Choosing Fans for Livestock and Poultry Ventilation

Livestock Industry Facilities & Environment

Introduction

Fans are an important component of any mechanically ventilated livestock or poultry house. They are the driving force behind the exchange of air that is necessary to create a healthy environment for animals and associated farm workers. Other components of the ventilation system, such as the inlets and control circuitry, are used to harness the quantity of air exchanged to create an acceptable and uniform building environment.

Quantifying quality

To understand the principles of fan selection, some basic terms must be understood. These include the following:

Air delivery

Air delivery is the amount of air that a fan will move in a given situation. This term is expressed as volume of air movement per unit time. The standard unit is cubic feet per minute (cfm).

Static pressure

Static pressure is the difference in pressure that a ventilation fan creates between the inside and outside of a mechanically ventilated structure. Static pressure may be measured using a manometer (figure 1). Fans are used to create a vacuum within a building by exhausting air. The indoor environment, having a lower pressure than the outside environment, will draw air in through inlets (figure 2). This is called a negative pressure system. In most animal housing situations, the static pressure of the ventilation systems is between 0.04 and 0.06 inches of water. A free hanging fan, such as a stirring fan, will operate with no static pressure.

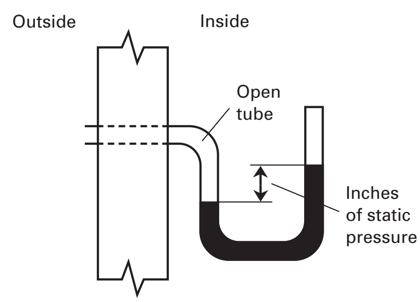

Figure 1. Static pressure as measured with a manometer

Efficiency

The efficiency of a fan generally is given as air delivery rate per unit of energy. Most ratings use the units of cfm per watt (cfm/W).

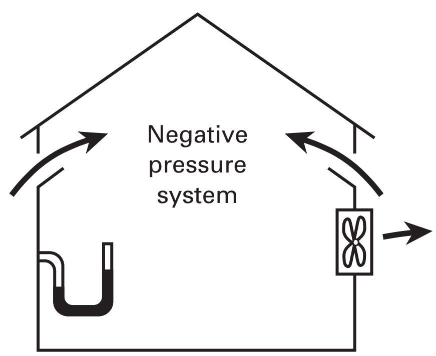

Figure 2. A negative pressure system with inlets and an exhaust fan

Important criteria

When choosing a fan, consider several important criteria, including:

- quantity of air delivered at different static pressures,
- energy efficiency,
- quality of dealer service and support,
- reliability and life,
- suitability for intended application, and
- cost.

These criteria must be considered and weighed against each other. Fans should not be chosen solely using the criteria of initial cost.

Fan rating

Never assume that two fans of equal size will perform the same. Fans from different manufacturers may perform much differently. For instance, it has been found through testing of several 24-inch fans that the air delivery ranged from 3,410 to 6,960 cfm, and the efficiency ranged from 8.2 to 15.3 cfm/W.

Fans should be rated to show performance as a function of static pressure. This information will be presented by using either a graph or table. When purchasing fans, a performance table should be provided. An example of this information appears in table 1. This information should be based on

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Table 1. Example fan data for a 24-inch fan with shutter, guard, and discharge cone

Static Pressure in. water	Speed rpm	Airflow cfm	Efficiency cfm/W
0.00	1,078	6,590	16.6
0.04	1,073	6,268	15.5
0.05	1,071	6,178	15.1
0.10	1,065	5,750	13.7
0.15	1,061	5,333	12.5
0.20	1,058	4,798	11.1
0.25	1,060	4,137	9.7
0.30	1,074	2,020	5.1

tests performed using the fans as they will normally operate, including use of guards, shutters, discharge cones, and other accessories. Beware of using manufacturers' data if it is not backed by an independent laboratory. Two laboratories, the Air Movement and Control Association (AMCA) in Chicago and the Bioenvironmental and Structural Systems (BESS) lab at the University of Illinois, are known to test fans impartially. AMCA has been the industry standard for many years. Fans that have been tested by AMCA will carry a decal similar to the one in figure 3.

Figure 3. This label indicates that the fan has been tested by the Air Movement and Control Association (AMCA)

Efficiencies generally are better for larger fans than smaller ones. For instance, a good rating for a 24-inch fan at 0.1 inches of water is 12 cfm/W. But a 36-inch fan should have an efficiency of 17 cfm/W, and a 48-inch fan should have one equivalent to 19 cfm/W.

Typically, mechanical ventilation systems include multiple fans. Various ventilation rates are needed because of the ever-changing outdoor temperature. A minimum ventilation rate is established to maintain a degree of air quality in the building during the winter. A maximum ventilation rate is established during the summer at a point where additional ventilation will not cool the building further. Several fans may be used to achieve the various ventilation rates required to bridge between these points. This is called "fan staging." For example, consider a building that requires 1,000 cfm in the winter and 13,000 cfm in the summer. A minimum ventilation fan would be selected that provides approximately 1,000 cfm. The next fan stage might provide 7,000 cfm; 1,000 from the minimum ventilation fan and 6,000 cfm from a second fan. The third stage might add another 6,000 cfm for a total of 13,000 cfm. By staging fans, a relatively constant environment may be maintained. When selecting fans for animal housing, use the rating at 0.125 inches of water to add a safety factor. Pit fans and fans used with evaporative pads use different static pressure criteria.

If the minimum ventilation rate is so low that no fan is available to move the proper amount of air, use a variable speed controller. Fans should not be operated at less than half speed and the second stage should not begin until the minimum ventilation fan has reached full speed. Do not use cycle timers to meet ventilation needs, especially in conjunction with ceiling inlets. Moisture will condense in the attic during periods when the cycling fan is off.

