Fan Selection and Maintenance

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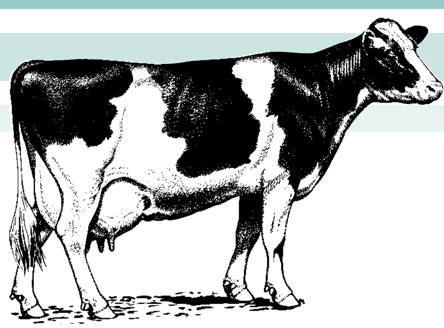

When reducing heat stress in dairy herds, fans are used to enhance the evaporation of moisture from a cow's back. Fan selection should be based on performance rather than horsepower and diameter. Certified lab studies of similar size fans show a 50 percent difference in airflow rate per unit of input energy. Maintenance is important to ensure desired performance and to prolong equipment life.

Fan Types

Fans can be axial flow or centrifugal. Axial flow fans pass air straight through the fan parallel to the fan blade drive shaft. Centrifugal fans, also known as squirrel cage fans, bring air in through a center inlet. The air then makes a right angle turn and is discharged perpendicular to the fan axis.

Axial flow fans are designed to operate at low static pressures — typically less than 0.5 inches of water column — and are commonly used for livestock building ventilation. The initial cost is less, and performance is influenced less by dirt buildup on the fan blades. Axial flow fans are either propeller, tube axial or vane-axial fans.

Propeller fans are the most common. Propeller fans have propeller-shaped blades mounted in a circular ring or orifice plate and a drive motor. Blade tip clearance is an important factor in propeller-fan performance to achieve higher static pressure. A small, uniform clearance is preferred to prevent air from flowing back around the propeller. These fans move large volumes of air at low static pressure.

Fan Performance

Airflow rate and static pressure are closely related for fans and ventilation systems. The airflow rate delivered by a fan is measured in cubic feet per minute (cfm) against a static pressure measured in inches of water. The amount of air moved is inversely rated to the static pressure. As the resistance to airflow (static pressure) increases, the delivered airflow capacity decreases. Therefore, a fan delivers more air against a lower static pressure than a higher static pressure. The relationship between static pressure and airflow delivery for a specific fan is represented by a tabulation of performance values or fan performance curve. Table 1 shows airflow data of several fans in a table format.

Table 1. Example of airflow rates (cfm) for different fans operating at different static pressure based on data taken from manufacturer's literature.

Fan Characteristics			Static Pressure (inch of water)			
Diameter	Horsepower	Rpm's	0.00	0.05	0.10	0.15
24	1/3	1100	5,300	5,000	4,700	4,400
36	1/2	845	10,800	10,300	9,700	9,000
48	1	845	19,200	18,200	17,800	16,800

Fan ratings are obtained using laboratory equipment and standards established by the Air Movement and Control Association (AMCA). If a fan manufacturer tests fans following these procedures, an AMCA label and certification can be listed in the company's literature.

Fan performance data is used to determine the airflow rate a fan will deliver when operating at a given static pressure. Ventilation fans are typically selected based on the air delivery capacity at 1/10 to 1/8 inch of static pressure. Generally in dairy freestall housing, the fans will be operating at 0 inches of static pressure. Fans will be operating against 1/10 to 1/4 inches static pressure in tie stall or tunnel ventilated buildings. Fan performance data should be reported with all attachments including shutters, guards and hoods.

Common measurements used to describe the characteristics of a fan are blade diameter, revolutions per minute (rpm) and motor horsepower. These are useful measurements but without performance characteristics such as airflow and static pressure, they give only general indicators of fan capacity.

For example, test results compared the performance of 39 commercially available 36-inch diameter fans used in the ventilation of enclosed buildings. The test showed variability in fan performance even though they were similar size fans. At a static pressure of 1/10 inch, The air delivery capacity of these fans varied from 6,400 to 10,000 cfm. Similar tests of 48-inch diameter fans showed that air delivery at 1/10 inch static pressure varied from 14,100 to 23,000 cfm.

These large variations in fan capacity for similar diameter fans significantly affects the selection process of fans. This shows the importance of selecting fans based on performance rather than strictly fan diameter or horsepower.

Energy Efficiencies

Another characteristic that is becoming important when selecting fans for an animal ventilation system is energy efficiency. This is expressed as airflow per unit of input energy, or cfm per watt. The higher cfm per watt rating will indicate a more efficient fan. Tests at the University of Illinois Agricultural Engineering Department on 36-inch diameter blade fans indicated a wide variation in both fan performance (6,400 to 13,000 cfm) and energy efficiencies (8.3 to 18.6 cfm per watt) at 1/10 inch static pressure. Table 2 shows some efficiencies ratings listed in manufacturer's literature for several 36-inch fans.

Even fans with similar airflow ratings can have a significantly different energy efficiencies. In the study at University of Illinois, six 36-inch fans had airflow ratings between 9,000 and 9,900 cfm at 1/10 inch static pressure. However, the energy efficiencies, as measured in cfm per watt, for these six fans varied 8.4 to 18.6 cfm per watt. The electrical energy cost of these two fans based on an airflow rating at 1/10 inch static

Table 2. Fan performance and efficiency for different types of 36 inch - $^1/_2$ hp fans based on manufacturer's literature and state performance.

