AGRICULTURAL EXTENSION SERVICE • UNIVERSITY OF MINNESOTA

Swine Update

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CHOOSING A HEAT EXCHANGER

Heat exchangers are presently being used in swine facilities, especially farrowing and nursery units, to recover a portion of the heat that is lost through the ventilation air. The heat recovery process (see Figure 1) is accomplished by moving the warm, moist room air past cold incoming fresh air, which is separated by plastic or metal sheets. These two airflows may be in opposite directions (counterflow), at right angles to one another (crossflow), or in the same direction (parallel flow). The amount of heat which is lost by the minimum ventilation air exchange is very significant, amounting to as much as 80% of the total heat loss from a typical nursery facility. Thus, a sizable amount of heat is available for reclamation by a heat exchanger. The following criteria should be used when choosing a heat exchanger for your swine facility: proper airflow, cleanability, compatibility, distribution, durability and economic return.

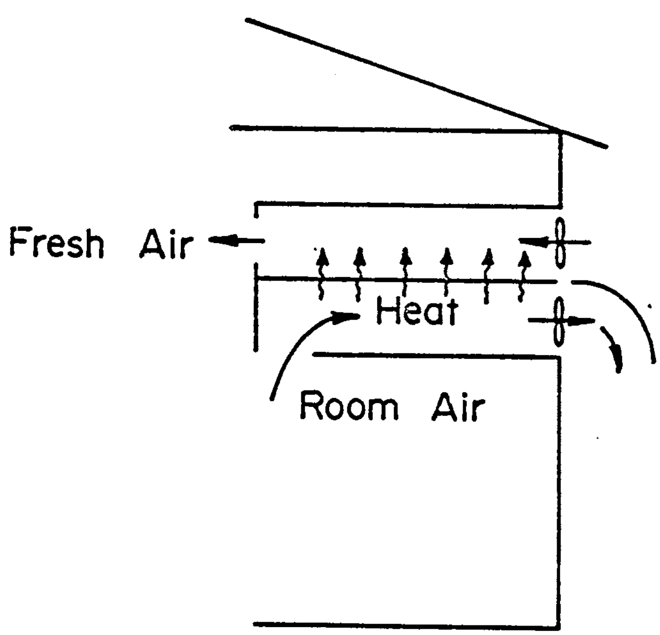

Figure 1.

A heat exchanger essentially replaces the continuous operating fan in a conventional ventilation system. Therefore, it must deliver the minimum ventilation rate for the particular number and size of pigs. The table below gives the Midwest Plan Service recommended minimum ventilation rates for all ages of pigs:

SWINE MINIMUM VENTILATION RATES

ANIMAL TYPE	WEIGHT, LBS.	RATE, CFM/HEAD
SOW & LITTER	400	20
PRE-NURSERY PIG	12-30	2
NURSERY PIG	30-75	3
GROWING PIG	75-150	7
FINISHING PIG	150-220	10
GESTATING SOW	325	12
BOAR	400	14

Table 1.

It is suggested that a heat exchanger be sized at or slightly higher than the above rates. However, even with a heat exchanger, one does not want to significantly "overventilate" since the net heating benefit will be lessened at higher minimum rates.

Historically, a major disadvantage of heat exchangers has been the problem with clogging of the exhaust air channels due to the combination of moisture and dust accumulation. This condition, known as "fouling", can reduce heat transfer, and more importantly, reduce airflow through the unit. As described above, the heat exchanger is the continuous running fan, and if the minimum ventilation is reduced, serious complications can result in the facility due to a lack of air exchange. Thus it is essential that a heat exchanger be cleaned on a regular basis (frequency given by manufacturer) that uses a minimum amount of time and labor.

When placing a heat exchanger in an existing swine housing unit, one must make sure that the existing system has compatible components. This means that air inlets have dampers which will automatically open when thermostatically controlled exhaust fans are activated (Figure 2) and close when only the heat exchanger operates (Figure 3). This point is essential, since a two-fan design is highly recommended to insure adequate airflow but results in zero or neutral static pressure (difference between outside and inside air pressure).

