Electrical Tech Note — 387

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Ventilation Fan Selection for Livestock Housing

In the case of confined livestock housing, the purpose of a ventilation fan is to create a pressure difference between the inside and outside of the confined space in order to bring about the desired amount of air flow to remove water produced within the space as well as any excess heat. Livestock, as well as activities necessary to tend to livestock, produce heat and water. Heat is also added to the space by equipment such as motors and lights. Heat is lost from the space by conduction through the space surfaces such as the walls, ceiling, and floor. When the outside temperature is lower than the inside temperature heat can be removed by ventilation. As the temperature increases livestock must remove heat from their body by evaporation of water. At higher temperatures the purpose of ventilation is to remove the water from the space. Air expands when it is heated. As a result the ability of air to take up water increases as the temperature of the air increases (see *Tech Note 386*). Air entering a confined space at low temperature, even at 100% relative humidity, is able to absorb more water if the temperature of the air is increased. Fans used for confinement space ventilation are rated in the volume of air they can move at a given static pressure difference between the inside and outside air. A manometer is used to measure the difference in pressure between inside and outside of a confinement building. A U-tube manometer is shown in *Figure 387.1.* For ventilation purposes static pressure is measured in inches of water difference between inside and outside. In the U.S., ventilation fans are rated in cubic feet of air moved per minute or cfm at a given static pressure.

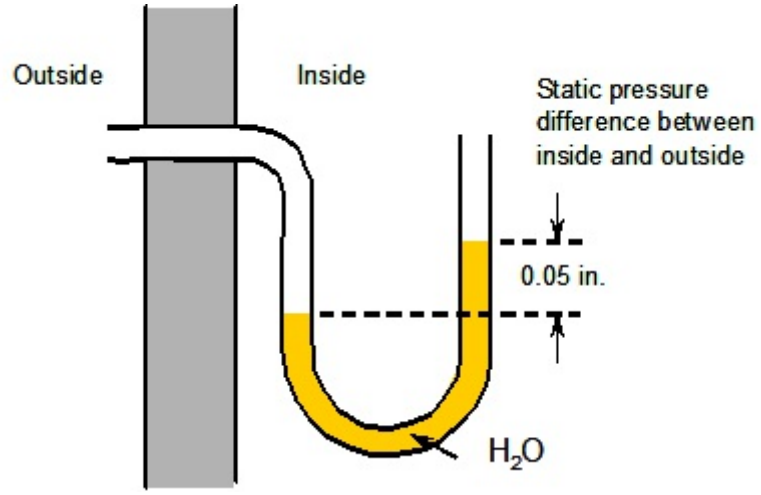

Figure 387.1 *A U-tube manometer is used to measure the static pressure difference between inside and outside of a confinement space. A typical static pressure difference used for livestock confinement space ventilation is 0.05 in. of water difference.*

In most applications air is exhausted from the confined space thus making the static pressure of the air in the confined space slightly lower than outside. Air then enters the confined space through air ducts or through a controlled air opening such as a long narrow inlet across one wall of the space, or across the ceiling of the space. Sometimes air is forced into a space by the fans to create a higher pressure inside than outside. In this case the exit of air is controlled through ventilation openings. If air is not allowed to enter a building with exit fans or to enter a building with pressurization fans the fans will develop the maximum pressure difference possible depending upon their power and design, and no air will move. In a confined space air must be allowed to enter if air is to exit the space. This Tech Note does not discuss ventilation system design, but discusses the basic characteristics of ventilation fans that must be understood in order to design livestock ventilation systems.

Types of fans: The basic types of fans used for ventilation systems are axial fans where the air passes straight through parallel to the propeller shaft as shown in *Figure 387.2.* The design is simple and they can move large volumes of air but usually at a relatively low static pressure difference. They are well suited for livestock ventilation systems. They also work well for applications where the air is not clean which is typical of livestock applications. One drawback is that they tend to be noisy. A centrifugal fan takes air into the fan perpendicular to the plain of rotation. Air is moved to the outside circumference of the fan which is constructed in a cylindrical form. Air is ejected in a direction tangent to the fan rotation. The blades around the circumference of the fan have different shapes depending upon the application. A silo blower used to fill a tower silo is actually a straight blade centrifugal fan. A centrifugal fan is often used to move air through duct type ventilation systems. They can be designed to be quiet and they can usually develop much higher static pressure differences than axial fans.

