AVIAGEN MEA BRIEF

June 2018

Ventilation Tips for Hot, Dusty Environments

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Introduction

External weather conditions have a substantial impact upon the management of poultry houses. Climates around the world vary from country to country and even farm to farm. The poultry manager is faced with the challenge of maintaining optimum in-house conditions for animal welfare and performance regardless of the external weather conditions, some of which can be very severe **(Figure 1)**.

Figure 1. Example of a farm in a hot, dry climate.

Temperature, humidity, carbon dioxide, carbon monoxide, ammonia and dust should be monitored regularly (**see Table 1**) and controlled within appropriate limits to ensure that the birds perform well. In regions where the external environment is of a more extreme nature achieving optimum in-house conditions for bird performance and welfare becomes more of a challenge. It is essential that farm staff have adequate knowledge and experience to understand how the external environment can impact the in-house environment, which problems they may trigger and how that will affect the birds. In addition, modern broiler breeders and modern broilers contribute significantly to the conditions within the poultry house through additional heat and moisture output which must be successfully managed, no matter what the external environment, to maintain bird health, welfare and performance.

Table 1. Frequency of environmental parameter monitoring.

Parameter	Frequency
Temperature	Twice per day for first 5 days and then daily
Humidity	Twice per day for first 5 days and then daily
Carbon dioxide	Twice a week during brooding and afterwards if a problem is detected
Carbon monoxide	Twice a week during brooding and afterwards if a problem is detected
Ammonia	Daily by smell and afterwards if a problem is detected
Dust	Daily

This article highlights the importance of good ventilation for maintaining optimum conditions in poultry houses in regions where, especially during the summer months, the temperature may range from 15 - 50°C within a 24 hour period and very low levels of humidity (typically 10 - 20%) are frequently observed. This creates a unique environment which requires appropriate management of the in-house environment.

The relationship between humidity and temperature

Temperature and humidity work together to determine bird comfort. Making the correct decision on the comfort of the birds can only be made if the relationship between temperature and relative humidity (RH) is understood. The ability of the air to hold water (humidity) changes depending on air temperature; warm air can hold a lot more water than cold air. This is why we use the term relative humidity. The temperature being felt by the bird (the effective temperature) depends on dry bulb temperature and RH (**Table 2**). Variation in relative humidity will influence effective temperature:

- Higher RH reduces evaporative heat loss from the bird, increasing effective temperature.
- Lower RH increases evaporative heat loss from the bird, decreasing effective temperature.

Table 2. Principles of how optimum dry bulb temperatures may change at varying humidities.

Dry bulb temperatures, at the ideal RH at an age, are colored red.

Age (Days)	Dry Bulb Temperature (°C)			
	40 RH%	50 RH%	60 RH%	70 RH%
Day-old	36.0	33.2	30.8	29.2
3	33.7	31.2	28.9	27.3
6	32.5	29.9	27.7	26.0
9	31.3	28.6	26.7	25.0
12	30.2	27.8	25.7	24.0
15	29.0	26.8	24.8	23.0
18	27.7	25.5	23.6	21.9
21	26.9	24.7	22.7	21.3
24	25.7	23.5	21.7	20.2
27	24.8	22.7	20.7	19.3

Effective temperature is also influenced by:

- Air speed m / s (ft / min)
- Stocking density
- Feathering

The problem

The ideal RH in a poultry house post-brooding is around 50 - 55% with less than 5 g / m^3 of dust or particulate matter, a carbon dioxide level of < 3000 ppm, and carbon monoxide and ammonia levels of < 10 ppm. To achieve this 'air quality', the appropriate levels of humidity and temperature, balanced by optimum ventilation and heating conditions must be maintained. In regions where the external environment is hot and dry (low humidity) and where there can be large diurnal swings in temperature, this can be difficult to achieve and the environment within the poultry house may be dusty and the temperature difficult to control for optimal bird comfort.

In hot, dry climates, there are typically three problems:

1. Houses are designed for high temperatures only and not enough attention is paid to designing the house for minimum ventilation, which is required for young birds, when there are large dirunal swings in temperature and cooler seasons.
2. High temperatures, low humidity and poor air flow will cause the birds to become lethargic and this will lead to decreased water consumption, dehydration, reduced performance (poorer growth and FCR in broilers and lower egg output and fertility in breeders) and various respiratory problems.
3. Excessively dry houses contribute to the transmission of pathogens in dust (bacteria, fungi and viruses), which will impair bird health and welfare and may result in lower performance levels and reduced livability.