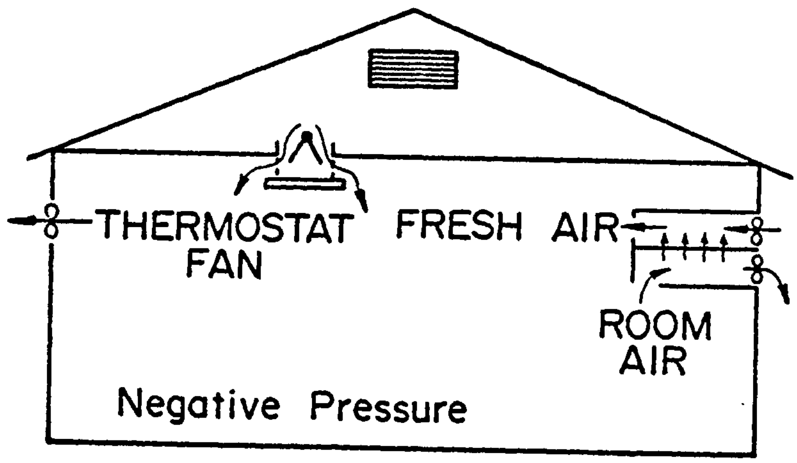

Figure 2.

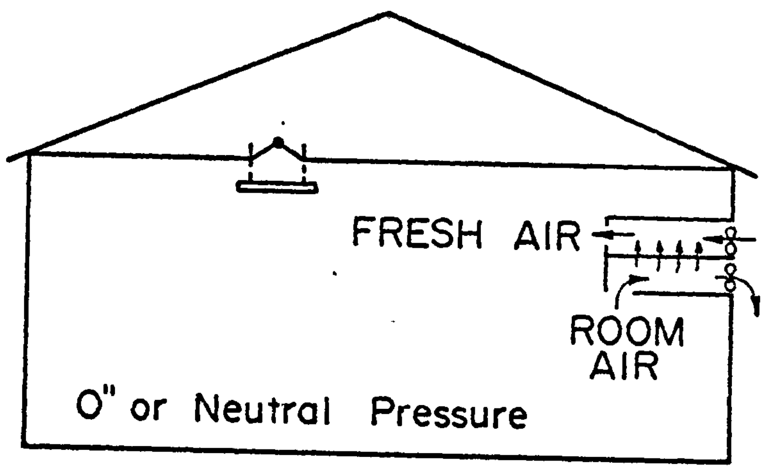

Figure 3.

If air inlets do not have baffles, air will backdraft into the attic (Figure 4), resulting in significant heat loss, building deterioration and wet insulation.

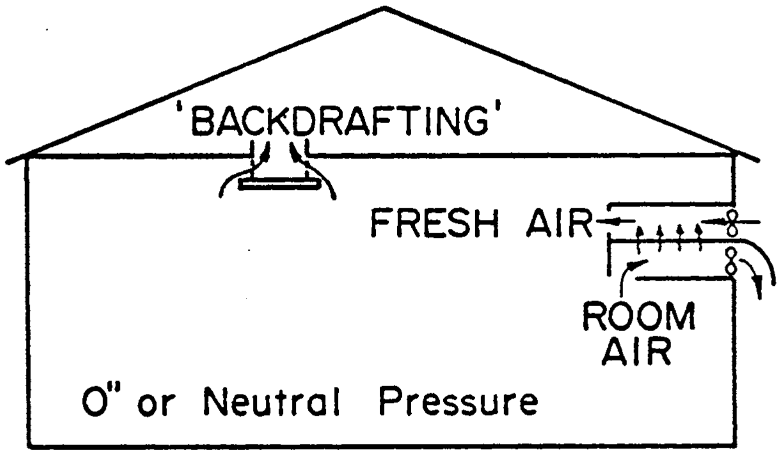

Figure 4.

