VENTILATION FOR SWINE

CIRCULAR 862

D. R. DAUM AND F. W. ANDREW
CONTENTS

Winter Ventilation .................................................. 3
Summer Ventilation .................................................. 4
Fan Systems .......................................................... 5
Fan Location and Air Inlets ........................................ 7
Controls and Wiring .................................................. 10
Building Construction ............................................... 11
Supplemental Heat ................................................... 12

This circular was prepared by D. R. Daum and F. W. Andrew, respectively Instructor and Associate Professor of Agricultural Engineering.
A GOOD VENTILATING SYSTEM IS A NECESSITY IN HOG HOUSES IF healthy living conditions are to be maintained. In summer, hog houses must be ventilated to control the air temperature. In winter, ventilation is needed to remove excess moisture from the atmosphere. While performing these primary functions the ventilating system also controls the odors in the building and provides fresh air which is essential for efficient animal growth. This circular will help you determine how to ventilate your hog house for both summer and winter use, and gives you fundamental information about the selection, installation, and control of a ventilating system.

**Winter Ventilation**

Eight sows and their litters will give off 20 gallons of water per day in the form of the vapor and liquid from breathing and excreta. In winter this moisture must be removed from the building or condensation will occur when the warm, moisture-laden air contacts the cool walls and ceilings. Since forced ventilation removes heat along with moisture from the building, there must be careful control of air movement in the cold weather. Normally an exhaust system is used to "pull" air from the building for winter ventilation. A fan or fans with adequate capacity can control the temperature and the moisture content of the air in the building, provided enough heat is available. Heat is usually dissipated in three ways: by warming the incoming air, by loss through the walls and ceiling of the building, and by evaporation. Since the animals themselves (with, in some cases, the help of a supplemental heater) must supply all the heat, precautions should be taken to avoid excessive heat losses. Insulation in the walls and especially in the ceiling will help reduce heat losses and prevent condensation.

The following table will enable you to calculate the proper ventilation rate for litters and for growing pigs. When selecting a fan (see the section on Fan Systems), make sure that it has the capacity to provide ventilation at these rates.

<table>
<thead>
<tr>
<th>Type of swine</th>
<th>Ventilation rate (cubic feet of air moved per minute)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sow and litter</td>
<td>50 c.f.m.</td>
</tr>
<tr>
<td>35-100 pound pig</td>
<td>15 c.f.m.</td>
</tr>
<tr>
<td>100-225 pound hog</td>
<td>20 c.f.m.</td>
</tr>
</tbody>
</table>

If the outside temperature becomes extremely low the ventilation rate should be reduced accordingly so that a reasonable inside tempera-
A ventilating fan with safety guard. Although this fan is directly connected to the motor, belt driven models may also be used. (Fig. 1)

ture can be maintained. This may be done automatically with a thermostat (see section on Controls and Wiring). All the excessive moisture may not be removed in very cold weather and slight condensation may occur, but this condition normally lasts only a relatively short time and is not serious. When the outside air temperature returns to average or above, the ventilation rate may be temporarily increased if excessive moisture has accumulated. An alternate solution is to add supplemental heat (heat lamps, underfloor heat, or warm air furnace) to the building so that the ventilation rate necessary to remove the moisture can be maintained irrespective of outside temperature.

Ventilating fans should be selected on the basis of maximum required air movement and thermostats should be used to reduce the volume when the requirement is less than maximum. Thermostats can be used to start and stop a fan, change the speed of a fan, or change the shutter position to control fan output.

**Summer Ventilation**

In warm weather, ventilation is primarily needed for temperature control. However, in achieving this primary objective, the ventilating system also controls moisture and odors in the building. The required air flow rates for summer temperature control are much greater than for cold weather moisture removal. It is recommended that the air be changed 15 to 30 times per hour. This means that the amount of air moved in one minute should equal \( \frac{1}{4} \) to \( \frac{1}{2} \) the inside volume of the
Ventilation for Swine

5

hog house. Forced ventilation in the summer requires more fans, a bigger fan, or a combination of these. (The following section will help you select a fan system for summer use.) For most effective cooling, air is usually blown into the building.

Of course, controlled ventilation is not always needed in warm weather. Open doors and windows, or the use of a vent system may provide sufficient air movement to remove excess heat and moisture. In this case the fans may be operated merely to assist air movement when the weather is extremely hot.

