pork industry handbook

Michigan State University Extension

Cooling Swine

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Hot weather reduces swine performance more than cold weather, resulting in significant economic loss to the pork producer. This occurs because buildings in much of the United States are designed for cold weather while producers often are content to "wait out" hot spells. Hot weather usually does not result in death losses, but it can cause conception problems and subtle reductions in feed intake that result in significant drops in production. Reduced sow feed intake also can affect baby pig performance.

The purpose of this publication is to suggest practices which minimize animal production losses through the use of effective, energy-efficient cooling systems. Discussed first are the ways in which pigs give off excess body heat. This is followed by a discussion of the various types of cooling systems based on heat dissipation principles. The information provides a basis for evaluating your present system or selecting one that best fits your situation.

Heat Dissipation

Larger pigs (animals in gestation, farrowing, breeding and finishing phases of production) begin to feel the effects of heat stress at about 70°F. If temperatures remain above 85°F for more than a short period of time, substantial losses in performance and in reproductive efficiency can result unless some type of cooling relief is provided. Pigs dissipate little moisture through their skin–certainly not enough to rid themselves of excess body heat. Therefore, to relieve heat stress, they must depend upon heat dissipation to their environment in one or more of the following ways: convection, conduction, radiation, or evaporation through the respiratory tract (panting). Evaporative cooling from the body surface also is possible if some type of artificial surface wetting is provided along with adequate air movement over the animals.

Convection

Convection heat loss results from air movement over the animal's body. This is an effective means of cooling, provided two conditions are met: (1) the air velocity is at least 2 mph, and (2) the air temperature remains at least 10°F below the animal's body temperature (102 ± 1°F). At air temperatures in the range of 80°F to 95°F, pigs can dissipate up to 30% of their body heat by convection to the surrounding air.

Conduction

Conduction heat loss occurs when the animal's skin is in direct contact with a cooler surface. Conduction usually accounts for only 5% to 10% of the total heat loss in hot weather, because temperature differences are small and only about 20% of the animal's skin is in contact with the floor surface, even less if the floor is slotted.

Conductive heat loss to the cool ground surface under a shade in a pasture or a lot can be significant. However, it is not as important in concrete-floored buildings, because higher building insulation levels and a greater concentration of animals maintain a warmer floor surface temperature. Insulation placed under the floor or along the foundation specifically to control winter heat loss further reduces summer conductive cooling.

Radiation

The surface of an animal's skin is constantly radiating heat to or receiving radiant heat from its surroundings. Where the surrounding wall, ceiling and floor surfaces are cooler than the skin, there will be a net loss of heat from the animal, making it feel cooler. Radiant heat loss is directly related to the insulation level of the building. Insulation keeps inside building surfaces cool in the summer, especially the roof or ceiling. Radiation typically accounts for about 20% of the total animal heat loss in the

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summer, but if building surface temperatures are above that of the animal, there will be a net heat gain by the animal.

Evaporation

Evaporative heat loss from the animal's breathing process is important, particularly at high temperatures. For every pound of water evaporated, about 1,000 Btu of heat is required. At 80°F, panting accounts for nearly 40% of the total heat loss. Consequently, in providing relief from hot weather, it is important to keep the air around the animal's head as cool and dry as possible. This is the basic premise behind the concept of snout cooling of sows and wet skin cooling systems.

Shade Cooling

The use of sun shades in pastures and outside lots is an effective method for helping livestock keep cool (Figure 1). Shades can cut the radiant heat load from the sun by as much as 40%. They work by blocking out the sun's direct rays and providing a cooler ground surface on which the animals can lie.

Shades should have their long axis oriented in an east-west direction. High shade height maximizes the animal's exposure to the "cool" northern sky, which will help maximize radiant heat loss from the animal.

From a cooling standpoint, shades with straw roofs are best because they supply a high insulation value as well as a reflective surface. However, uninsulated aluminum or bright galvanized steel roofs also are effective. Painting the upper surface white (or with a reflective paint) and the lower surface black improves cooling by about 10%. Wood snow-fencing, a common shade material, is about half as effective as straw or painted metal. Greenhouse shade cloth works well and is reasonably durable when exposed to the sun and wind.

