidity change of 5% during incubation gives a 1% difference in moisture loss at 18 days. Moisture loss can be improved by increasing the minimum ventilation after seven days or lowering the CO_2 set-point, effectively forcing the ventilation to open more.

However, in high humidity regions, the air coming into the hatchery is already saturated with water vapour, and no amount of ventilation ensures sufficient moisture loss. In this case, water vapour needs to be removed from the air before it enters the incubators.

Absolute humidity (g/m³)

Temperature (°C) \ Relative humidity (%)	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
40	2.58	5.15	7.73	10.30	12.88	15.45	18.03	20.60	23.18	25.75	28.33	30.90	33.48	36.05	38.63	41.20	43.78	46.35	48.93	51.50
35	2.00	3.99	5.99	7.98	9.98	11.97	13.97	15.96	17.96	19.96	21.95	23.95	25.94	27.94	29.93	31.93	33.93	35.92	37.92	39.91
30	1.53	3.06	4.59	6.12	7.65	9.18	10.70	12.23	13.76	15.29	16.82	18.35	19.88	21.41	22.94	24.47	26.00	26.53	29.05	30.58
25	1.16	2.32	3.48	4.63	5.79	6.95	8.11	9.27	10.43	11.59	12.74	13.90	15.06	16.22	17.38	18.54	19.70	20.85	22.01	23.17
20	0.87	1.74	2.60	3.47	4.34	5.21	6.08	6.95	7.81	8.68	9.55	10.42	11.29	12.15	13.03	13.89	14.76	15.63	16.50	17.36
15	0.64	1.29	1.93	2.57	3.22	3.86	4.51	5.15	5.79	6.44	7.08	7.72	8.37	9.01	9.65	10.30	10.94	11.58	12.23	12.87
10	0.47	0.94	1.42	1.89	2.36	2.83	3.31	3.37	4.25	4.72	5.19	5.67	6.14	6.61	7.08	7.55	8.03	8.50	8.97	9.44
5	0.34	0.69	1.03	1.37	1.71	2.06	2.40	2.74	3.08	3.43	3.77	4.11	4.45	4.80	5.14	5.48	5.82	6.17	6.51	6.85
0	0.25	0.49	0.74	0.98	1.23	1.47	1.72	1.96	2.21	2.45	2.70	2.94	3.19	3.43	3.68	3.92	4.17	4.41	4.66	4.90

Table 1. The relationship between temperature, absolute humidity and relative humidity.

Relative humidity (RH%) and absolute humidity

Historically, relative rather than absolute humidity has been used for measurement in the hatchery. However, it is essential to understand the difference between the two.

The absolute humidity is the amount of water in the air, regardless of temperature, and is usually expressed as grams of water in a cubic metre (g/m³).

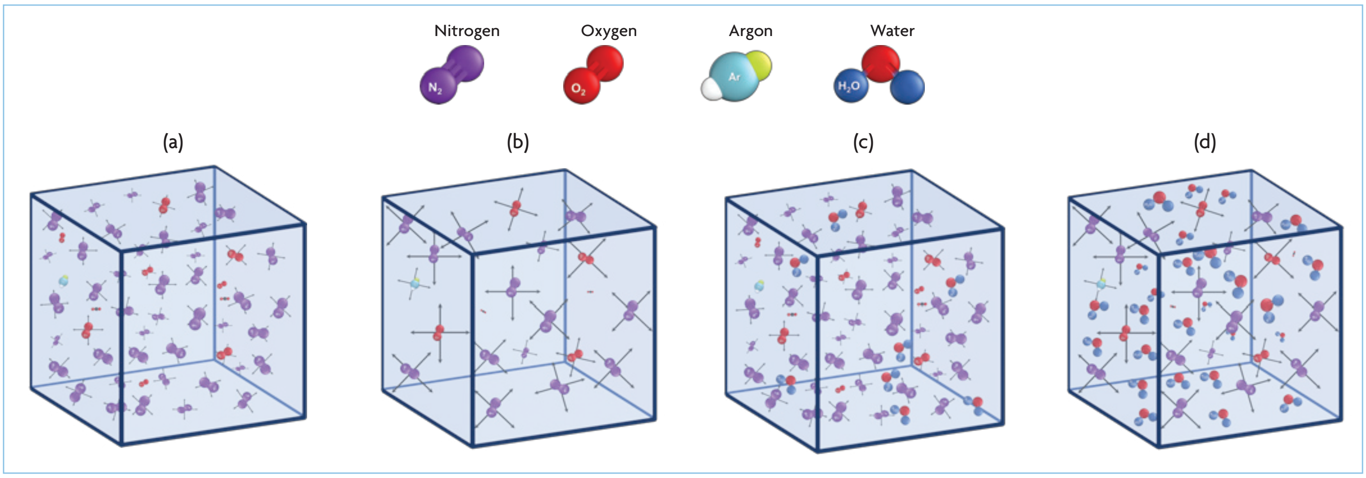
The RH% is a measurement of the volume of moisture the air can hold at a given temperature. For example, at 12°C, the maximum volume of moisture held by the air is only 10.7g/m³, which makes 10.7g/m³ = 100% relative humidity.

