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IMPORTANCE OF MINIMUM VENTILATION

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Minimum ventilation defines the minimum amount of air exchange required to maintain the environment in the poultry house for optimum health, well being and production efficiency. The benefits of a correctly operated minimum ventilation system include:

- The provision of oxygen to meet the birds demand
- The allowance for control of relative humidity
- The maintenance of good litter conditions.

The mistake many producers make is that they place 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. This editorial technical focus will provide guidelines for establishing an effective minimum ventilation system.

It is important that the birds always have adequate oxygen and minimum amounts of CO2, CO, NH3, and dust.

Air Quality Guidelines	
Oxygen %	> 19.6%
Carbon Dioxide (CO_2)	< 0.3%/3000 ppm
Carbon Monoxide	< 10 ppm
Ammonia	< 10 ppm
Relative Humidity	45-65%
Inspirable Dust	< 3.4 mg/m^3

Changes after Fans Turn Off				
	0 min.	5 min.	10 min.	15 min.
Ammonia	15 ppm	35 ppm	50 ppm	80 ppm
Carbon Dioxide	300 ppm	1500 ppm	2600 ppm	3500 ppm
Humidity	68%	78%	86%	97%
Temperature	68°F	75°F	82°F	88°F

Ammonia

Without minimum ventilation, the air quality in the poultry house can deteriorate causing increased litter moisture and increased levels of ammonia. Always evaluate ammonia levels at the bird height. Some of the negative effects of ammonia are: Foot pad burns, eye burns, breast blisters/skin irritations, decreased weights, poor uniformity, disease susceptibility, and employee discomfort. High concentrations of ammonia in the air will cause capillary constriction and increase heart and respiratory rates. This will lead to increased blood pressure and eventually pulmonary edema (congestions).

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

1. The house needs to be as air tight as possible. Typically, leaks that are located at the ridge, close to the fans, or close to the floor, are a detriment to chick health.

Negative pressure will be less effective when hidden air leaks exist in the poultry house. 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. It is advisable to have instruments such as a manometer and an anemometer to measure the pressure and air speed in order to properly set up the house for operation. The effects of unwanted air leaks will be lessened when operating the minimum ventilation system at the lowest pressure necessary to achieve optimum air mixing patterns.

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2. Fans must have the capability to work against the necessary negative pressure and achieve the required air exchange rate.

3. 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) consistently based on the width of the house being ventilated.

4. Inlets must direct the air into the peak of the house to prevent drafts on the floor and utilize the energy accumulated at the peak.

5. House temperature must be adequate to allow for expansion of the outside air entering the house to increase the moisture holding capacity of the air and reduce the relative humidity.

6. 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 ten minutes. The fans should run for at least 20% of this cycle.

For example:

- A 10 minute cycle includes 2 minutes on and 8 minutes off
- A 5 minute cycle includes 1 minute on and 4 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.

7. There must be a temperature override to either speed up a variable speed fan or override the cycle timer on fixed volume fans.

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
- In order to maximize energy efficiency, select fans between 36" (91 cm) and 52" (132 cm) 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-inch (91 cm) fan can provide both the minimum and maximum volume required for the minimum ventilation system more effectively than two smaller fixed volume fans.

Fan 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.

8. During severe cold weather, the shutters on the summer fans must be air-tight or all but two of them covered from the outside.

9. 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. (No minimum inlets have the capability to work against wind speed on the outside of the house without excellent wind protection.

Many make the mistake of operating a minimum ventilation system by directing the air down the center 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. In this situation, the chicks are chilled.

The minimum ventilation should be directed across the house when the house is more than 250 ft (76 m) 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, as we will see later.

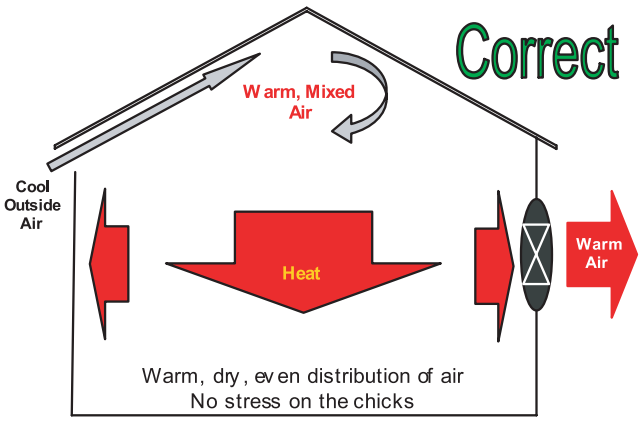
Negative Pressure

The most efficient way to accomplish minimum ventilation is by using a negative pressure cross flow ventilation system. This system should direct 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 the 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 downward to the floor and increase the temperature at the bird level and help keep the litter dry.