Shades are most effective if they are placed on high ground where they can catch the summer breezes. Lightweight shades must be well-anchored to prevent overturning in strong winds. Locating them at least 150 ft downwind from a wooded area or lush vegetation helps cool the breeze.

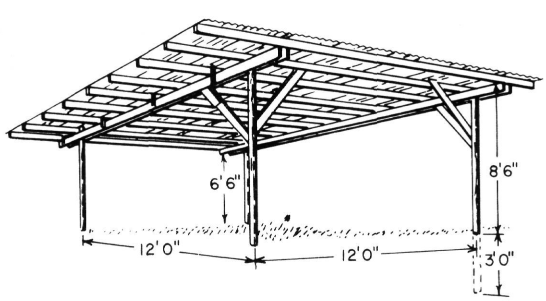

Figure 1. Shades shield out the sun's rays and provide a cool ground surface for the animals to lie on. Ideally, the high side of the shade should be located on the north to maximize radiant heat loss from the animals. See USDA Plan No. 5947 (12 ft x 16 ft shade) and No. 6257 (16 ft x 16 ft shade) available from the Agricultural Engineering Department at your state land grant University.

Adequate Insulation

In enclosed buildings, insulation in the roof or ceiling is essential to minimize solar heat buildup in hot weather. See PIH-65, *Insulation for Swine Housing* for detailed information on insulation for swine buildings.

Sidewall insulation is not significantly beneficial for summer cooling if the building is oriented east-west because the summer sun passes almost directly overhead during the heat of the day. A north-south oriented building, however, should have the sidewalls as well as the roof or ceiling insulated because of the high solar heat load on the sidewalls. Sidewall insulation also will be needed to control winter heat loss in most climates and in buildings which use evaporative or refrigeration-type cooling.

In north-south oriented naturally ventilated buildings with large sidewall openings, horizontal sun screen may be needed on the west to block the afternoon sun. This should not block the flow of cross building ventilation air. The attic area over a building with a ceiling should be well ventilated to prevent heat buildup and subsequent radiation of heat to the animals. Provide at least 1 sq ft of ridge and eave vent opening to the attic for each 300 sq ft of floor area.

Ventilation Cooling Systems

Rapid air movement over the animal aids in both convective and evaporative heat loss. An air velocity below 1/2 mph (9 inches/second) is considered "still air." While low velocities are desirable in winter months to prevent drafts, an air velocity of at least 2 mph around large animals is necessary for appreciable hot weather cooling. To achieve this, the slot in an air-intake ventilation system should be designed to impart a high air entrance velocity (about 1 sq in. of intake opening per 4 cfm of fan capacity). If possible, deflect fresh air directly onto the animals.

Summer heat is removed by a ventilation system primarily by replacing hot air with cooler fresh air. Temperatures also can be reduced by using heat from the air to evaporate moisture from the floor, thus creating an evaporative cooling effect, and by taking high-humidity respired air away from the immediate vicinity of the animals.

Table 1 lists normally recommended ventilation rates for pigs housed in enclosed buildings. Hot weather ventilation systems are typically designed to maintain an inside temperature that is no more than 2°F to 5°F higher than outside conditions. Required rates will depend on climate conditions as well as the insulation level of the building. Hot weather rates recommended for larger animals (sows in farrowing and gestation, finishing and breeding facilities) vary greatly around the United States. In the northern areas, hot weather rates which are about one-half those in Table 1 may be sufficient while hot weather ventilation rates in the Southeast may range to twice the values shown.

Table 1. Total per-head ventilation rates for enclosed swine buildings during various times of the year.

	Cold weather	Mild weather	Hot weather
		--cfm--	
Sow and litter	20	80	500
Pre-nursery pig (12-30 lb)	2	10	25
Nursery pig (30-75 lb)	3	15	35
Growing pig (75-150 lb)	7	24	75
Finishing hog (150-220 lb)	10	35	120
Gestation sow (325 lb)	12	40	150*
Boar (400 lb)	14	50	180*

*Use 300 per sow or boar in breeding facilities due to low animal density and susceptability to poor performance at high temperatures.