This moisture retention shows that even a high RH% does not automatically equate to a large volume of actual moisture in the air.

The moisture-holding capacity of air is determined by how far apart the component molecules are and how fast they vibrate.

The way the molecules are packed into a cubic metre of air determines how much moisture the air can hold. At low temperatures, molecules are packed tightly together, leaving little space between them (Fig. 1a). In contrast, molecules in air with a higher

Fig. 1 Dry air at 12°C (53.6°F) with 0% relative humidity (a). Dry air at 37.8°C (100°F) (b). Air at 12°C (53.6°F) with a high relative humidity (c). Humid air at 37.8°C (100°F) (d).



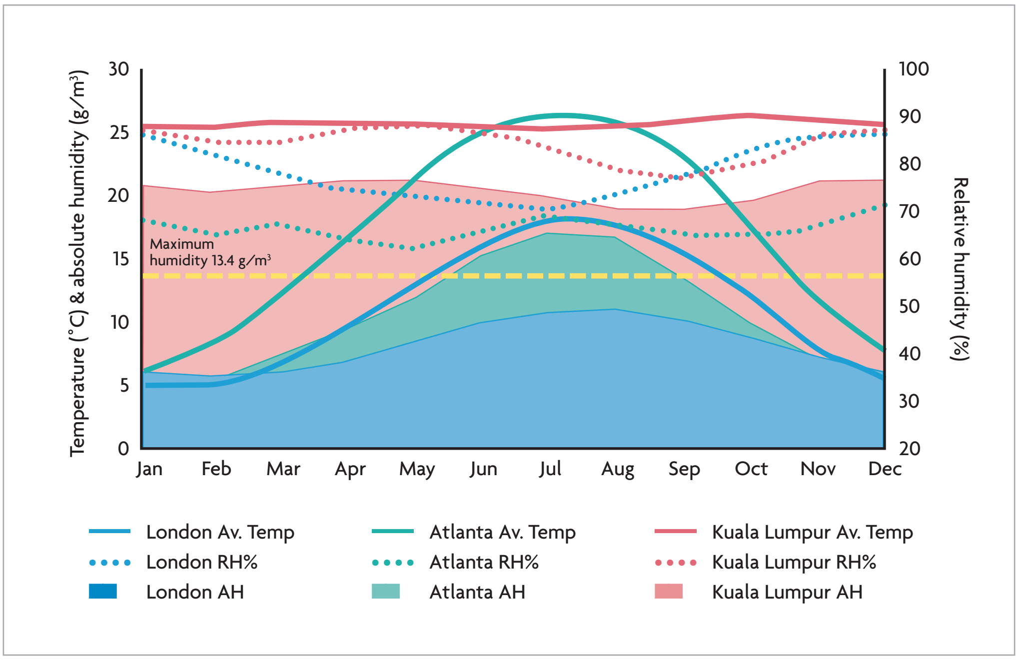


Fig. 2. Temperature, RH% and absolute humidity in London, Atlanta and Kuala Lumpur in one year (Source: www.weatherspark.com).

temperature will move faster and further apart, creating greater voids (Fig. 1b). Even with high relative humidity, at low temperatures, there is not much space, and the air cannot hold much moisture (Fig. 1c). With higher temperatures and larger spaces, the air can hold much more moisture (Fig. 1d).