Proper distribution of air in a swine housing facility is always of concern when ventilating at the minimum rate. This is even more important when a heat exchanger is being used, since they generally operate at a neutral static pressure level which places all of the air distribution forces on the incoming air from the heat exchanger. If this is at a single discharge point and the room is reasonably large, very poor distribution will result. Thus, in a building which is over 25 feet long, some type of distribution duct should be connected to the single discharge point from heat exchangers (Figure 5). This can be in the form of a plywood duct, or rigid circular duct. One should make sure that ducts are of adequate size, so that the air velocity within the duct does not exceed 800 fpm (feet per minute). Since most ducts are relatively short (less than 50 feet) evenly spaced holes or continuous slots will give good distribution of air down the length of the tube or duct.

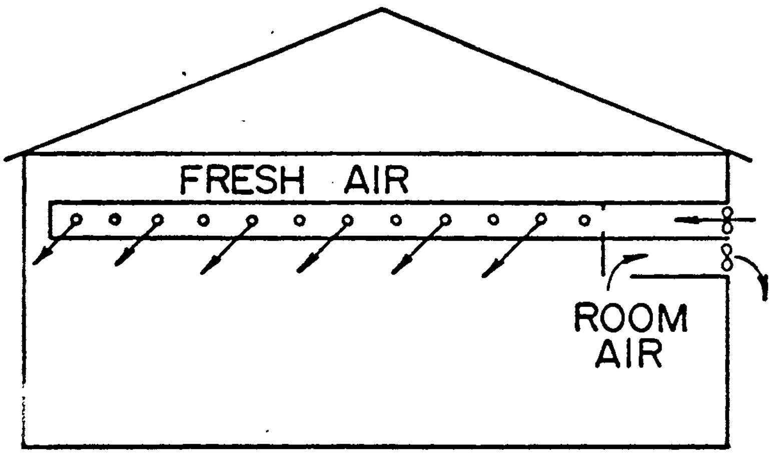

Figure 5.

Any equipment that is used in a swine housing system must be of durable construction. It is therefore essential that heat exchanger material be made of non-corrosive material such as plastic, fiberglass, or alloys of aluminum. Heat transfer rates are essentially the same for plates constructed of metal or plastics, since a high portion of the resistance to heat exchange is the air films on each side of the surface.

The economic return or payback period for heat exchangers is an important consideration when choosing a unit. Many factors will affect the return on investment with some of the more important being: initial cost, unit's efficiency, and temperature difference between the room and the outside. An estimate of the payback period, based on limited research and field observations, would be from 5 to 10 years for most of the commercial systems sold today. This estimated return only considers the savings in fuel (generally L.P. Gas) and not claims such as improved environmental conditions and better gains which, even if correct, are difficult to convert to dollars and cents.

INSULATION OF CONCRETE WALLS

Walls of either block, or poured concrete are common in swine housing facilities. Although durable and easily constructed, concrete walls offer little thermal resistance. For large animals, this disadvantage of concrete walls is not a major problem, but for young animals it can play a large role in the performance of the small pig and fuel usage to maintain proper inside temperatures.

One can insulate a concrete wall from the inside, the outside, or by placing insulation inside the wall. The three basic types of thermal insulation: rigid, blanket and spray-on, can all be used to insulate concrete surfaces.

The most common method of insulating concrete walls is to attach insulation to the interior face. This is also the least expensive, although it does isolate the thermal mass of concrete from the inside space. The most common method of insulating on the inside involves 2 x 2 furring strips with 1-1/2 inch thick rigid insulation (Figure 6) placed between these vertical members for a total R-value of from 8 - 10. One can increase the thermal resistance by adding another 1-1/2" layer of rigid board insulation (total R-value from 14-18) over the 2 x 2 furring strips (Figure 7). In either case, a continuous vapor barrier (generally 4 or 6 mil thick polyethylene) is placed over the insulation and plywood or metal nailed to the furring strips to act as the interior surface.

Insulating concrete walls on the exterior surface is generally the most costly method of insulation. However, the exterior insulation does expose the thermal mass of the concrete to the inside air space. It is also an advantage to apply insulation on the exterior in some remodeling applications so the interior concrete surface can be left untouched. This allows the use of insulation down into the ground next to the foundation to prevent heat loss in that area. The most common type of insulation used in exterior application is the rigid board insulation material. They are used primarily because they resist water.