Air circulation systems, such as plastic air tubes and large diameter ceiling-hung or floor-mounted circulation fans, often are used to increase air velocities around animals. These systems are especially useful in naturally ventilated buildings and in wide (40 ft or more) fan ventilated buildings. See PIH-41, *Maintenance and Operation of Ventilation Fans for Hog Barns,* and PIH-60, *Mechanical Ventilation of Swine Buildings,* for further information on the design of livestock ventilation systems. Summer circulation fans should be sized at about one-half the hot weather rate given in Table 1. For example, a farrowing room would be designed to exhaust 500 cfm per sow and provide circulation fan capacity equal to 250 cfm (1/2 x 500) per sow. In naturally ventilated buildings, locate the structure on high ground away from other structures and trees that might block air flow. See PIH-60 and PIH-120 for information on sizing openings for mechanical and non-mechanical ventilation systems.

Water Cooling Systems

Water Supply

Animals must drink large quantities of water in hot weather if their evaporative heat loss system is to help them cool off. Table 2 lists the summer water requirements for pigs. Table 3 lists the nipple waterer flow rates recommended for pigs. Water should be kept as cool as practical in order to achieve best weight gains in summer. Cooled water can slightly increase daily weight gain in very hot weather. Thus, water direct from a well is preferable to water stored in an above ground tank for an extended period or from a shallow farm pond.

Table 2. Typical summertime water usage for pigs.*

Type of animal	Water per head per day, gal
Sow + litter	8
Nursery pig	1
Growing pig	3
Finishing hog	5
Gestation sow	6

*Includes water use for drinking and moderate water wastage. Water cooling systems may increase usage.

Wet-Skin Cooling

The pasture wallow has been used for many years for wet-skin cooling. In addition, the mud pack acquired helps protect the skin from the sun's rays. Wallows located under shade are more effective in improving animal comfort than unshaded wallows, because they are shielded from the sun's rays and the water remains cooler.

Substantial cooling is possible by wetting the animal's skin and allowing the moisture to evaporate. Research studies measuring the performance of finishing hogs in hot weather reveal that animals perform as well with sprinklers as they do with evaporative cooling of inlet air. Air movement across the animal increases the evaporation rate and improves cooling.

In extremely hot weather, relief can be gained by hosing the animals down once every hour or so. This requires more water and labor than a sprinkler system but can help during a crisis.

Sprinkling is preferred to fogging, which uses smaller water droplets. Sprinkling cools the skin surface by wetting the skin surface and allowing the water to evaporate, whereas fogging cools the air and the air must then cool the animal. Also, the smaller fog droplets drift with air movement.

Animals cooled with sprinklers should be provided access to shade or shelter to avoid possible "sunburn."

Most sprinkler systems operate by using thermostat-controlled timers that wet the animal and then allow it to dry. Sprinkler systems usually are designed to run for 1 to 2 min during each 30-min period (a few operations use 1 to 2 min during each 10-min period) when the temperature is above some set value (typically in the 80°F to 85°F range). Locate sprinklers over the slots in a partially slotted floor or over the dunging area in solid floor systems.

Tables 4 and 5 provide water line and nozzle size information. Provide at least 0.02 gal of water per hour per finishing hog (1 gal per 50 finishing hogs) for adequate sprinkler cooling. If the available nozzles do not provide the proper amount of water at the available water pressure, either adjust the water pressure, adjust the timer accordingly or use more than one nozzle per pen. While producers often construct sprinkler systems by simply punching holes in polyethylene pipe with a 20 gauge needle, a specifically designed nozzle provides a better spray pattern and is less apt to become plugged.

Table 3. Nipple drinker recommendations for swine facilities.

Stage	Pigs per nipple	Nipple distance apart, inches	MINIMUM flow per minute
Nursery	10	12	1-1 1/2 cups
Grower	10-15	18	2-3 cups
Finisher	15	24-36	3-4 cups
Gestation	15	36	3-4 cups
Lactation	1	NA	3-4 cups

Table 4. Nozzle sizes for sprinkler system (based on operation at 40 psi).

