The importance of minimum ventilation

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The importance of minimum ventilation is frequently overlooked. Even in the coldest weather, there is a need to maintain minimum ventilation to provide enough oxygen to meet the birds' demand, to control relative humidity and to maintain good litter conditions.

The mistake many producers make is placing too much emphasis on summer or tunnel ventilation. Often the theory is that minimum ventilation is not required in warm climates, or that summer ventilation procedures can be used in moderation.

The common misconception is that minimum ventilation can be achieved simply by limiting air velocity, but this does not address the air quality requirements of the flock. The main purpose of minimum ventilation is to provide good air quality and low air speed across the chicks. Good air quality will lead to better performance evidenced by less ascites, better feed conversion, better livability and lower cost of production.

Oxygen (%)	>19.6
Carbon dioxide (CO_2)	<0.3%/3000ppm
Carbon monoxide	<10ppm
Ammonia	<10ppm
Inspirable dust (%)	45-65
Relative humidity	<3.4mg/m^3

Table 1. Air quality guidelines.

It is important that the birds always have adequate oxygen and minimum amounts of carbon dioxide, carbon monoxide, ammonia and dust.

Ammonia levels

Without minimum ventilation, air quality deteriorates causing increased litter moisture and increased ammonia levels. Always evaluate ammonia levels at bird height. Increased levels of ammonia lead to foot pad burns, eye burns, breast blisters/skin irritations, decreased weights, poor uniformity, disease susceptibility and employee discomfort. High concentrations cause capillary constriction and increased heart and respiratory rates, leading to increased blood pressure and eventually pulmonary oedema (congestion).

Time	0 minutes	5 minutes	10 minutes	15 minutes
Ammonia (ppm)	15	35	50	80
Carbon dioxide (ppm)	300	1500	2600	3500
Humidity (%)	68	78	86	97
Temperature (°F)	68	75	82	88

Table 2. Changes after fans turn off.

Target	<10ppm
Human detection	>5ppm
Cilia stop/respiratory tract damage	20ppm (3min)
Body weight/FCR diminished	25-51ppm
Eye damage/starve outs/dehydration	46-102ppm (12 hours)

Table 3. Effects of ammonia exposure.

- The house needs to be as air tight as possible. Typically, leaks at the ridge, close to the fans or close to the floor, are a detriment to chick health. Negative pressure will be less effective with hidden air leaks. When properly sized inlets are installed, air leaks are not as detectable. Since air seeks the point of least resistance, it will tend to be drawn through the larger inlets instead of the smaller incidental openings. Use a manometer and anemometer to measure the pressure and air speed.
- Fans must have the capability to work against the necessary negative pressure and achieve the required air exchange rate.
- Inlets must be properly weighted, or the suspension adjusted, to have the capability to react to the fan volume and control the house pressure (pressure drop across the inlets).
- Inlets must direct the air into the peak of the house to prevent drafts on the floor and utilise the energy accumulated at the peak.
- House temperature must be adequate so the outside air expands on entering the house, increasing the moisture holding capacity of the air and reducing the relative humidity.
- The cycle timer must be adjustable and run time increased as air quality begins to deteriorate. The optimum total cycle time is five minutes and should never exceed 10 minutes. The fans should run for at least 20% of this cycle. For example: A 10 minute cycle includes two minutes on and eight

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Variable speed fans vs fixed volume fans

- Fixed volume fans are preferred to variable speed fans, but variable speed fans are useful in situations where the volume of the house does not match the capacity of any combination of fixed speed fans.
- To maximise energy efficiency, select fans between 36" (91cm) and 52" (132cm) in diameter. These fan sizes are most efficient in terms of the amount of air volume moved versus the energy required to run them.
- In small houses a single 36" (91cm) fan can provide both the minimum and maximum volume required for the minimum ventilation system more effectively than two smaller fixed volume fans.

Fans performance for variable speed fans compared to solid state controls

- The speed of a variable speed fan is determined by the voltage supplied to the fan by the controller. The fan is always most efficient when it runs at 100% speed.
- The set speed of the fan stated in percentage is only a guide to follow. It rarely accurately defines the fan speed or air volume being moved.
- The speed of any variable fan will vary based on the compatibility of the control with the fan being used.
- The relationship between the pitch of the blade and the blade speed means that 80% of the air volume is normally obtained as the fan moves from 80 to 100% speed.

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minutes off. A five minute cycle includes one minute on and four minutes off. When the air quality begins to deteriorate, the fans should be adjusted to run for a greater portion of each cycle. By the time the birds are 35 days of age, the fans should run a minimum of 25% of each cycle. For adult birds the fans should run for a minimum of 30% of each cycle. The total time for each cycle should never be changed.

- There must be a temperature override to speed up a variable speed fan or override the cycle timer on fixed volume fans.
- During severe cold weather, the shutters on the summer fans must be air-tight or all but two of them covered from the outside.

Pressure	Inlet space needed for number of cfm's	Width of house (ft/m)	Velocity (fpm/mps)
-0.03	1.0sq.in. for each 4.0cfm of fans	34/10.4	700/3.55
-0.04	1.0sq.in. for each 4.5cfm of fans	36/10.9	800/4.06
-0.05	1.0sq.in. for each 5.0cfm of fans	40/12.2	900/4.57
-0.06	1.0sq.in. for each 5.5cfm of fans	45/13.7	1000/5.08
-0.07	1.0sq.in. for each 6.0cfm of fans	50/15.2	1100/5.59
-0.08	1.0sq.in. for each 6.5cfm of fans	60/18.3	1200/6.10
-0.09	1.0sq.in. for each 7.0cfm of fans	70/21.3	1300/6.60

Table 4. Negative pressure scale.

