BUSINESS
PROGRAMS

VENTILATION FANS FOR ANIMAL HOUSING

ENERGY EFFICIENT CHOICES OFFER FINANCIAL AND OPERATIONAL BENEFITS

TECHNICAL DATA SHEET

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Animal barns require ventilation to keep cows, hogs, poultry, and other farm animals comfortable and productive year round. Ventilation provides fresh air, removes excess moisture and helps regulate seasonal temperature swings. The benefits are real and practical: ventilation helps farmers maintain healthy, productive animals.

Ventilation systems vary, depending on the barn configuration, climate zone and the type of animals being housed. For example, a naturally ventilated dairy freestall barn may require stirring fans only on the hottest summer days, while a tunnel ventilated poultry barn will need the system to operate more regularly.

A ventilation system's overall energy efficiency and its energy costs will depend on the fan. If you choose the least efficient fan available, you could double your energy costs and obtain less air output from the fan than more efficient models. Energy efficient fans will reduce energy costs and offer better air output. However, after you choose the right fan, you must also make sure it is installed properly and maintained according to the manufacturer's instructions.

This fact sheet discusses ventilation fan designs, components, controls and maintenance. It also introduces different fan types and describes their use and ventilation benefits.

ALL FANS ARE NOT CREATED EQUAL!

Laboratory tests confirm that fan efficiency varies greatly. Tests conducted on high speed agriculture fans at the University of Illinois Bioenvironmental and Structural Systems (BESS) Lab and the Air Movement and Control Association (AMCA) demonstrate that fan choice impacts energy efficiency, operating costs, air output and ventilation effectiveness.

STATIC PRESSURE is defined as the difference in air pressure between the inside and outside of an enclosed building. When a fan is used to exhaust air out of a building, a slight negative pressure occurs inside the building, when compared with the pressure outside the building. Fans are tested at various static pressures to determine how each static pressure level affects their cfm output.

Testing has identified a 100 percent difference in the energy efficiency levels of two comparably sized fans. Some fans actually use twice the energy and will cost twice as much to operate. This difference can be attributed to several factors: the equipment supplied with the fan (shutters, guards, discharge cone and motor) or the fan's design. Given this finding, you should consider fan energy efficiency when purchasing new units or replacing existing ones. The energy and cost savings make it worth your time.

Most fans are rated in two ways: 1) by air volume output in cubic feet per minute (cfm) at a specified static pressure (in inches) and 2) by energy consumed, or wattage of electrical consumption (watt). Combining these two components provides a comprehensive rating for fan efficiency:

__X__ cfm/watt at __X__" of static pressure

For example, a low efficiency fan will have a rating of 17 cfm/watt at 0.05" static pressure and a high efficiency fan will have a rating of 20 cfm/watt (or greater) at 0.05" static pressure.

FAN COMPONENTS AFFECT EFFICIENCY

Shutters and guards can obstruct air flow and increase static pressure. On the other hand,

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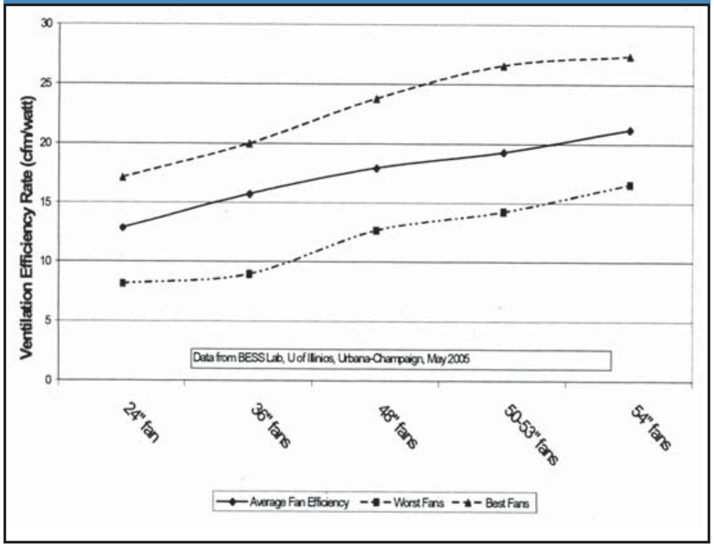
FIGURE 1 – FAN EFFICIENCY VS SIZE @ 0.10" STATIC PRESSURE



use of a discharge cone reduces a fan's static pressure. Reductions in static pressure can improve energy efficiency by 12 percent to 23 percent, depending on fan size. Fans used for tunnel ventilation should also be equipped with a diffuser to improve the energy efficiency.

