Supplemental Ventilation Systems for Modified Open-front Swine Buildings

Livestock Industry Facilities & Environment

Poor ventilation in modified open-front (MOF) buildings often causes pigs to give less than optimal performance. The biggest problem is from respiratory diseases that occur in winter because buildings are sealed too tightly. Respiratory disease can lower the feed conversion. In fact, every 0.1 difference in feed conversion costs about $1.20 per pig, assuming that pigs gain 200 pounds and feed is $0.06 per pound.

Some of the solutions used by pork producers to improve winter ventilation, however, only make the problems worse. One common solution is to divide the area into smaller rooms to achieve all-in, all-out production. Some producers add ceilings in gable-roof buildings to keep in heat during cooler weather.

The problem with these solutions is that divider walls block the normal east-to-west air currents in winter, which allow for the building's air exchange. The normal expansion of the cold air that enters the building causes existing warmer air in the building to rise, which ventilates the building. The effect is strongest in ridge-ventilated buildings that do not have ceilings. It also is difficult to ventilate flat ceiling-type buildings in winter without fans and proper air inlets. Using only natural ventilation in the winter can create a variable climate that can lead to respiratory problems.

Another reason for supplemental ventilation would be during hot weather when there is little or no wind. Under these conditions, pigs tend to dung on the solid portion of the pens, where it may be warmer, instead of on the slats in the front of the building. When producers create an artificial air flow in the rear of the pens, they tend to have cleaner pens and do not need to clean the building as often.

This publication looks at several ways to improve cool weather ventilation in partial-slat MOF swine buildings. The most economical system will correct both winter and summer ventilation problems.

Ridge openings and natural ventilation problems

The most common MOF design is a rectangular building in an east-west orientation to take advantage of natural cross breezes. Ventilation is through adjustable or nonadjustable 6-inch wide ridge vent openings with a ventilation curtain on the south wall of the building and manually controlled vent doors on the north wall of the building. The ridge vent openings may run the full length of the building, or be intermittent.

This design, however, has several drawbacks. The openings (1) make it difficult to add a ceiling to keep the building warmer in winter, (2) create a wind suction (if the proper ridge cap is used) proportional to the square of the wind speed, which causes too much air to be exchanged in windy conditions, and (3) cause a chimney effect, a function of outside and inside temperature differences in which the cold air that enters the building is heated by the pigs or furnaces, tending to rise and escape.

Mechanical ventilation solutions

You can automate the ridge vent openings with a curtain machine or other device. This will decrease the temperature fluctuation in the building to an acceptable 10° F. However, these machines and their controls are expensive for buildings with multiple rooms that house pigs of different ages.

Another option is installation of a power duct system, which has been tested on farms since 1989. This system can be used in buildings with or without ceilings. No ridge vents are needed. The power duct constantly brings in fresh air by continuously exhausting stale air. This system typically reduces the time to market by 6 to 7 days; one producer was able to market 20 percent more pigs in a year using this system. The ducts also reduce respirable-size particles by 50 percent in winter, supply continuous fresh air to stimulate pig appetites, and dilute pathogens in the air.

The power duct system is a low-energy system that requires only 15 cubic feet of air per minute (cfm) per pig. The

IOWA ENERGY CENTER

Funding provided by the Iowa Energy Center

IOWA STATE UNIVERSITY
University Extension

Pm-1761 October 1998

recommended winter rate is 3 cfm for a 40-pound pig, and 10 cfm for a 250-pound pig. The power duct system uses a 1,500 cfm variable-speed exhaust fan for every 100 pigs (four 8' 3 25' pens).

To distribute the air, a 12-inch PVC pipe with 3-inch diameter holes is mounted east to west along the length of the building (about 32 feet). The exhaust fan is connected to the center of each pipe section. In a monoslope-roof building, the pipe is located in the rear about 5 feet from the back of the pen (see Figures 1a and 1b). In a gable-roof building with a 3-foot alley running along the north wall, the pipe is located 8 feet from the wall (see Figures 2a and 2b). A 16" 3 16" plywood crossduct connects the pipe to the north wall where the fan is located (see photo A).