Pigs per pen	Water requirements (gal/hr)	Frequency of use: 2 min/10 min gal/min	2 min/10 min gal/hr	1 min/30 min gal/min	1 min/30 min gal/hr
10	0.2	0.017	1	0.10	6
20	0.4	0.033	2	0.20	12
30	0.6	0.050	3	0.30	18

Table 5. Water line sizes for sprinkler systems.*

Pipe size ID	Class 160 PVC	Class 200 PVC	Schedule 40	Schedule 80
3/4 in.	7 gpm	6 gpm	4.5 gpm	3.5 gpm
1 in.	13 gpm	13 gpm	9 gpm	7 gpm
1 1/4 in.	25 gpm	23 gpm	18 gpm	15 gpm
1 1/2 in.	35 gpm	32 gpm	28 gpm	23 gpm
2 in.	55 gpm	55 gpm	50 gpm	45 gpm
2 1/2 in.	85 gpm	80 gpm	70 gpm	65 gpm

*Based on maximum pressure drop of 2 psi per 100 ft or velocity less than 5 ft per second.

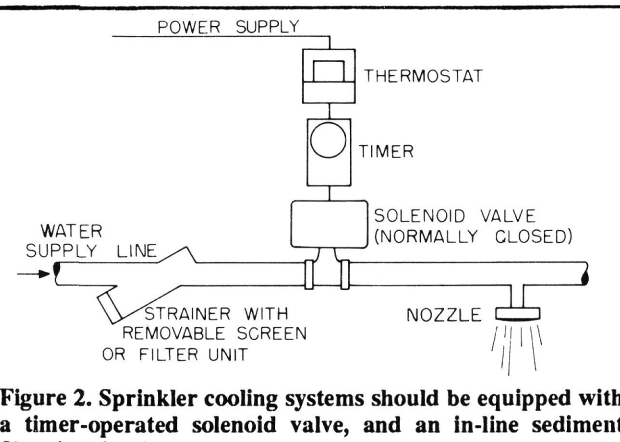

Figure 2. Sprinkler cooling systems should be equipped with a timer-operated solenoid valve, and an in-line sediment filter (strainer).

Be sure to have an easily cleaned, in-line sediment filter (100 mesh strainer or cartridge unit) and a timer-operated solenoid valve in the line between the water source and the nozzles (Figure 2). Nozzles are an especially important component of any sprinkler system. Select noncorrosive nozzles specifically designed to furnish a solid cone of water droplets, not a mist or fog.

Drip cooling utilizing drip irrigation emitters works well in farrowing houses. These systems operate at low pressure. Obtain drippers rated at 0.5 to 1.0 gal/hr at the manufacturer's pressure rating. Control the drippers with a thermostat and solenoid valve. Operate drippers when air temperature exceeds 85°F.

Locate the water supply pipe (a 1/2 in. polyethylene can deliver 150 gal/hr) over the top bar of the stall about 20 in. behind the front headgate. This location reduces feed wetting, keeps young pigs dry, and provides effective sow cooling. Center drippers over the sow's neck and shoulder area. Do not install drippers where water can flow into the creep area.

Single nozzle drip systems can be used in individual pens such as boar pens. Locate the nozzle in the dunging area.

Evaporative Cooling Systems

Operation Principles

Evaporative coolers use the heat of water vaporization to cool ventilation air in the same way that water sprayed on animals evaporates and cools their skin. The incoming ventilation air is passed through a moist pad, where heat in the air evaporates moisture into the air. This raises the relative humidity while lowering the temperature of the air.

The lower the relative humidity of the incoming air, the more effective the evaporative cooling. This kind of cooler is more effective in dry western states than in the midwestern or eastern United States. Even so, evaporative cooling can provide some relief from heat stress under most summer conditions in these areas. Relative humidity drops as the air temperature rises and is usually at its low point during the hottest part of the day. Theoretically, a temperature drop of 18°F is possible under typical midwestern summer conditions. In practice, however, a temperature drop of only about 8°F can be expected. The hot weather ventilation rates shown in Table 1 should be used to design an evaporative cooler.

Several types of evaporative coolers are available for commercial use in livestock buildings. Most were developed for greenhouse or residential use. Local greenhouse suppliers are excellent sources of information for this equipment. Most units use a circulating pump to distribute water over a fibrous pad. Air is drawn through pads into the animal area. Routine maintenance is essential to maintain the system in proper operating condition (i.e., to control algae growth and dirt build-up).