Factors affecting fan performance

The configuration in which a fan is installed and the manner in which it is maintained greatly affect its performance. Guards generally decrease the fan performance less than 5 percent. Guards should always be left in place because they protect workers from the fan and the fan from objects.

Shutters reduce fan performance from 10 to 25 percent. If fans are to run continuously, shutters should not be installed because they serve no useful purpose in this situation. Dirty shutters can reduce air delivery by as much as 40 percent. Regular cleaning and maintenance keep shutters operating at their manufactured level of efficiency. Lubricate with graphite products to prevent dust from sticking to lubricated parts.

If belt-driven fans are used, check belt tension regularly. Loose belts will cause the fan to be less efficient and contribute to belt wear. An over-tight belt will cause undue wear on bearings. Discharge cones and other well designed fan housings can increase fan efficiency by 15 percent or more. This is due to reduced air turbulence of air entering or leaving the fan.

Fans for specialized uses

In certain situations, specific fan characteristics are needed for special uses.

Mixing fans generally are selected for their ability to throw air. This is accomplished by use of special shrouds and deflectors that create a jet of air that travels farther than normal fan discharge. Mixing fans are considered to operate at “free air” or 0.0 inches of static pressure.

Ceiling fans also are used for mixing and are not easily rated because they are free-air fans. Most ceiling fans have small motors and are relatively efficient. They do a good job in situations where temperature stratification is a problem or if air movement is needed in pens with solid partitions.

Minimum ventilation fans are used to provide ventilation air during cold conditions. Generally, these fans are sized by calculating a required quantity of air to ensure proper air quality. The fan selected then provides this amount of ventilation air by running continuously, by running on a variable speed, or, in the case of some poultry facilities, by intermittent operation using a cycle timer. These fans should be influenced little by changes in static pressure. In other words, air delivery at 0.04 and 0.1 inches of static pressure should be nearly equal. This is to prevent substandard ventilation during windy winter conditions. Use the rated air delivery at 0.125 inches of static pressure to select minimum ventilation fans. If minimum ventilation fans run continuously, do not install shutters.

Fans used for under-slat ventilation or **pit fans** should have sealed motors and be made of corrosion-resistant materials. If they are used on a pit duct, select a fan that will move the required air at 0.25 to 0.30 inches of water. Deep-pit buildings should use pit fans for minimum ventilation.

Fans used in livestock ventilation systems using **evaporative cooling pads** should be sized to provide the necessary air flow at higher static pressure. This is necessary because of increased resistance from drawing air through wetted pads. Fans used to draw air through evaporative pads should be sized based on static pressure of 0.15 to 0.2 inches of water, depending on the thickness and material of the evaporative pad.

Fan installation

The location and wiring of fans are essential to good performance and safety of operation. The following are some guidelines to fan installation:

1. Fans should be installed on the side opposite the prevailing winds, if possible. If a sheltered area is not available, commercially available fan shrouds help reduce the effect of wind on fan performance.

2. Inlets should not be installed within 8 feet of fans. When installed closer, the ventilation system may be thwarted by exhausting fresh air rather than mixing it within the building.

3. Motors must be securely fastened to a rigid, flat surface to prevent vibration and to minimize noise.

4. Fan motor circuits should have:

- branch circuit overcurrent protection to protect circuit conductors against short circuits and ground fault currents;

- a power disconnect to completely disconnect the motor from the power supply;

- a controller to start and stop the motor, and to interrupt the current if the motor fails; and

- an overload protection device to disconnect an overloaded motor.

5. Increase wire size when locating motors a distance from the power source. Wire size must be adequate to minimize voltage drop during startup and running. Inadequately sized wire can cause motor failure. Table 2 gives proper copper wire conductor sizes.

Sizes of openings

Although fans are a necessary part of a mechanical ventilation system, they are not the only thing to consider. Also needed is some way to bring air into a negative pressure system. A standard rule for sizing air openings is to provide one square foot of area for every 800 cfm of capacity. Inlet placement is the key to good distribution of fresh air.

Summary

Good quality fans are essential for proper performance of mechanically ventilated livestock facilities. Inefficient fans can add to production cost in two ways. The most obvious cost is wasted energy that is expended while using an inefficient fan. Another cost, and one that probably has a much greater effect on profit, is associated with poor air quality in the building. Fans that are inefficient do not move as much air as one might think. This allows air quality to diminish and therefore stresses animals. Stress to animals can lead to disease problems as well as less than optimal animal growth and feed conversion.

As a rule, the best way to choose a proper fan is to shop around and compare based on independent lab ratings. The extra time will save you money in the long run.

For more information on proper ventilation rates, see your local county extension staff person.

Table 2. Copper wire conductor sizes for single-phase motors

	Distance of Wire Run (ft.)									
	50 ft.		100 ft.		150 ft.		200 ft.		250 ft.	
HP	115V	230V	115V	230V	115V	230V	115V	230V	115V	230V
1/8	12	12	12	12	10	12	10	12	10	12
1/6	12	12	12	12	10	12	8	12	8	12
1/4	12	12	10	12	8	12	6	12	6	12
1/3	12	12	10	12	8	12	6	12	6	12
1/2	10	12	8	12	6	12	4	12	4	10
3/4	10	12	6	12	4	10	4	10	3	8
1	10	12	6	12	4	10	4	10	3	8
1.5	8	12	6	10	4	10	3	8	2	6
2	8	12	4	10	4	10	2	8	1	6
3	6	12	4	8	2	6	1	6	0	4

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