The 3-inch diameter holes in the pipe are placed in the 6 o'clock position on 10.5-inch centers. At maximum fan speed, this pipe size and hole spacing result in a 900 ft./minute air speed in or out of the pipe. When the top of the curtain or vent doors are cracked about 0.75-inch, cool air from the south curtain travels along the floor to the pipe. A chill factor of 10° F is created when incoming air moves faster than one foot per second across the pigs, which can cause piling of pigs. Producers comment that in cool weather the rear vent doors do not need to be opened as early in the season.

Another variation of this system uses a 15-inch PVC pipe (the largest available) and a 2,400 cfm variable-speed exhaust fan. This system can handle 150 pigs, or about six pens of 25 pigs in a building 48 feet long. The 4-inch holes in the 15-inch pipe must be spaced 18 inches on center, and the plywood crossduct must be 19" 3 19".

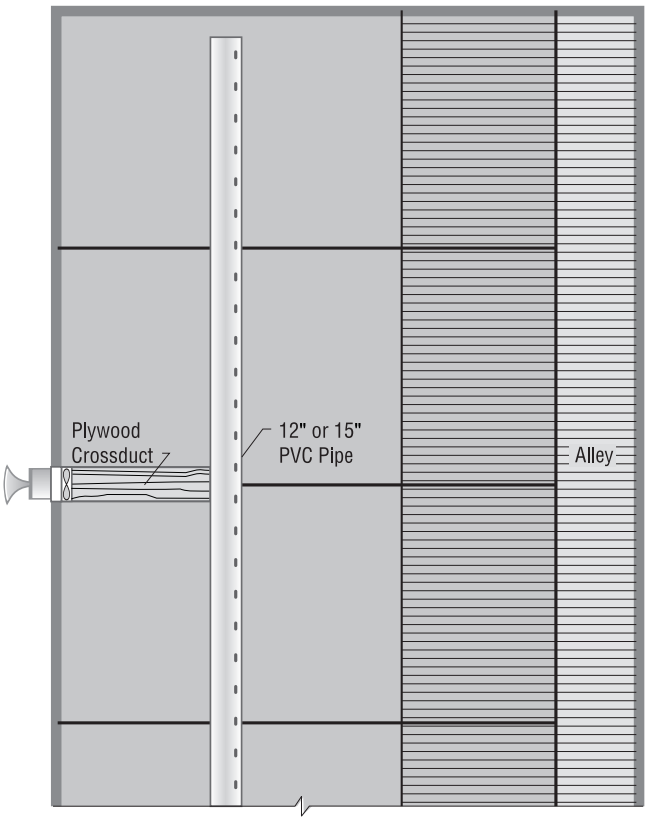

Figure 1a. Power duct plan view for a monoslope-roof building

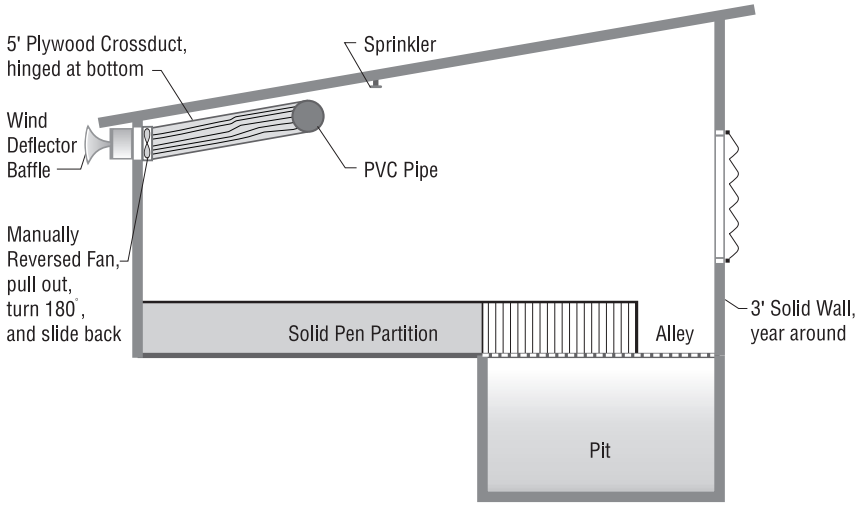

Figure 1b. Power duct cross-section for a monoslope-roof building

To give faster payback to the power duct, consider changing it to help cool the building in summer. This can be done by buying a reversible fan or constructing the fan to be manually reversed to blow air into the building instead of exhausting air out of the building during cool weather. You can reverse the fan to blow air where you want pigs to lie down in the summer, which reduces dunging problems on the solid floor section. Reversible fan motors do not move air at the same air flow rate in both directions. However, when you manually turn around a fan, you get 100 percent efficiency in both directions because of the pitch of the blades. You also eliminate the need for a reversing switch.