Fan Systems

Several types of fans are available for ventilating livestock buildings: single-speed, single-volume; single-speed, dual-volume; and dual-speed, dual-volume. The type selected depends on both the capacity requirement and the desired operating characteristics. Fans should be selected to deliver air against a static pressure of ½ inch water. This will compensate for resistance of the building and shutters to air flow. Protective guards must be installed on ventilating fans for the safety of people and animals, but they must not appreciably restrict air movement. To determine typical propeller fan specifications (at ½ inch static pressure) use the following table:

<table>
<thead>
<tr>
<th>Fan diameter</th>
<th>Fan Revolutions per minute</th>
<th>Fan horsepower</th>
<th>Fan Cubic feet per minute</th>
</tr>
</thead>
<tbody>
<tr>
<td>13&quot;</td>
<td>1550</td>
<td>1/35</td>
<td>500</td>
</tr>
<tr>
<td>13&quot;</td>
<td>1725</td>
<td>1/8</td>
<td>1500</td>
</tr>
<tr>
<td>19&quot;</td>
<td>1740</td>
<td>1/6</td>
<td>2500</td>
</tr>
<tr>
<td>26&quot;</td>
<td>1140</td>
<td>1/3</td>
<td>4340</td>
</tr>
</tbody>
</table>

Single-Fan Systems

When a single fan is being used, it is selected on the basis of maximum requirement. Thermostats are thus needed to control the air movement when the inside temperature drops below the desired level. A typical fan is shown in Fig. 1.

If a single-speed, single-volume fan is employed, the fan is operated when the inside air temperature is above the desired level, usually 45° to 50° F. The thermostat stops the fan when the temperature drops below this level. The objection to such a system is that long “off” periods during prolonged cold spells permit moisture to condense on the walls and ceiling.

A second possible system uses a single-speed, dual-volume fan. The rate of air flow is controlled by a motor driven shutter which is
These two thermostats are used to control a dual-volume fan system. One thermostat regulates either high or low volume and the other stops the system completely during extremely cold weather. The switch-fuse combination provides an on-off control and motor overcurrent protection. (Fig. 2)

controlled by two thermostats (see Fig. 2). This system provides a high volume of air for warm temperatures and a low volume of air when the temperatures are low. When the room temperature is above the pre-set level on the shutter-control thermostat, the fan operates at full volume, and when the temperature is below the thermostat setting, an automatically controlled motor partially closes the shutters so the fan delivers approximately 40 percent of full volume. The second or safety thermostat stops the fan motor if the inside air temperature drops too low. This protects the pigs from extremely cold temperatures and prevents freezing in water lines, waterers, etc.

There are also available dual-speed, dual-volume fans. The air movement is determined by the speed of the motor which is controlled by two thermostats. When the temperature is above the pre-set level on one thermostat, the fan operates at high speed, delivering the full volume of air; as the temperature falls below the desired level the fan changes to the slow speed and moves air at a slower rate. The second thermostat stops the fan motor altogether if the air temperature in the building drops too low.

Multi-Fan Systems

When air requirements exceed the capacity of a single fan, a two-fan system may be used. Select one fan to deliver about ¾ of the total amount of air required and a smaller one to deliver the remainder. The larger fan is controlled by a thermostat that is set to cut off at a predetermined temperature, usually 45° to 50° F. The smaller fan can
Ventilation for Swine

continue to operate except in extremely cold weather when it also is cut off by a second or safety thermostat.

If two or more fans of equal capacity are used, it is recommended that they be of the dual-volume type. Set the thermostats for each fan at different temperatures about 3 or 4 degrees apart so that all fans do not start and stop at the same time. A stepping effect is realized in air flow rate; as the temperature rises more fans are turned on, and as the temperature decreases the fans are turned off accordingly. Thermostats should be mounted in an area where the fans do not create a draft over them.

**Fan Location and Air Inlets**

If the fan is to be placed in a side wall, it should be located away from prevailing winds. Place it near the ceiling for best air movement control. Single fans are normally installed in the middle of the wall. When two fans of equal size are used, place both on the same wall, \( \frac{1}{4} \) of the distance from each end (Fig. 3).

Wall fans are located in the side of the building opposite the prevailing winds. If two fans are used, they should be placed \( \frac{1}{4} \) of the wall length from each end. (Fig. 3)
Protective hoods over the fan opening will aid in keeping rain, snow, and wind from entering the building. (Fig. 4)

This fan is equipped with motor-driven shutters to control air flow. The motor is behind the shutters. (Fig. 5)

If the fan or fans are placed in the ceiling, locate them along the ridge line, or equal distance from each side in a flat ceiling. When only one fan is required, it should be placed in the center of the building. Two or more fans should be evenly spaced along the center line of the building. Ceiling fans remove heat from the building faster than wall fans. This is an advantage in summer ventilation but requires careful attention during cold weather.

If the house is divided into walled rooms, at least one fan for each room is recommended. All fans should have exhaust hoods and gravity shutters to prevent back drafting when they are not operating (Figs. 4 and 5).