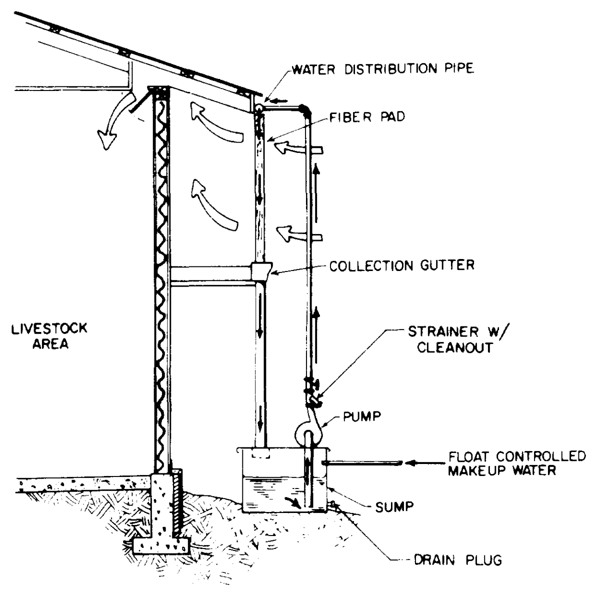

Figure 3. In a sidewall mounted evaporative cooling system, ventilation exhaust fans pull hot outside air through wet fiber pads. Heat from the air is used to evaporate the water, thus lowering temperatures but increasing the relative humidity. Consider modifying the baffle for down-the-wall air flow for maximum benefit when the cooling system is in operation.

Design

Figure 3 shows a typical evaporative cooler design. The water distribution system usually consists of a rigid plastic pipe with spaced holes to allow the water to be distributed uniformly over the pads. A 2-in. pipe with 1/8-in. holes spaced 4 in. apart (4 ft water gauge pressure head) or a 4-in. x 4-in. open gutter with 1/4-in. holes spaced 4 in. apart (2 in. water gauge pressure head) will produce about the same flow rate over 100 linear ft of pad area, but a better practice is to size pipe diameter, hole diameter and spacing for each system individually.

The best procedure for sizing total pad area is to follow the manufacturer's specific recommendations for your location. In the absence of specific manufacturer recommendations, the pad area needed (sq ft) can be approximated by dividing the ventilation rate (in cfm) to be cooled by 150 for aspen pads, or by 250 for cellulose honeycomb-style pads. The water sump should have a capacity of at least 0.5 gal per sq ft of aspen pad, or 0.8 gal per sq ft of 4 in. thick cellulose pad. The flow rate to the water distribution pipe over the pads should be at least 0.3 gal per min (gpm) per ft of linear length of 2 in. to 4 in. thick aspen pad (0.4 for aspen pad under desert conditions) or 0.5 for 4 in. thick cellulose pad to ensure adequate wetting.

A gutter sloped at 1 in. per 20 ft is located beneath the pads to collect any water not evaporated and convey it back to the sump to prevent water wastage. Recycled water should pass through an inclined 50 mesh screen before entering the sump. The sump and open distribution gutter should be covered to shut out sunlight (to control algae growth) and to keep out insects and other debris. Make-up water to the sump is normally controlled with a shutoff valve. Up to 1 gpm per 100 sq ft of pad can be evaporated on hot, dry days.

Set the thermostat so that the pump begins wetting pads when the temperature reaches 80°F to 85°F. The pump should be wired so that it shuts off before the fans. This allows the pads to dry out after use and minimize the buildup of algae growth.

Maintenance

Pads made from woven aspen fibers must be replaced annually; however, cellulose and other types of pads with a useful life of 5 years or more are available now with some units. Pads usually are mounted either on the side or endwall, or on the roof. Wall-mounted pads are easier to maintain and, therefore, are preferred for livestock buildings. Vertically mounted pads should be checked periodically to eliminate sagging, resulting in voids which allow ventilation air to by-pass the wetted pads and enter the building without being cooled.

Pads should be hosed off at least once a month to wash away any trapped dust and sediment. Algae build-up in the recirculated water system is sometimes a problem but can be controlled with a copper sulfate solution. Some units use light-tight enclosures around the pads to help control algae growth.

Because water is constantly being evaporated, salts and other impurities build up. Constantly bleeding off 1% to 2% of the water (0.05 gpm per 1000 cfm of air cooled) will help flush these salts from the system as they are formed. The entire system also may be flushed out periodically, with the frequency depending on the hardness of the water used. Install removable caps or valves on the ends of the distribution lines to facilitate flushing.