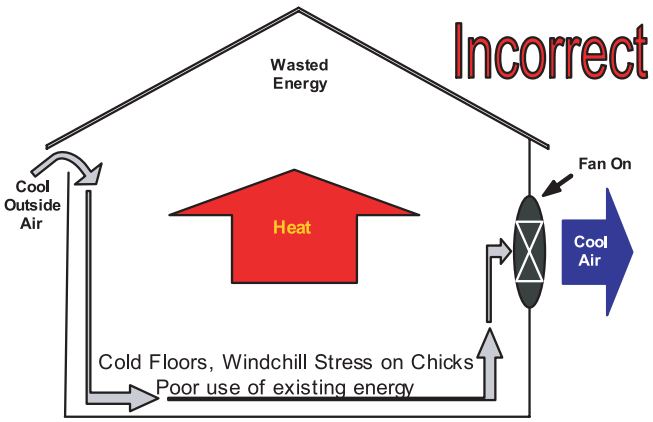
Negative Pressure Scale

Pressure	Inlet space needed for number of cfm's	Width of house	Velocity
-.03	1 square inch for each 4.0 cfm's of fans	34 ft, 10.4 m	700 fpm 3.55 mps
-.04	1 square inch for each 4.5 cfm's of fans	36 ft, 10.9 m	800 fpm 4.06 mps
-.05	1 square inch for each 5.0 cfm's of fans	40 ft, 12.2 m	900 fpm 4.57 mps
-.06	1 square inch for each 5.5 cfm's of fans	45 ft, 13.7 m	1000 fpm 5.08 mps
-.07	1 square inch for each 6.0 cfm's of fans	50 ft, 15.2 m	1100 fpm 5.59 mps
-.08	1 square inch for each 6.5 cfm's of fans	60 ft, 18.3 m	1200 fpm 6.10 mps
-.09	1 square inch for each 7.0 cfm's of fans	70 ft, 21.3 m	1300 fpm 6.60 mps

Cross-Flow for Minimum Ventilation



Cross-Flow Ventilation with Low Pressure Drop Across Inlets



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

Calculations

1. 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.

2. Calculate the total cubic volume of air.

Total cubic volume = Length x Width x Average Height

3. 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 8 minutes to one air exchange every 5 minutes. To determine the air volume of the first stage of minimum ventilation, divide the total cubic volume by 8.

4. 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 5.

5. 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 to 3 inch (6-8 cm) 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.

6. Calculate air velocity.

Total fan volume/cross section of house (ft)

Example:

House = 400 ft long X 40 ft wide

1. Calculate the average height.
7.5 ft + 12. 5 ft = 20 ft / 2 = 10 ft

2. Calculate the total cubic volume of air.
400 ft X 40 ft X 10 ft = 160,000 cfm

3. Calculate the air volume of the first stage of minimum ventilation.
160,000 cfm/ 8 = 20,000 cfm

4. Calculate the maximum volume of the minimum ventilation system.
160,000 cfm/5 = 32,000 cfm

5. Calculate the number of fans for the minimum ventilation.
32,000 cfm / 10,500 cfm = 3 fans needed

If the minimum ventilation fan volume was 31,500 cfms (3 36 inch fans) the air velocity going across the house would only be 7.9 feet per minute and this is prevented by the air being directed into the peak of the house, therefore the chicks only feel still air.

Cautions

The first 14 days the air speed across the birds should be as low as possible. From 15 days to 21 days the air speed across the birds should be no more than .5 mps (100 fpm). From 22 days to 28 days the air speed across the birds should be no more than 1.02 mps (200 fpm). After 14 days of age, the effective temperature (dry bulb temperature - relative humidity - air speed) and not actual temperature for best performance of the birds.

Conclusions

The most important period of the life of the chicken, after the hatchery, is the first 10 days in the brood house. During this time, the chicken is more efficient than it will be during the rest of its life. Therefore, their start during the first 10 days is essential to the entire life cycle and performance. The cardiovascular, respiratory and immune systems are developing more rapidly during this time period than at any other time in their life as well as the structural development of the frame. The first requirement is oxygen (19.6%) and the only source of oxygen we have is air volume, therefore this should be our first priority. The second priority is temperature (heat). 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. The improved performance can be in the form of improved bird health, weight gain, feed conversion and livability.

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