



FARM ENERGY

Sizing minimum ventilation to save heating energy in swine housing

Wasted heating energy is a costly problem for producers, and ventilation accounts for 80–90 percent of the heat lost in swine housing during the winter. Air exchange is critical to providing a healthy environment that fosters efficient pig growth by reducing humidity and noxious gases like ammonia and carbon dioxide. Since under-ventilation creates an unhealthy environment and over-ventilation wastes valuable heating energy, finding the right balance is the key to energy savings and efficiency.

Wean-to-finish buildings provide one of the greatest challenges to efficient heating. A good target for liquefied petroleum (LP) usage is two gallons per pig space per year. Actual usage will depend upon what time of year the weaned pigs are started in the building. Figure 1 shows that over-ventilating by as little as 10% can increase annual LP consumption by 27%. Likewise, over-ventilating by 40% can double LP consumption. Over-ventilating is more common than expected since it is difficult to know just how much air is actually being exchanged.

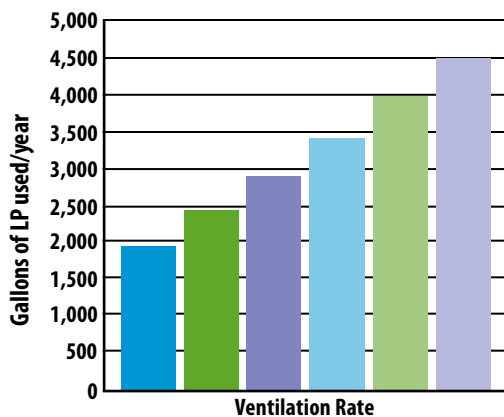


Figure 1. Over-ventilation of a 1000-head wean-to-finish facility significantly increases estimated LP usage.

■ Proper ■ 20% Over ■ 40% Over
■ 10% Over ■ 30% Over ■ 50% Over

To size minimum ventilation, refer to the rules of thumb that appear in Table 1. As an example, a 1,000-head wean-to-finish building with newly placed pigs should be ventilated at 1,500 cfm (1,000 pigs x 1.5 cfm/pig) during the coldest weather. This rate must be adjusted as the pigs get larger. It seems simple enough to pick a fan rated at 1,500 cfm. However, to meet the changing needs of the pigs and to minimize the number of fans required, a controller is used to slow down the fan speed, which causes it to deliver less air. These fans, often called “variable speed” fans, can be used to fine tune the ventilation rate and save heating costs by reducing LP fuel consumption.



Table 1. Rules of thumb for swine ventilation (adapted from Midwest Plan Service).

Production Phase	Weight (lbs)	Ventilation Rate (cfm/head)	
		Winter Minimum	Hot Weather
Sow and Litter	450	20	500
Nursery	12-30	1.5 to 2	25
Nursery	30-75	3	35
Finishing	75-150	7	75
Finishing	150 to Market	10	120
Gestating sow	400	14	250



Air delivery

There are limits to how much a fan can be slowed down using variable speed and still be effective. Figure 2 shows how a 24" fan tested at BESS Labs performs with varied voltage. The important thing to notice is that half voltage does not yield half air flow. For instance, full voltage at 0.10 inches of water will deliver 7,000 cfm but at 120V only about 700 cfm is delivered. Fans that receive less than half voltage are likely to require replacement more frequently because the electric motor will run hot. Fans operating at low speed also cannot operate against much pressure so it is important to protect fans facing prevailing winds. Figure 3 shows one method of protection.

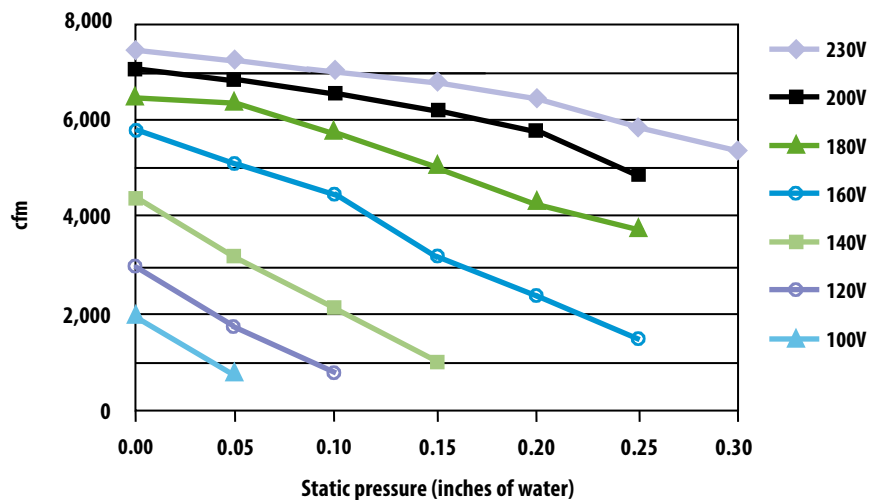


Figure 2. Flow rate for a 24" fan for various voltages. BESS Lab



Figure 3. Variable speed fan with wind protector.

When selecting fans for variable speed usage, it is good practice to not expect them to deliver less than half their rated airflow at 0.10 inches of water. For instance, in the 1,000-head example above, 1,500 cfm is needed and a selected fan might be rated at 3,000 cfm. This fan can therefore be used with a variable speed controller to deliver half its rated amount. An additional fan would be required once the pigs grow beyond 75 lbs and require more air.

Prepared by Jay Harmon, professor, ag and biosystems engineering; Mark Hanna, extension ag engineer; and Dana Petersen, program coordinator, Farm Energy Conservation and Efficiency Initiative; Iowa State University Extension. Sponsored by the Iowa Energy Center.

The management of variable speed fans is a complex prospect. Controllers have settings for the minimum speed but the percentage of fan speed is not necessarily related to the percentage of the full air flow rate. However, using the percentage of fan speed as a guideline of full air flow is a good initial approximation. This percentage can then be adjusted based on room conditions. If relative humidity or gases are too high, the percentage can be increased. If the air quality is good, lowering the percentage may be appropriate. With experience, this becomes easier. Further usage of controllers will be addressed in another fact sheet.

Summary

Ventilation is necessary for a healthy production environment but can also be costly in terms of demand for heating energy. Using variable speed fans can help to maintain good air quality while limiting heating fuel usage.

Important points to remember:

- **Size variable speed fans to run no lower than half of the full speed rated capacity.**
- **Adjust the speed based on air quality. If the relative humidity is higher than 60% or ammonia seems high, increase the speed. If the relative humidity and gases are low, try reducing the fan speed slightly.**
- **The energy cost of wasted heat exiting the building is far greater than the electricity required to operate variable speed fans.**
- **Protect variable speed fans from prevailing winds.**
- **Understand your controller and how it interacts with variable speed fans.**