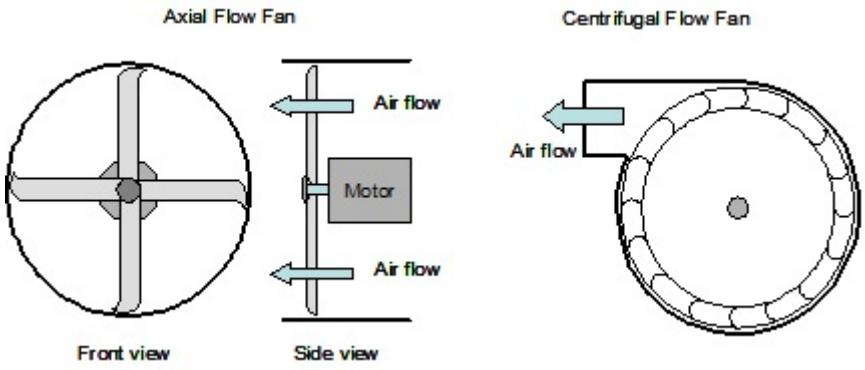

Figure 387.2 *Axial fans shown on the right are generally the type used for livestock ventilation systems. Centrifugal fans are usually used where air is moved through duct systems and higher pressures are necessary.*

Circulation fans: Another type of ventilation used in livestock spaces are circulation fans. The purpose of these fans is to keep the air in motion over the livestock. Without forced air movement air in the space close to livestock is static and the relative humidity quickly increases especially in hot weather. Cows are provided shade in summer to reduce heat gain from the sun, but shade provided in the form of an open sided building confines air movement. Bovine (cows) derive most of their cooling in warm weather by evaporation of water from lung surfaces. Animals pant when excessively warm to increase air movement across the surface of the tongue. Air circulation fans can be used in open livestock confinement buildings to increase air movement to assist livestock in cooling their body.

In warm and hot weather it is important to keep the air moving near the livestock if possible. Since livestock cool their bodies mainly by evaporation in hot weather, it is important to move that humid air away from the animals. Buildings with open sides and ends allows natural air flow through the building, but if there is little or no wind the air within the confined space does not move adequately to allow effective cooling of the livestock. This is especially true in humid climates. Circulating fans can be used to keep the air moving within the confined space. The most popular methods are to install high speed fans above the livestock and blow the air slightly downward and horizontal to the floor. An added benefit to high speed air flow is that it helps with fly control. Insects have difficulty landing on animals when the air speed is greater than 4 miles per hour (mph). Another method is to use large diameter paddle fans that direct air directly towards the floor or towards the ceiling. This type of fan is more energy efficient than axial fans, but lower air flow rates are achieved.

Ventilation fan performance curves: The air flow rate (cfm) verses static pressure performance curve for typical axial flow fans is shown in *Figure 387.3.* If air is to be moved evenly through a livestock confinement space without dead air spaces, it is important to construct the space tightly enough that the fans can develop a static pressure difference between the inside and outside spaces. A typical static pressure difference used for livestock confinement spaces is 0.05 in. of water. Usually the system is designed to exhaust air from the space but sometimes the fans are used to pressurize the space. Air flow is controlled through designed air inlets. Usually these inlets are long narrow slots the length of the building with an adjustable door opening. If there is an adequate static pressure difference between the inside and outside of the space air will flow evenly along the inlets. It is best to install a manometer to monitor the static pressure difference, but if there is a slight resistance experienced when opening a door to the space there is probably an adequate static pressure difference.