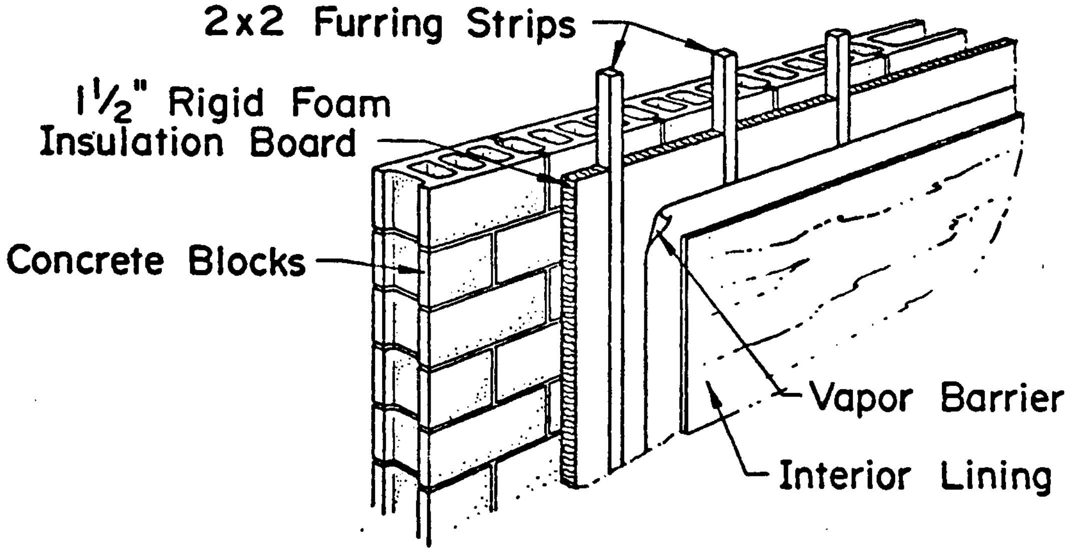

Figure 6.

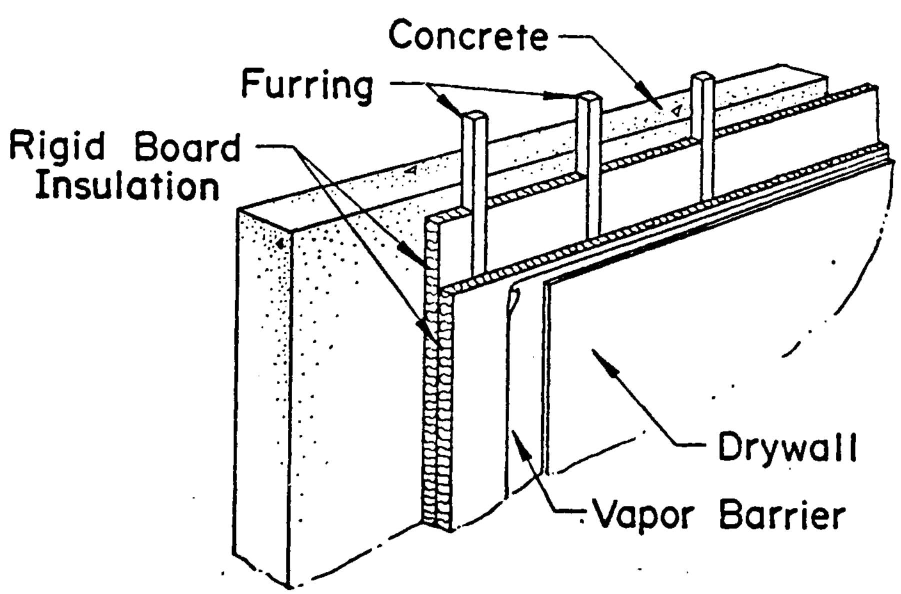

Figure 7.

These rigid sheets are either glued or mechanically fastened to the outside concrete surface and fiberglass or steel mesh is then placed over the insulation to provide reinforcement for a finishing surface of plaster or stucco (Figure 8). There are also a variety of finished surfaces that already adhere to various thicknesses of insulation which can be applied in one operation and have an acceptable outside finish.

