VENTILATION SYSTEMS

Exhaust fans with wind hoods

The goal of a well-managed ventilation system is to limit moisture and gas accumulation in the winter and heat in the summer. Too little ventilation results in low air quality - too much ventilation wastes energy. Ventilation systems use a lot of energy, especially the fans, with the finisher barn accounting for approximately 60% of all energy consumption. You can calculate electrical energy cost of a fan using the following equation:

Electrical energy cost of a fan ($) = (Reference kW) x (hr/day fan is running) x (#days/yr. fan is used) x (current cost of electricity $/kWh)

In winter, pigs lose heat by conduction through walls and floors so ventilation rate must be low. Table 7 shows general guidelines for the minimum ventilation rates for various ages of pigs. Several factors affect the minimum ventilation rate, such as barn design, number of animals in the room, fan specifications not being accurate, and fluctuating heating requirements. The implication is that minimum ventilation rates should be flexible for adjustment as conditions change.

Table 7. Minimum ventilation rates.

Room	Rate in cfm	Rate in L/sec/pig
Gestation	10	5
Farrowing	15	7 (per sow with litter)
Nursery	1.6	0.8
Grower-Finisher	3	1.5

A good relative humidity (RH) in the barn is around 60%. If RH is below 50%, ventilation rate is too high, wasting energy. For example, increasing the ventilation rate by 40% above the proper ventilation rate doubles your propane or natural gas use. Over-ventilating in the winter also expels heat, resulting in increased heating, thereby wasting more energy. A whopping 80 to 90% of heating energy is lost through the ventilation system, so it is important to use correct controller settings and ensure the correct fan size for each room and stage. Both can have a big influence on energy use. Do not try to winter ventilate a large room with several slowly operating variable speed fans. One properly sized fan running at its recommended speed is the most energy efficient.

Getting the ventilation system ready for winter

If you're in the market for new fans, be aware that performance data like air flow for fans are often reported for 0" static pressure, but barns generally have a static pressure of 0.1", and wind can cause the pressure across the fan to vary between 0.5" and 0.2". Generally, higher static pressure is associated with lower airflow. Use fans that are certified by BESS Lab (University of Illinois, http://www.bess.illinois.edu), so you get the airflow that you are paying for. BESS Lab provides the airflow and energy efficiency of fans tested at different static pressures (Table 8), as well as an 'airflow ratio', which is the ratio of a fan's airflow at 0.2" static pressure divided by its airflow at 0.05". An airflow ratio close to one is ideal, as this means the airflow does not go down much when static pressure increases. To reduce the effect of wind on the fan, it is helpful to add cones on large fans and wind hoods on small fans. Adding cones and wind hoods can improve energy efficiency by 15-20%.

Table 8. BESS lab test result for a 36" fan (Test: 00080bd) showing the efficiency at different static pressures

Static pressure (inches water)	Speed (rpm)	Airflow (cfm)	Efficiency (cfm/Watt)
0.00	860	12,210	26.1
0.05	853	11,300	22.5
0.10	846	10,450	19.5
0.15	838	9,420	16.3
0.20	830	8,050	13.0
0.25	817	6,300	9.6
0.30	784	4,060	5.4

When buying a fan, choose one that provides the proper amount of airflow at 0.1" static pressure. Keep in mind that you require backdraft devices on intermittently operating fans to prevent the fan from acting as an air intake. These backdraft devices close by gravity; so note that the fan must exert additional force to open the shutters.

Also, know that there is a difference in efficiency between fans. Energy efficiency of fans can be determined by looking at the cfm/W rating. The higher the cfm/W, the more energy efficient the fan is. In order to be considered efficient, small fans (≤ 24") should have a rating of at least 12 cfm/watt, whereas moderate sized fans (36"-48") should have a rating of at least 17 cfm/watt. Depending on the energy efficiency, every exhaust fan consumes between 1,000 and 10,000 kWh of electricity per year based on continuous operation. Over a 10-year period, savings for using efficient small sized fans (11.5-12.5") can be as high as $3,000 and $10,000 for medium sized fans (14.5-16.5").

Shutters on fans are used as backdraft devices to prevent the fan from acting as an air intake

Air inlets. Good inlets introduce air uniformly, direct winter air along the ceiling, are adjustable and require very little energy to operate. Self-adjusting air inlet baffles require no energy at all. Ensure inlets close tight enough to maintain negative static pressure across the fan. An air inlet velocity of 4 m/s to 5 m/s is desirable to prevent overloading of exhaust fans, which decreases output and energy efficiency. Often inlet adjustment and maintenance can accommodate changes or fluctuations in barn temperature. Instead of checking inlets, a common mistake is to increase ventilation rate to lower barn temperature and thus increase energy consumption.

These air inlets should be adjusted and calibrated to introduce air uniformly

What's the cost?

Assume that we will provide a minimum ventilation rate of 300 L/sec/pig for a 200-head grower-finisher room with dimensions 42' x 45' x 10'. This surface area works out to 9.45 ft2/pig including pens and alleyways. Two small ventilation fans will be compared with respect to energy usage and energy efficiency. This example only considers energy usage and fan efficiency and disregards heating, relative humidity and temperature dependent increases in ventilation. Carbon tax is also not factored into the calculation.

To provide the 300 L/sec/pig one small ventilation fan can run continuously for the year. Prairie Agricultural Machinery Institute (PAMI) of Humboldt, SK. did a comprehensive evaluation of small sized fans evaluating flow rate versus energy efficiency. We will choose two of these fans and consider the results:

- Fan 1 – Specifications: 12.5" (318 mm) propeller fan, variable speed, direct drive, 110 W, 220 V electric motor. To provide the 300 L/sec/pig, use a variable speed minimum setting at 0.105 kW input power. The fan will cost **$39.97** to run for the year.
- Fan 2 – Specifications: 12.38" (314 mm) propeller fan, variable speed, direct drive, 186 W, 115/230 V electric motor. To provide the 300 L/sec/pig, use a variable speed minimum setting at 0.165 kW input power. This fan will cost **$63.00** to run for the year.

Fan 1 has a higher cfm/W rating than fan 2 and a higher total efficiency %. Therefore, Fan 1 is more energy efficient than Fan 2. This is confirmed in the calculation as Fan 2 costs **$23.03** more per year to operate.