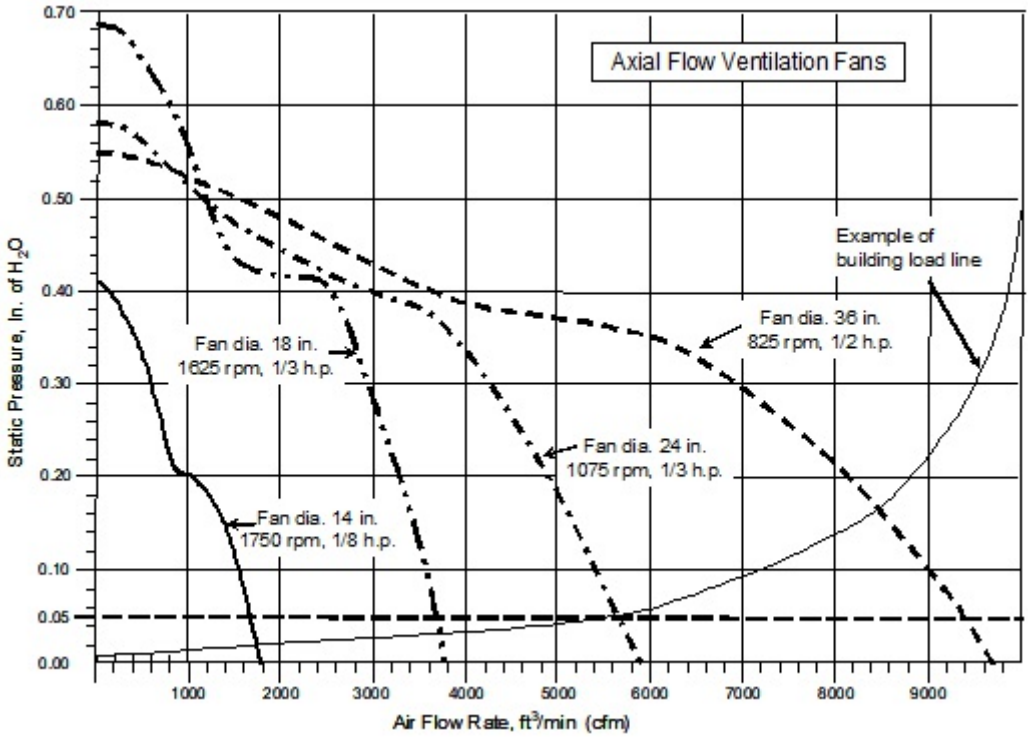

Figure 387.3 *The air flow rate that a fan can deliver depends upon the static pressure difference the fan is capable of developing.*

Note in *Figure 387.3* that the air flow rate delivered by a fan depends upon the static pressure developed by the fan. Maximum air flow can be achieved if the fan is not required to develop a static pressure difference. But, if the fan does not develop an adequate static pressure difference then the air inlets to the confined space will not draw evenly. When selecting fans for animal confinement ventilation it is necessary to select air flow at a known static pressure difference. *Table 387.1* gives the air flow rates for the fans of *Figure 387.3* at several different static pressure difference levels. Before selecting a ventilation fan for a livestock confinement space it is important to obtain cfm verses static pressure information from the manufacturer.

Note the confinement space load line in *Figure 387.3.* As the air flow increases through the confined space the static pressure required to move that air increases. The confined space load line depends upon the size of the air inlet openings. By changing the air inlet opening setting the load line will change. This load line is a function of the air inlet setting of the confined space. The ventilation rate required for a confined livestock space is determined by performing a heat balance and a moisture balance calculation based upon the desired inside conditions. These calculations must be performed for several outside temperatures. As the outside temperature increases the air flow rate must be increased. Thermostats are usually used to control the fans as the temperature changes. Using a minimum continuous air flow rate will make sure excessive moisture build up does not occur. For some spaces heat may be required in the winter. A typical design strategy for summer ventilation is to move about ten times the air flow in summer as required for minimum winter ventilation. In summer the building air inlets are opened to the maximum and the static pressure difference often decreases below the winter setting.

Table 387.1 *Ventilation fans are capable of delivering different air flow rates at different static pressures. Fans are to be selected based upon the static pressure difference required by the ventilation system design. This data is a summary of the axial flow fans of Figure 377.3.*

Fan dia.	Horsepower	cfm at 0.00 in. H_2O	cfm at 0.05 in. H_2O	cfm at 0.10 in. H_2O
14"	1/8	1750 cfm	1620 cfm	1600 cfm
18"	1/3	3780 cfm	3620 cfm	3590 cfm
24"	1/3	5900 cfm	5610 cfm	5400 cfm
36"	1/2	9680 cfm	9180 cfm	9000 cfm