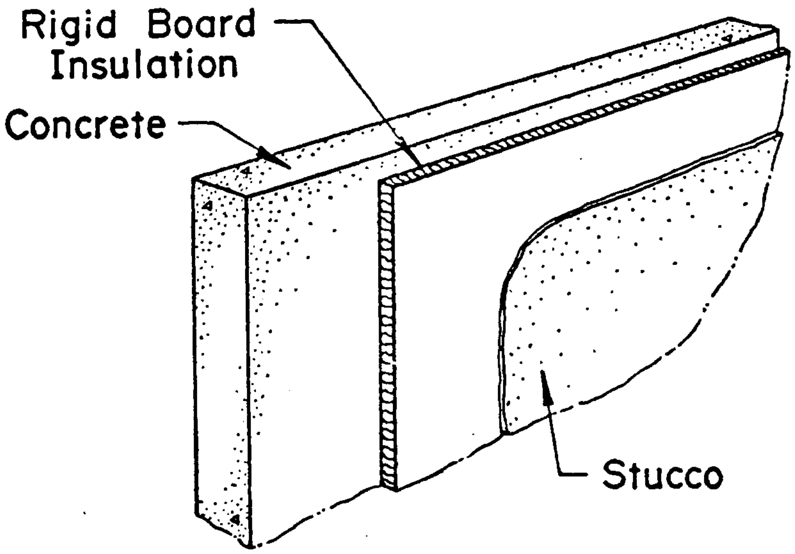

Figure 8.

The other method of insulating concrete walls involves embedding the insulation inside the wall (Figure 9). These "sandwich" walls use insulation as an integral part of the wall panels when the concrete is poured or cast in place. The primary advantage to doing this is that the insulation is protected from destructive action of the environment and from physical damage due to rodents or other construction practices. Again, rigid board insulation is primarily used due to its structural strength and moisture resistant qualities.

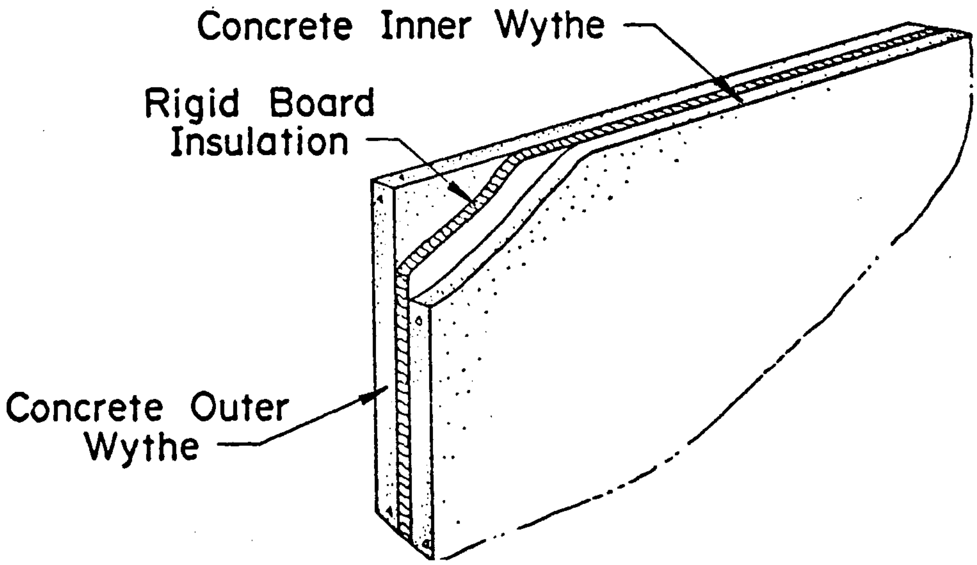

Figure 9.