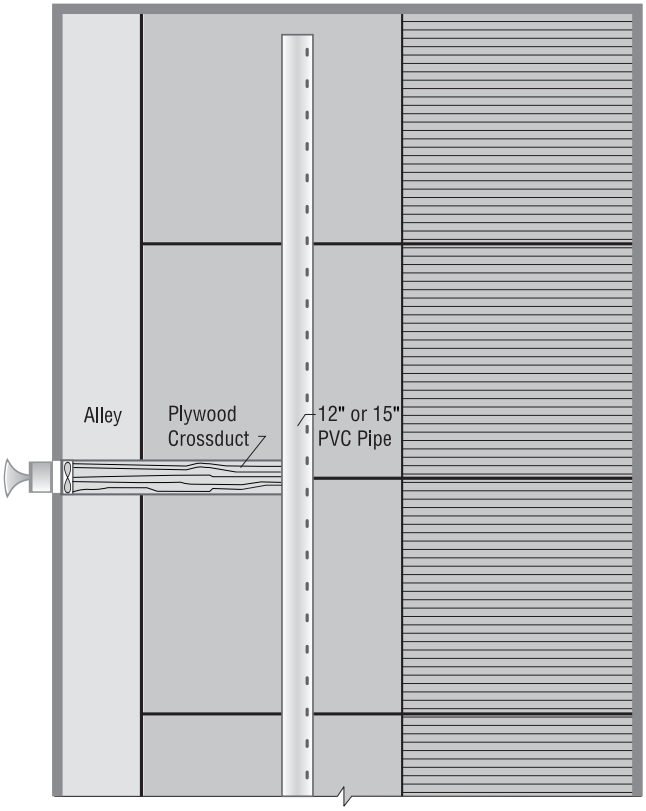

Figure 2a. Power duct plan view for a gable-roof building

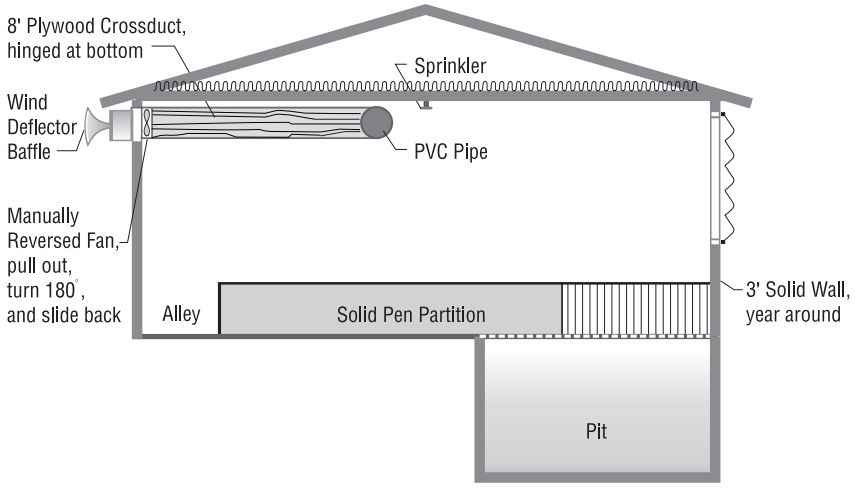

Figure 2b. Power duct cross-section for a monoslope-roof building

When the inside temperature reaches 75° F, the system should be reversed to blow air into the building (see photo B). You can start the fan system at higher temperatures if pigs weigh only 40 pounds. The north-side fan location pushes in cooler air during the day and helps cool the building at night. The fan and duct help provide a comfortable zone in which the pigs can lie down.

In this system, the variable speed fan is pushed to the limit to achieve 15 cfm per pig. A 40-pound pig, however, requires only 3 cfm for winter ventilation, which is only 20 percent of full fan speed. A wind diverter or trumpet-type hood (see photo C) is highly recommended to reduce wind action on the fans, especially when the fans run at slower speeds. The wind diverter is needed only during cool weather because northern winds help fans push air into the building during the summer.

Other considerations

A 3-foot solid south wall keeps pigs cleaner in hot weather by making the area over the slats less comfortable than the area in the rear of the pen, which has a solid floor. Locating a sprinkler 2 feet south of the PVC pipe helps keep pens cleaner as well.