As a fan's diameter increases, its energy efficiency increases. Therefore, one large fan is more energy efficient than two small fans (see Figure 1). From a ventilation control standpoint, it may be better to have multiple fans that can be staged; this configuration will help you achieve a balance between energy efficiency and efficient control.

To learn more about the energy efficiency of agricultural fans on the Internet, visit www.bess.uiuc.edu, BESS Lab or http://cart.amca.org/estore/download/amca_262.pdf for AMCA's publication. You can also order a printed copy of the Agricultural Ventilation Fans, Performance and Efficiencies from BESS Lab, Agricultural Engineering Department, University of Illinois, 332 Agricultural Engineering Sciences Building, 1304 W. Pennsylvania Avenue, Urbana, IL 61801.

FAN MOTORS

The single-phase fractional horsepower (hp) motors used in agricultural fans generally range from 1/3 hp to 1-1/2 hp. A standard motor of this size range has a typical efficiency of 60 percent to 75 percent. Most motor manufacturers do not publish efficiency data for single-phase motors, so efficiency is unknown unless the motor is tested.

In the past few years, several companies have introduced high efficiency single-phase motors that increase the motor efficiency to 77 percent to 84 percent and reduce energy use for the same air output by 11 percent to 26 percent. Contact your motor supplier for more information on high-efficiency single-phase motors.

If a barn is wired for three-phase electrical power, and fan motors are greater than one hp in size, you might want to consider three-phase motors. Premium efficiency three-phase motors offer higher efficiency (two percent to eight percent) than standard three-phase motors. However, three-phase motors – less than one hp in size – are not readily available.

FAN CONTROLS

If fans are used for temperature control, you should install programmable thermostats to control the fans. This automatic control ensures fans are turned on only when needed. Place the thermostats in an area of the barn that will measure its air temperature, but make sure they are protected from possible damage by animals. If you choose to stage fans, set thermostats at progressively higher temperatures to reflect increased heat loads.

Choose a thermostat that is designed for the appropriate environment and make sure the enclosure for the thermostat is rated for moist environments. Keep the thermostat and its enclosure free of dust. Dust covering the sensor will act as an insulator and yield an incorrect temperature reading. You should also calibrate thermostats once a year for critical applications to ensure they are working properly.

WIND FIGHTING FANS: CHOOSE THE CORRECT AIR FLOW RATIO

Wind affects fan performance. At some point, most fans will fight winds creating static pressure, but you can minimize this "battle." Before installing fans, you should consider the prevailing wind direction and install fans on the downwind side of the barn. This placement is more efficient because the wind will have minimal effect on the fan's performance. This placement is not always possible, given the barn's location. And, in many places, wind direction changes continuously. Wind breaks can help, but it takes time to grow trees or vegetation and it may not be possible or desirable in certain situations.

Choose fans with a high air flow ratio; a high ratio ensures that fans are less affected by winds than low air flow ratios. Air flow ratio is defined as the air flow at 0.20" static pressure divided by the air flow at 0.05" static pressure. For 48" fans, air flow ratios range from 0.28 to 0.87 with an average of 0.74. There is little correlation between the ventilation efficiency rating and the air flow ratio; review both ratings when selecting a fan.

FAN MAINTENANCE

Any dirt that accumulates on louvers, guards/grills, shrouds or blades will reduce the air moved by the fan. If louvers do not open freely or if dust builds up on safety screens/grills, fan air flow can be reduced by 30 percent to 40 percent. All fans should be cleaned regularly to improve energy efficiency.

SAFETY REQUIREMENT: BEFORE YOU BEGIN ANY FAN OR MOTOR CLEANING TASK, YOU MUST TURN OFF THE ELECTRICITY TO THE FAN AND DISCONNECT THE UNIT FROM ITS POWER SOURCE

You should clean the accumulated dirt off the louvers and lubricate them with a dry lubricant such as graphite so they will not attract dust/dirt.

Dirt on motors can cause them to run hot, which leads to a breakdown in motor insulation and reduced motor life. A vacuum cleaner and a stiff brush will work best to clean motors, but for heavy deposits, a plastic scraper may be helpful. If the fan's motor is totally enclosed and has a water tight wire connection, you could use a power sprayer to clean the fan.