ESTIMATED COST OF SWINE FACILITIES

An estimate of the cost of swine housing facilities is often desired and necessary for meaningful financial planning. Farmers, lenders, and agribusiness personnel cannot always afford the money and time spent to obtain "actual" cost figures from building firms and contractors. Therefore, the following "ballpark" investment figures are given on a per pig capacity basis for different swine housing facilities:

Type of Facility	Cost/Unit Capacity
Gestation:	
Outside in dirt lots	$ 150/sow
Inside in pens	$ 360/sow
Inside in crates	$ 500/sow
Farrowing:	
Remodeled Barn	
- Pens on floor	$ 650/pen
- Crates on floor	$ 750/crate
- Raised crates	$1000/crate
New Facility	
- Crates on partially open flooring	$1500/crate
- Raised crates with outside pit	$2000/crate
Nursery:	
Remodeled Barn	
- Pens on floor	$ 20/pig
- Raised deck	$ 50/pig
New Facility	
- Partially open flooring	$ 60/pig
- Raised deck with outside pit	$ 80/pig
Finishing:	
Pasture or dirt lot	$ 40/hog
Open front	$ 70/hog
Naturally ventilated, modified open front	$ 100/hog
Mechanically ventilated	$ 130/hog

The above figures are intended to serve as guidelines for initial planning. They were obtained from information used to train FMHA personnel, with input from Larry Jacobson, Agricultural Department, Vernon Eidman, Ag and Applied Economics Dept, Jerry Hawton, Animal Science Dept. and Al Leman, Veterinary Science Department.

TWO-STAGE THERMOSTAT FOR HEATERS AND FAN CONTROL

The proper control of the hot air furnace or heater, and the fan which controls the normal winter or fall and spring ventilation rates, is many times, difficult due to the calibration of two separate thermostats. One cannot have the heater operating at the same time that the thermostatically controlled fan operates, otherwise large amounts of heat will be lost and room temperatures will not be consistent. Therefore, it is essential that some type of control be used, so that the heater and the larger ventilation fan (not the continuous running fan) will never run simultaneously. This can be accomplished for less cost and with greater reliability by using a two-stage thermostat, rather than two separate thermostats for each unit. The diagram given below shows the wiring diagram for a two-stage thermostat to accomplish this.

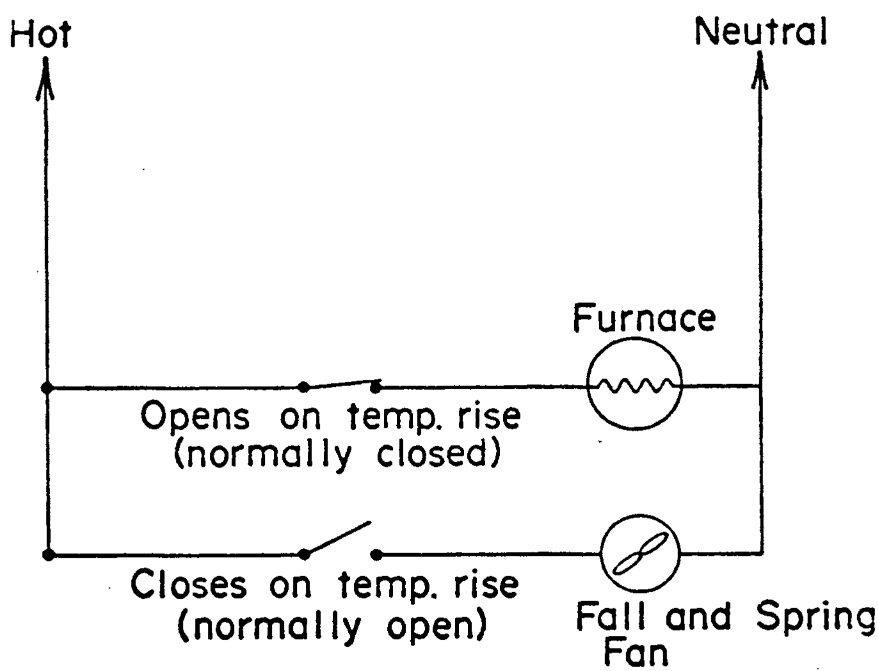

Figure 10.

There is only one sensing unit with a two-stage thermostat which eliminates calibration problems and separate locations when two single-stage thermostats are used. Although cost of a two-stage thermostat is approximately 50% more than a single-stage unit, it is still cheaper than buying two units. More importantly, results in the field using this type of system have been very good, with almost no chance of the heater and thermostatically controlled fan operating at the same time.

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