Fan Diameter (inches)	Airflow (cfm) at 0 static pressure	Fan Efficiency (cfm/watt)
36	11,100	17.0
36	10,400	19.0
36	11,500	19.6
36	10,810	20.0
36	10,500	24.5
36	13,200	24.8
36	11,000	15.4*
36	11,700	16.4*

*Watts calculated based on amps and 115 V rather than measured as with other fans.

pressure with an electrical rate $0.10 per kilowatt hour and 120 days (24 hrs per day) of operation for a warm-weather fan, shows a cost savings of nearly $190 per year ($340 compared to $150) by using the more energy efficient fan. A more energy efficient fan will cost an additional $150 to $250. Remember in freestalls, one 36-inch fan is used per six stalls, so the net savings is around $30 per stall after the initial cost is recovered.

Guards typically reduce airflow and efficiency by less than five percent. Guards are essential for the safe operation of the fan. Guards also protect the fan from being damaged by large objects that can strike the blades. Some fan manufacturers rate fans both with and without shutters or guards.

If fan efficiency ratings are not available, the following guidelines may be helpful.

- For a given airflow and static pressure, a large diameter fan is more energy efficient than a small diameter fan.
- For a given ventilating rate, one large diameter fan is more efficient than several small diameter fans.
- When two fans have the same diameter and rpm, the fan with the lower motor current input rating is usually more efficient.
- If two fans deliver the same airflow at the same static pressure, the fan with the slower speed is usually quieter and more efficient.
- If there are no methods for comparison, a reasonable goal for a 36-inch fan is 11,000 cfm at zero inches static pressure. The goal for a 48-inch fan would be 20,000 cfm.

Maintenance

Poor maintenance can reduce fan efficiency by 40 percent or more. Follow manufacturer's recommendations for cleaning and lubricating fans. Livestock buildings should be wired according the National Electric Codes. Visual observation at dairies reveal dust accumulation on fans, fan orientation adjustments and fan damage by skid-steers as some of the areas where routine maintenance may be improved.

Fan blades that are damaged or misaligned can be repaired. Wind and vibration loosen the mounting brackets often causing them to become misaligned. Correct fan orientation is obtained by tightening the fan and mounting brackets. Careless operation of equipment used to scrape alleys, level freestalls and bed freestalls may damage fan guards. The whole fan may have to be replaced due to blade damage.

Always turn off the electricity at the circuit breaker or fuse box before servicing or adjusting fans. If pressure washers are used for cleaning, it is a a good idea to turn the power off for the entire building. The water stream may come in contact with other electrical circuits such as outlets or lights. It is also important to use lock-out procedures when washing fans. Lock-out procedures allow the individual performing maintenance on the system to place a lock on the service entrance panel, or circuit breaker box, to prevent it from being opened. The individual performing the work keeps the lock key and is the only one authorized to open the box. This prevents another person from turning on the electrical circuit during maintenance.

Ventilation systems require routine maintenance. This involves cleaning and adjusting fans and thermostats. A dust build up of an eighth of an inch on fan blades can reduce fan performance. Dust accumulations on fan guards and shutters can reduce fan performance up to 40 percent. Fans should be cleaned with a vacuum cleaner and stiff-bristled nylon brush to loosen dirt before washing with a sprayer. Care must be taken when using a brush or high-pressure washer to avoid damaging the blades. A bent or scratched blade will cause an imbalance between the blades, reducing fan life and performance. A pressure washer can be used to clean the fan, housing and hood. Recommended fans for livestock buildings should use the TE (totally enclosed) label and ball bearings. The fan motor must be totally enclosed to prevent water and dirt from damaging motor windings. If the motor is not totally enclosed, then it must be removed and cleaned separately before cleaning the housing with water.

Motors should be lubricated based on manufacturer's recommendations. Most ventilation fans have sealed bearings and do not require lubrication. Manufacturer's recommendations on oil type and amount should be followed. Oil should be used sparingly on fans and motors since it attracts dust and soaks into the motor windings.

Thermostats should be checked and recalibrated monthly. Dust and dirt accumulate on the sensors acting as an insulator. As a result, the sensor does not measure temperatures accurately or rapidly.

It is also a good idea to schedule routine maintenance on the electrical circuit. Fuses should fit tightly and be free of corrosion. Periodically examine the wire and other electrical system components for signs of predator damage. Poor connections or corrosion result in greater electrical resistance that can lead to overheating and increase the chance of fire. Plastic, water-tight boxes and conduit are recommended for frequent cleaning in livestock buildings.

Examine fan housings, frames and hoods for dirt build up and corrosion. After cleaning, they can be repainted with a rust and corrosion-resistant paint to prolong their life. When ordering new fans, consider fans constructed of fiberglass, stainless steel, plastic or epoxy-coated housings.

Ventilation equipment needs routine maintenance to ensure efficient operation. Establish a service schedule for all components and maintain written records of activities. Table 3 provides a routine maintenance schedule.

Summary

Many factors influence the efficiency of a fan. These include motor ability, blade speed, housing design, clearances and blade shape. However, even the most efficient fan will not perform satisfactorily if it is not kept clean and properly serviced. Remember to keep fan blades clean and motors clean and lubricated.

Table 3. Listing and recommended schedule of maintenance activities.

Maintenance Activity	**Maintenance Schedule**			
	Daily	**Monthly**	**6 Months**	**Annual**
Fan guards attached	X			
Sprinkler nozzles working	X			
Leaks in sprinkler water lines	X			
Clean/calibrate thermostat		X		
Fans fastened tightly to post		X		
Check fan orientation		X		
Clean fan guards			X	
Clean motor and controls			X	
Calibrate curtain controller			X	
Lubricate fans				X
Repaint corroded metal				X
Check total electrical circuit				X

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