Air inlets must be provided in a tightly constructed building. These must be large enough to serve the fan system, but should be carefully placed to prevent objectionable drafts during cold weather. A large number of small inlets distributed along the side of the building will provide more uniform air movement than a few large openings.

One successful inlet arrangement for wall fans is to provide 1-inch slots in the ceiling near the wall opposite the fan location (Fig. 6). The length of the slots should be 6 inches to 1 foot per 100 c.f.m. of air moved. Five to ten 1 1/4-inch diameter holes per 100 c.f.m. may be used instead of the slots. The actual area of the inlets will depend on the tightness of the building. Similar inlets located in both sides of the building can be used with ceiling fans (Fig. 7). Inlets should be located at least 10 feet from the fan. All openings near the fan should be tightly closed to insure proper air flow in the building.
Wall fans should be located near the ceiling in the wall away from the prevailing winds. Air inlets are placed to provide good air movement through the building. The arrows indicate air flow.

(Fig. 6)

Ceiling fans should be located in the middle of the building. Air inlets are located on both sides of the building to provide uniform movement of air in the building. The arrows indicate the movement.

(Fig. 7)
Controls and Wiring

The ventilating system can be automatically controlled very easily. All that is needed is a thermostat to control the fan motor or motors. The control is based on the inside air temperature and the fan will operate only when the air temperature is above the thermostat setting.

A schematic wiring diagram for a single-volume fan is shown in Fig. 8. As indicated, the thermostat is located in the "hot" line to the motor. Fig. 9 illustrates a diagram for a dual-volume, single-fan system; one thermostat starts and stops the fan and the other controls an actuator that opens and closes the shutters to regulate the air flow.

This schematic diagram illustrates the wiring for a thermostatically controlled single-speed, single-volume fan. (Fig. 8)

A schematic diagram illustrating the wiring for a two-thermostat control on a single-speed, dual-volume fan. (Fig. 9)
Fig. 10 shows a dual-volume, dual-speed system. Two thermostats are used to control the fan; one changes the motor speed and the other is a safety to stop the fan in extremely cold weather. In most cases it is wise to follow the wiring diagrams that are furnished with the equipment by the manufacturer. Make sure you select a fan motor that is protected by an overload device. If the motor does not have a built-in thermal overload, a time-delay fuse or a circuit breaker should be used in the circuit as shown in Fig. 2. The rating of the overload device should be 1.15 to 1.25 times the current rating on the motor nameplate. The usual quick-acting fuses are not satisfactory. Use totally-enclosed dustproof motors for safety and for longer life.

When planning your control and wiring set-up, make sure that the thermostat is located near the animals, but protected from possible damage by them.

**Building Construction**

Insulation is extremely important in hog houses both in summer and winter. In winter, insulation reduces heat loss, and by keeping the walls and ceiling warm prevents moisture condensation. In summer, insulation reduces solar heat. Insulation is thus one of the first things to be considered when constructing a hog house.

Two types of hog house walls are commonly used in Illinois. One is constructed of light-weight concrete masonry blocks. The cores in the blocks are filled with the coarse light-weight aggregate used in
making the block, or with any other pour-type waterproof insulation. The second type of wall construction is wood frame. Studs are 2" x 4" members with 25/32-inch insulation board sheathing and wood siding on the outside, and a vapor barrier and wood lining on the inside.

More insulation is needed in the ceiling than in the walls. A 4-inch thickness of blanket, bat, or expanded plastic insulation is recommended. The blanket or bat should have a vapor barrier on the bottom side. A layer of 4-mil plastic film placed next to the inside wall will provide a good vapor barrier. The expanded plastic insulation needs no vapor barrier because it is waterproof.

If windows are used in the hog house, either storm sash or double-paned glass should be used to reduce the heat loss. Many operators are eliminating windows in hog houses in order to reduce construction costs, and to reduce the heat exchange between the building and the outside.

**Supplemental Heat**

If the desired indoor temperature cannot be maintained during cold weather it may be due to one or more of the following reasons: insufficient number of animals in the building to provide the necessary heat, insufficient insulation, or ventilation rates that are too high. It is often the practice in farrowing houses to use a supplemental heater to provide extra heat so that the proper inside temperature can be maintained. When this is done adequate ventilation rates can be maintained and moisture will be removed from the building. The supplemental heat supplied by a warm air furnace, heat lamps, heat pads, or underfloor heat will raise the temperature so that the ventilating system for removing moisture-laden air will operate. A 100,000 BTU per hour furnace is commonly used in a 20-pen farrowing house.

The thermostat "on" setting for the supplemental furnace heater should be about 40° to 45° or a little lower than the "off" setting of the thermostat for the ventilating fan. Under many conditions this means that both the furnace and the fan will be running at the same time. Supplemental heat is seldom used in finishing houses because the temperature here is not as critical and the added cost may not be justified.