- To allow proper house pressure control during periods of cold weather, minimum ventilation fans should be located on the side of the house facing the prevailing wind.

Many make the mistake of operating a minimum ventilation system by directing the air down the centre of the house like summer or tunnel ventilation. This produces too much air flow on the chicks and will not allow the cool air to mix with warm, chilling the chicks. The minimum ventilation should be directed across the house when the house is more than 250ft (76m) long. If mechanically operated (baffle) inlets are used, they should only operate when sidewall fans are running. Only inlets on the opposite side of the house to the fans should be used. When operated properly, the air speed should be minimal across the birds.

Negative pressure

The most efficient way to accomplish minimum ventilation is by using a negative pressure, cross-flow ventilation system, directing the incoming air into the peak of the house.

The pressure drop across the inlets should be adjusted to ensure that the incoming air reaches the peak of the house where heat has accumulated. The pressure drop selected will depend on the width of the house or how far the air is to travel once it enters the house. When the cool incoming air mixes with the hotter air it expands, increasing the moisture holding capacity of the air, thus reducing the relative humidity. Since the cooler air is heavier, it will force the warm air downwards and increase the temperature at the bird level and help keep the litter dry.

The following are calculations used to find the cubic volume of the house and to determine the number of fans needed.

- Calculate the average height of the house. Sidewall height (top of sidewall to floor) + the peak height (peak of roof to floor) / 2 = average height of house.
- Calculate the total cubic volume of air. Total cubic volume = length x width x average height.
- Calculate the air volume of the first stage of minimum ventilation. The fan volume for the minimum ventilation system should range from one air exchange every eight minutes to one air exchange every five minutes. To determine the air volume of the first stage of minimum ventilation, divide the total cubic volume by eight.
- Calculate the maximum volume of the minimum ventilation system. To determine the maximum volume of the minimum ventilation system, divide the total cubic volume by five.

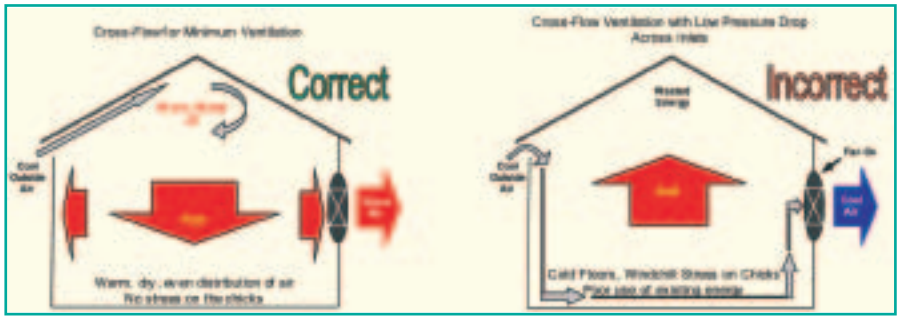

Fig. 1. The correct cross flow for minimum ventilation.

● Calculate the number of fans. Total air volume/fan volume at actual working pressure. As the fan volume increases and decreases, the minimum inlets must react to the change and maintain the same pressure drop across the inlets regardless of the fan volume. Air cannons and pressure control inlets are a useful way of supplying the needed amount of inlet area in a way that gives good air distribution, control the house pressure and help maintain feasible utility costs. Air cannons are simply 2.5-3.0" (6-8cm) plastic pipes installed through the sidewall of the house at the top of the sidewall at the same angle as the pitch of the roof.

● Calculate air velocity: Total fan volume/cross section of house (ft/m). For example: House = 400ft long x 40ft wide (121m x 12m)

- Calculate the average height.
  7.5ft + 12.5ft = 20ft/2 = 10ft (2.3m + 3.8 = 6.1m/2 = 3.05m)
- Calculate the total cubic volume of air.
  400ft X 40ft X 10ft = 160,000cfm (121m x 12m x 3m = 4356cmm).
- Calculate the air volume of the first stage of minimum ventilation.
  160,000cfm/8 = 20,000cfm (4356cmm/8 = 545cmm).
- Calculate the maximum volume of the minimum ventilation system.
  160,000cfm/5 = 32,000cfm (4356 cmm/5 = 871cmm).
- Calculate the number of fans for the minimum ventilation.
  32,000cfm/10,500cfm = 3 fans needed (871cmm/285cmm = 3 fans)

If the minimum ventilation fan volume was 31,500cfms with 3 x 36" fans (858cmms with 3 x 0.9m fans), the air velocity going across the house would only be 7.9ft per minute (2.4m per minute) and this is prevented by the air being directed into the peak of the house, therefore the chicks only feel still air.

During the first 14 days the air speed across the birds should be as low as possible, from 15 days to 21 days no more than 0.5mps (100fpm) and from 22 days to 28 days no more than 1.02mps (200fpm). After 14 days of age, use the effective temperature (dry bulb temperature – relative humidity – air speed) and not actual temperature for best performance of the birds.

After the hatchery, the most important period of the chicken's life is the first 10 days in the brooder house. Providing the birds with a good start is essential to their well being and overall performance. The cardiovascular, respiratory and immune systems are developing more rapidly than at any other time as well as their body structure. The first requirement is oxygen (19.6%) and the only source of oxygen is air volume. The second priority is the right temperature.

Without a good minimum ventilation system properly managed for good air and heat distribution, it is hard to maintain good air quality at a reasonable cost of energy.

As we do a better job at providing minimum ventilation, without too high air velocity across the birds, we can expect better performance. This will be seen in improved bird health, weight gain, feed conversion and livability. ■