For example, an egg store running at a 15°C (59°F) saturation point (when relative humidity reaches 100%) would have 12.87g/m³ of water.

When that air is warmed, it expands, and if increased to 35°C (95°F), holds 39.91/m³. So the original 12.87g/m³ represents only 32.2% of the humidity the air can hold at the higher temperature (Table 1).

Moisture is lost from the egg through osmosis, the rate of which is determined by the RH% of the environment where the egg is placed.

Air should be supplied to the incubators with a maximum absolute humidity of 13.4g/m³ (air at 26°C, relative humidity of 55%).

In high humidity regions (Tropical Zone), air temperature and humidity are far higher. For demonstration purposes, the temperature, RH% and absolute humidity of three cities; London (located in a cool Temperate zone), Atlanta (in a Subtropical Zone) and Kuala Lumpur (in the Tropical Zone), are shown in Fig. 2.

If we examine the maximum volume of water (13.4g/m³) above which it is not possible to control humidity sufficiently to optimise weight loss, it is clear that London never normally reaches this level, meaning weight loss is not a problem.

However, in Atlanta, the absolute humidity is above 13.4g/m³ from May to September, and during this time, moisture loss is problematic. And, in Kuala Lumpur, absolute humidity never goes below 13.4g/m³.

Therefore, any moisture above the yellow line (maximum humidity) must be removed (all year round in Kuala Lumpur and between May and September in Atlanta) before it is delivered to the incubators (Fig. 2).

How can moisture be removed from the air?

The volume of moisture that air can hold is determined by its temperature, which affects the distance between the component molecules and the speed at which they vibrate. Therefore, if moisture removal is necessary, the air must be cooled until it can no longer hold more than 13.4g/m³, occurring at 15.7°C.

Because air travels rapidly in a heating, ventilation, and air conditioning (HVAC) system, it is typically necessary to chill the air using cooling water of around 10-11°C to ensure sufficient moisture is removed (Fig. 3).

After surplus moisture has been removed, the air needs to be reheated. Otherwise, cold air creates cold spots in the machines while ventilating. The air can be heated using a cross plate heat exchanger. These use the hot return air from the setter to re-warm the now-dry air before delivery to the setter room. An auxiliary heater may also be needed to increase the temperature, if necessary (Fig. 4).

Conclusion

Ventilating with high humidity air will not enable further moisture loss. Therefore, any moisture above the 13.4g/m³ threshold needs to be removed.

The most efficient way to remove the moisture is by cooling the air to a level below its moisture-holding capacity of 13.4g/m³. Air can be warmed back up via the cross-plate heat exchanger, utilising the warm air returned from the setters.

A good quality chick from an egg that loses sufficient moisture during incubation will be active and curious (thrifty), seeking out water and feed upon arrival at the farm. ■

The first part of this incubation article was published in International Hatchery Practice, Volume 35 Number 6

Fig. 3. Removing extra moisture with the HVAC system.

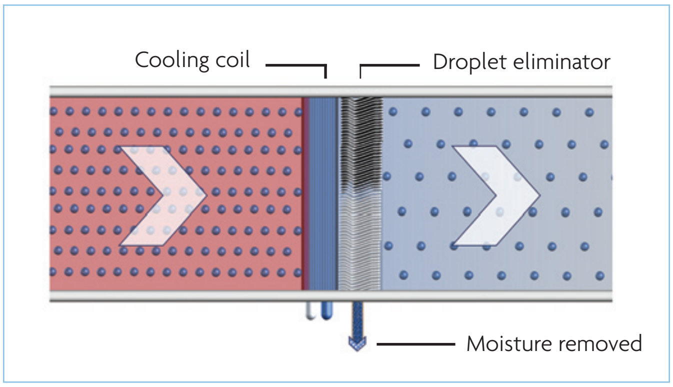


Fig. 4. Re-warm air by cross plate heat exchanger.