Refrigerated Air Systems

Refrigeration cooling systems are seldom used in livestock buildings because of their high installation and operating cost. Unlike residential units, air conditioners in livestock buildings usually are not installed to reuse room air because of the high level of corrosive gases and dust in the air. To prevent rapid clogging and excessive maintenance, the air conditioner must continually cool incoming fresh air in a one-pass process. Some producers use refrigerated air units for space cooling in their farrowing houses or in swine breeding units, and the systems do perform satisfactorily, except for the high operating cost.

Operation Principles

Air conditioners both cool and dehumidify the air as it passes over a cold, finned refrigeration evaporator coil. If the air is cooled below the dew-point temperature, moisture in the air condenses. The relative humidity of the air leaving the unit is higher than the relative humidity of the incoming air because of the lower temperature, but it contains less moisture because of the condensation. As this air is warmed by mixing with air inside the building, its relative humidity decreases, enabling it to pick up additional moisture.

Design

A "ton of refrigeration" is a term originating in the days of ice block cooling. It is defined as a cooling capacity of 200 Btu per min or 12,000 Btu per hr. For a well-insulated building, use 1 ton of refrigeration for each 275 cfm of conditioned ventilation air. To determine the size of the unit needed for a specific building, refer to the following example.

Table 6. Air ventilation rates for swine in enclosed refrigerated buildings.*

Type of animal	Ventilation rate per head
Lactating sow	100 cfm
Gestating sow (325 lb)	40 cfm
Boar (400 lb)	50 cfm
Finishing hog (150 lb)	30 cfm

*Assumes 20°F temperature drop across evaporator.

Example: What size air conditioning unit is needed to cool a 20-sow farrowing house? From Table 6, the total refrigerated air ventilation rate is found to be 2000 cfm (100 cfm x 20 sows). Size of the cooling unit, therefore, should be about 7 1/4 tons (2000 cfm ÷ 275/ton).

Earth-tempered air often is an economical form of refrigerated air. See PIH-102, *Earth Tempering of Ventilation Air, or MWPS-34 Heating, Cooling, and Tempering Air* for a detailed discussion of earth tempering and for specific design procedures.

Zone Cooling Systems

Since, in hot weather, 50% to 60% of animal heat loss is through evaporation from the respiratory tract and convection from the skin surface, cooling the zone around the animal's head can be an effective cooling method. A supply of high-velocity air around the head enables the animal to lose more heat and thus remain cooler. Zone cooling does not satisfy all of the hot weather ventilation needs. A conventional hot weather ventilation system sized to remove air at the rate given in Table 1 also is needed.

Zone cooling is generally used only for crated or tethered animals or a small number of animals in a small pen, such as in a boar pen. In farrowing houses, zone cooling helps maintain a cool environment for the sow while allowing higher temperatures in the pig creep.

Zone cooling systems can use either fresh uncooled air or refrigerated air. Evaporative cooled air is NOT recommended for zone cooling systems because the high moisture content of the air prevents effective dissipation of respired moisture around the animal's head. Air cooling with earth tubes or other non-evaporative methods should be designed according to the amount of temperature drop. If cooling is as efficient as refrigeration (i.e., 20°F or more drop in temperature), the same design can be used.

Design

A zone cooling system (Figure 4) has a main air supply duct open to the outside or to the cooling unit and downspouts or drop ducts located as needed for the animals.

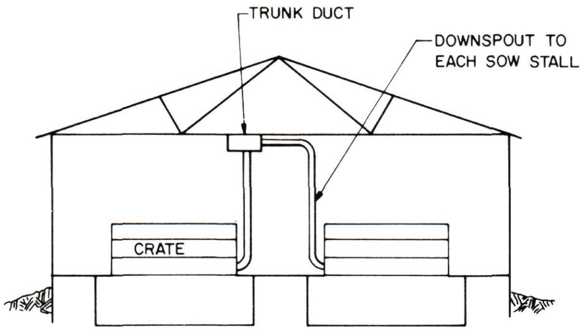

Figure 4. Zone cooling systems provide only a portion of total ventilation needs but are very effective, since high-velocity air is transported directly to the animals.