The importance of minimum ventilation in hot climates with low humidity

In hot, dusty climates, the aim is to increase the humidity and reduce the temperature inside the house. Prior to chick placement and litter spreading, humidity can be increased using water reservoirs on the floor (**Figure 2**). Once the flock is in the house fogging systems can be used. *Note: It is essential to only use clean, good quality water, free from pathogens, in any system used to increase in-house humidity levels.*

In many cases in hot, dry regions, houses are built only with tunnel ventilation capabilities which has the sole purpose of temperature reduction to deal with periods of extreme high temperatures. For older birds this works well, as tunnel ventilation will provide cooling, and if cool pads are installed, humidity to the house. However, in many dry climates, extreme diurnal temperature swings are also experienced and the temperature can range between 0 - 25°C in winter; under these conditions tunnel ventilation is not ideal. For young chicks, the combined use of tunnel ventilation and cooling pads is not suitable either, as it can lead to chicks becoming chilled and the use of tunnel fans alone, can actually increase the in-house temperature as large volumes of external hot air are drawn into the house. The use of minimum or transitional ventilation can therefore be hugely beneficial to maintain optimum levels of in-house temperature and humidity for chicks, and during periods when the external environment is cooler.

Figure 2. Example of in-house water reservoir prior to chick placement.

Minimum ventilation

For chicks and in cooler weather the key is to pull in smaller volumes of air on a regular basis at a lower air speed; this is the principle of minimum ventilation.

The principles of operating minimum ventilation fans in a dry climate are as follows:

- Operation of minimum ventilation fans should be timer rather than temperature driven. Fans should be rotationally operated on a 5 minute cycle timer at a constant speed, and the length of time the fan is on must be increased as bird biomass increases.
  - Minimum ventilation requirement = number of birds in house X appropriate minimum ventilation rate for bird weight (**see Broiler Handbook for more information**).
  - Percentage of time fan should be on with a cycle = minimum ventilation requirement ÷ total capacity of fans being used.
- The ventilation capacity of the fans running on the timer should allow enough air to be drawn into the house, to replace the total volume of air in the house.
- The timer fans should constantly work when the house set temperature is exceeded by 0.5 - 1.0°C. When the house temperature reaches the set point once again, the fans should then operate on the cycle timer again.

Reducing dust levels

There are several ways to help control and reduce dust levels in a house:

1. Displace or evacuate the contaminated air with regular air exchanges through correct ventilation management.
2. If litter is excessively dry as a result of low humidity, the movement of the birds in the house may increase the amount of dust present in the air, potentially raising levels by up to 50%. To control dust levels in the house, humidity can be increased by using fogging / misting nozzles.
3. Air filtration units may be added to inlets to reduce dust levels brought in from outside the house. However, it is important to remember that these units will reduce ventilation capacity. The ventilation system must be designed to accommodate an air filtration system.

The importance of house design

Besides having the correct ventilation equipment, the design of the poultry houses is important in hot and dusty climates. General principles of an ideal poultry house design and essential equipment requirements are listed below:

- The house should be oriented on an east-west direction to decrease the effect of sunlight during the day on the side walls.
- The poultry house needs to be designed to reduce temperature fluctuations by correct insulation of ceilings and walls.
- The house must be well sealed keeping air leakage to a minimum.
- Adequate heating capacity must be provided.
- Hot air should be able to build up in the peak of the roof or in an insulated loft space away from birds.
- Air inlets must be of good quality.
- The ventilation system should consist of:
  - Minimum ventilation (92 cm fan + inlets + pressure control)
  - Transitional ventilation (minimum ventilation fans + 2 - 3 tunnel fans + inlets + pressure control)
  - Tunnel ventilation (tunnel fans 127 cm + cooling pads)
  - A simple controller
- Fans operate on a cycle timer.
- Inlets operating by negative pressure.

In many poultry producing areas a large percentage of houses are now totally solid-wall construction, without curtains (**Figure 3**). These houses can be made extremely air tight and therefore the environment in the house can be 100% controlled by the ventilation and heating system. Solid wall houses save fuel and can provide maximum comfort to the birds in hot and cold climates, contributing to better flock performance.

Figure 3. Farm with solid side walls.

Management techniques under hot weather conditions

The importance of stockmanship in hot climates must not be overlooked. The correct operation of the ventilation equipment requires expertise in order to be able to operate and adjust the equipment correctly for bird comfort, flock behavior and condition must be monitored by an experienced and knowledgeable stockperson.

Other useful management strategies include:

- Walking slowly among the birds to aid air circulation, releasing heat trapped under the birds and encouraging water consumption, should be done throughout the day and especially in the morning to dissipate any heat as early as possible. This reduces overall house heat load before the hottest part of the day.
- Removing feeders 6 hours before the hottest time of the day. This means the feeders will not be a barrier to air movement and will also reduce the heat energy associated with feed consumption during the hottest period of the day. This also allows the birds access to more floor space.

Conclusions

Correct ventilation will allow;
- Better bird welfare
- Better feed efficiency
- Better growth rate, production levels and flock uniformity
- Better livability
- Stronger immune system
- Reduced total cost of production
- Reduced energy requirements and costs

Achieving the correct ventilation in hot and dusty climates is difficult. Increasing humidity and reducing the temperature in the house is essential. However, this must be done in a way that is appropriate for birds of all ages by effectively using the equipment available in the house. A good ventilation system should have the ability for minimum, transitional and tunnel ventilation.