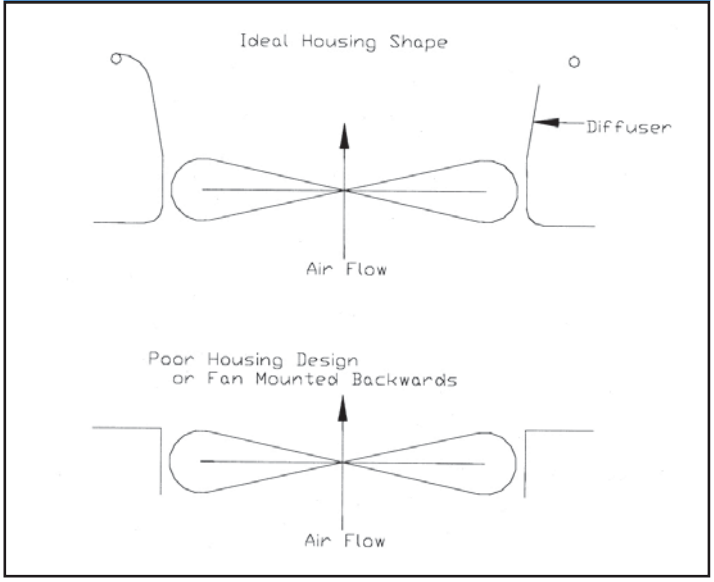
Loose belts can cause belt slippage, reduce air flow by up to 30 percent and shorten belt life. You should check and re-tension the belts monthly if the fan does not come equipped with an automatic tensioning device. This maintenance chore rarely gets performed as frequently as recommended by manufacturers. Therefore, most fan manufacturers offer V-belt self tightening devices for new fans. Some of these devices can be retrofitted on existing fans to reduce maintenance costs and ventilation disruptions.

Finally, if your ventilation system is set up with emergency backup power or another ventilation system, test it regularly.

SUMMARY: FAN SELECTION TIPS

- You should consider many parameters when determining the size and number of fans required for ventilation.
- Generally, larger diameter fans will be more efficient than smaller fans.
- Fans with a discharge cone will be more efficient than those without.
- Motor efficiency will affect energy use and the motor's speed can affect efficiency and noise levels.
- Fan blade tip speeds greater than 4,500 feet per minute will create excessive noise levels. To keep noise levels low, fan revolutions per minute (rpm) should be less than 720, 480, 360 and 320 rpm for fan sizes of 24", 36", 48" and 54" respectively.
- Machete or straight and teardrop blade designs are more efficient and accumulate less dust than cloverleaf shaped fan blades.
- The clearance between the fan blade and the housing will affect efficiency and the static pressure at which the fan is capable of operating. Large clearances will allow air to leak back past the fan blade and housing. If the entrance of the housing to the blade is smooth and rounded, it will reduce the turbulence and drag of the air as it enters the fan blade air foil, as shown in Figure 2.

FIGURE 2 – FAN SHROUD SHAPE



FAN TYPES

Stirring Fans

Stirring fans move air within a structure to maintain a uniform temperature, eliminate dead zones and increase air velocity to cool animals. Currently no energy efficiency data is available for stirring fans. BESS labs began testing them in 2005. Focus on Energy recommends that you check the BESS Web site and publications for test data. Two types of stirring fans are used to ventilate animal barns: high speed fans and high-volume, low-speed (HVLS) paddle type fans.