The downspouts should be placed as close as possible to the animals' heads. They should be constructed of nondestructible material and well anchored if within the animal's reach. If the duct opening is too far above the animal, the cooled air mixes with the surrounding air, both reducing its velocity and raising its temperature. Dampers can be used on downspouts to shut off the airflow when crates or pens are empty.

Table 7 gives recommended air flow rates for systems using uncooled outside air or refrigerated air. Tables 8 and 9 present supply duct and downspout sizes to accommodate various airflow rates. These suggested minimum sizes permit an air velocity of 600 ft per min (fpm) through the supply duct and 800 fpm to 1000 fpm through the downspouts. The trunk ducts can be slightly larger but should not be smaller if good air distribution is to be obtained. Sizes shown for downspouts are more critical in maintaining the proper air exit velocity and should be adhered to carefully.

Table 7. Per-head air flow rates for zone cooling of swine.*

	System	
Type of animal	Uncooled air	Refrigerated air
	--cfm--	
Farrowing sow	70	40
Gestating sow (325 lb)	35	20
Boar (400 lb)	55	30

*Systems using zone air cooling systems should still be ventilated at the hot weather rates shown in Table 1.

If zone cooling ducts are used to supply refrigerated air in summer or fresh air in winter (as a part of a winter ventilation system), they must be insulated (R = 6 minimum) to prevent condensation. With refrigerated air, insulation also will minimize heat gain as the cooled air passes through the duct to the animal.

The following example shows how to determine, from Tables 7, 8, and 9, the airflow and duct size requirements of zone cooling systems for a 20-sow farrowing house.

Uncooled air. From Table 7, airflow in each downspout should be 70 cfm, and in the supply duct it should be 1400 cfm (70 cfm/sow x 20 sows). From Tables 8 and 9, a proper downspout size for 70 cfm is 4 in. diameter, and the minimum trunk size for 1400 cfm is 18 in. x 20 in.

Refrigerated air cooling. From Table 7, each downspout should supply 40 cfm, while the supply duct supplies 800 cfm (40 cfm/sow x 20 sows). From Tables 8 and 9, this airflow rate requires a downspout diameter of 3 in. and the trunk size of 12 in. x 20 in. Note that the size of the air conditioner required for zone cooling is about 3 tons (800 cfm ÷ 275 cfm/ton) compared to 7 1/4 tons required to cool the entire building (see earlier example).

Table 8. Minimum supply duct sizes for zone cooling systems (600 fpm air velocity).*

Air flow rate within duct, cu ft/min	Inside duct dimensions if: Rectangular, in. x in.	Round, diam, in.
250	6 x 10	9
500	10 x 12	12
750	10 x 18	15
1000	12 x 20	18
1250	15 x 20	
1500	18 x 20	
2000	18 x 27	
2500	18 x 34	
3000	18 x 40	
3500	24 x 35	
4000	24 x 40	
5000	24 x 50	
6000	30 x 48	
7000	36 x 48	
8000	36 x 54	

*It is the minimum cross section area, not the actual duct dimensions given in the table, that is important. Almost any duct shape of comparable size should deliver the same amount of air.

Table 9. Recommended downspout sizes for zone cooling systems (800-1000 fpm air velocity).

Air flow rate per sow, cfm	Inside duct dimensions if: Rectangular, in. x in.	Round, diam, in.
20	2 x 2	2 1/2
30	2 x 3	2 1/2
40	2 1/2 x 3	3
50	3 x 3	3 1/2
75	3 x 4 1/2	4
100	4 x 4 1/2	5
125	4 x 5 1/2	6
150	4 x 6 1/2	6
175	4 x 8	8
200	6 x 6	8
250	6 x 7 1/2	8

Summary

The lack of a cooling system is a serious deficiency in many buildings. Many pork producers experience enough loss due to poor performance and animal deaths each summer to pay for a cooling system in a short time. Cooling systems need not be sophisticated to be effective, but they must be selected and designed for ease of maintenance. Reliability should be a primary consideration in selecting a system.

Suggested Reading: MWPS-34 *Heating, Cooling and Tempering Air for Livestock Housing 1990* is available ($6.00 plus postage and handling) from: Midwest Plan Service, 122 Davidson Hall, Iowa State University, Ames, Iowa, 50011. Phone 515-294-4337.