You must clean the rigid PVC pipe at least once a year because it acts like a vacuum cleaner when the fan is exhausting air. To clean, insert a garden hose with a spray nozzle or a scraper-type unit into the 3-inch holes. The bottom of the plywood crossduct should be hinged for easier cleaning.

If you use a manually reversing fan, locate it in the plywood crossduct next to the north wall for easier access. The fan can be placed on a sliding piece of plywood. Do not use a shutter or tightly screened fan guard. To cut installation costs, use one thermostat to run every two fans. It is not desirable, however, to have more than 100 feet of building on one thermostat because temperatures are higher on the west end of a building when wind is from the northwest.

Make sure that the winter air inlet openings above the south curtain are not too wide. This could cause two ventilation systems (natural and mechanical) to work together, and the building could become too cool in cold, windy weather. You may want to shut the south wall's suggested 0.75-inch continuous opening on the west 8 feet of the building for the same reason. In winter, backup heaters are recommended for each room, especially those with 40- to 50-pound pigs and all-in, all-out production systems. The power ducts work best in properly insulated buildings without many cracks in the north wall vent doors.

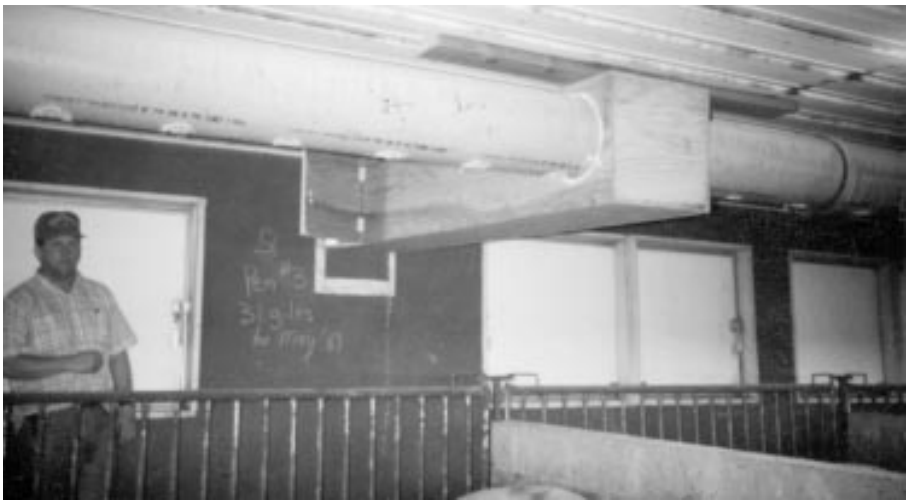

Photo A. The location of the crossduct and pipes is critical in a power duct system.

Photo B. The hinged access door (located to the right of the fan) allows you to manually turn around this fan, which does not have a reversible motor.

Photo C. A wind diverter is important for fans located on the north wall to reduce wind action on the fans, especially when they're run at slower speeds.

The principles outlined in this publication work well unless other buildings or trees are in the area. During hot weather, other trees and buildings block the natural summer air flow and the power duct system may not have enough capacity to keep the pens clean and the pigs cool. It is important to use a 2-foot continuous air inlet opening on the north side wall and a 3- to 4-foot opening on the south side wall.

MOF buildings usually are 28 feet wide, but they can be wider. A wide building (35 to 40 ft.) may require two rows of ventilation pipes. If the building's ventilation is already adequate in winter, you may need only 18-inch recirculating fans placed within 1 foot of the south side wall curtain between every other pen. The fans should be pointed downward, blowing north to cool the pigs, and be regulated by a thermostat. The recommended thermostat setting for these single-speed fans is about 85 degrees.

The power duct system has certain design criteria to help make it work properly. If you use a design other than those described in this publication, consult an engineer or a qualified building center. The typical costs to install a power duct system run about $13 per pig capacity. However, the average return on your investment is about 30 percent per year, based on a 0.2 improvement in feed conversion on two turns per year.

File: Engineering 1-1

Prepared by Daniel J. Meyer, agricultural engineering field specialist, Department of Agricultural and Biosystems Engineering. Reviewed by Jay Harmon, extension agricultural and biosystems engineer, Department of Agricultural and Biosystems Engineering.