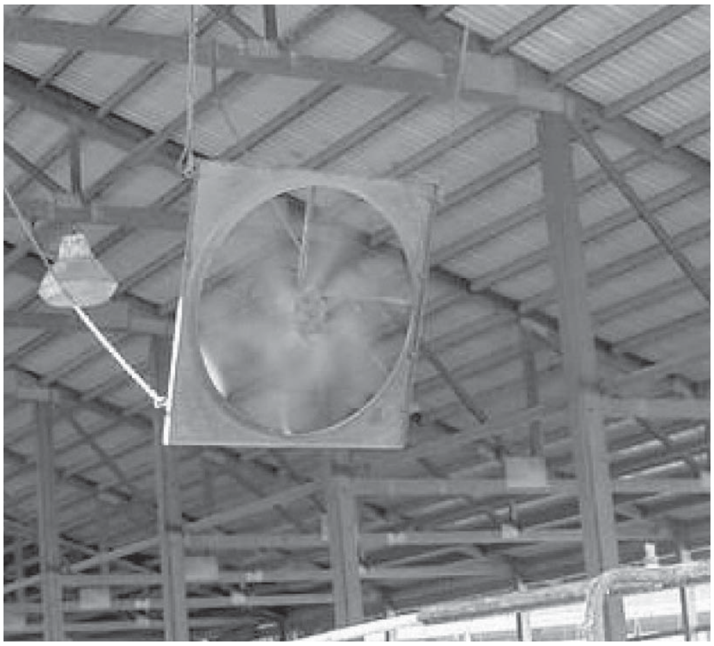
High Speed Fans

High speed fans can be very simply designed. Some have a motor with a blade connected to the motor shaft and a grill to protect the blades. Others include box type fans in which the motor and blade are supported by a shroud (the same type fan as is found in tunnel ventilation, but without shutters or diffusers). These box fans may or may not have a grill.

In a dairy freestall barn high speed fans are typically installed over the feeding alley and/or over the center cow beds to provide cooling. Fans are generally spaced at a distance of ten feet for each foot of fan diameter. Therefore, 48 inch fans would be spaced at 40 feet, while 36 inch fans are typically spaced at 30 feet. Stirring fans are also commonly used in greenhouses and crop storage facilities to provide uniform temperatures and keep condensation from forming.

High Volume, Low Speed Fans (HVLS)

HVLS fans have been used in the agricultural market since the late 1990s. They should be installed in buildings with high ceilings, such as dairy freestall barns. HVLS fans are large paddle type ceiling fans that range in diameter from 8 to 24 feet; dairy freestall barns typically use HVLS fans



with diameters of 16 to 24 feet. The fans are mounted horizontally to push a column of air down to the floor. As the air movement is impeded by the floor, the air moves out in a radial pattern away from the fan.

These fans are the most energy efficient units available today. A 24 foot HVLS fan will move as much air as six high speed fans and consume only 1/6 the energy. In a typical four or six row dairy freestall barn, the fans are placed over the feed alley every 35 to 60 feet, depending on the fan size. Current owners have described other advantages, including drier floors, less flies, fewer birds in the barn and reduced noise. HVLS fans come with a variable speed controller that adjusts the fan speed. Some dairy farmers are using the fans at slower speeds to keep the air from stagnating during cooler times of the year.

Critics of this technology are concerned that the air velocity over the cows is too low to provide effective cooling if the fans are placed down the feed alley. Feed manger lockups, cows and stall dividers all impede the air movement from the center of the barn to the outside walls of the building. For additional information on HVLS fans refer to Design of High Volume Low Speed Fan Supplemental Cooling System in Dairy Free Stall Barns by David Kammel, et.al, from the University of Wisconsin at www.uwex.edu/energy/dairy_V.html.

MISTING SYSTEMS TO AUGMENT VENTILATION

Misting water into the air or onto the backs of dairy cows can increase the effectiveness of ventilation cooling. Studies have shown that combining misting with stirring fans provides a significant decrease in heat stress when compared with fans alone.

Generally, these systems mist water over cows' backs for a period of one to three minutes. Then, the misting is shut off for 12 to 25 minutes while fans help to evaporate the water. You should not mist dairy cattle in humid conditions, such as Wisconsin's summer months, without using fans. If the water does not evaporate fast enough, wetting the cow can increase heat stress rather than decrease it.

LEARN MORE

If you are interested in learning more about animal housing ventilation or other energy efficiency opportunities for farms, contact Focus on Energy at 800.762.7077 and ask to speak with an Energy Advisor from the Agriculture and Rural Business Team. Or visit our Web site at focusonenergy.com.

ADDITIONAL REFERENCES:

Dairy Freestall Housing and Equipment, MWPS-7, Midwest Plan Service, Iowa State University, Ames, IA 50011, 2000.

Heating, Cooling and Tempering Air for Livestock Housing, MWPS-34, Midwest Plan Service, Iowa State University, Ames, IA 50011, 1990.

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Sprinkler Systems for cooling Dairy Cows at a Feed Line, J.P. Harner, et. al, MF-2401, Kansas State University, Manhattan, KS, July 1999. Available on the web at www.oznet.ksu.edu/library/lvstk2/mf2401.pdf.

High Efficiency Single phase motor manufacturers:
Baldor Electric Company - www.baldor.com
- Preminum Efficiency motors

Leeson Electric Coporation - www.leeson.com
- Premium Efficiency WATTSAVER General Purpose motors