Heat Exchangers in Swine Facilities: Pork Industry Handbook
Michigan State University Extension Service
Larry D. Johnson, University of Minnesota; Martin Hellickson, Oregon State University; Jay D. Harmon, Iowa State University
Reissued July 1997
4 pages

pork industry handbook

MICHIGAN STATE UNIVERSITY EXTENSION

# Heat Exchangers in Swine Facilities

(Keywords: swine, heat exchangers, facilities, environment)

**Authors**
Larry D. Jacobson, University of Minnesota
Martin L. Hellickson, Oregon State University
Jay D. Harmon, Iowa State University

**Reviewers**
Maynard Hogberg, Michigan State University
Palmer Holden, Iowa State University
James A. Lindley, North Dakota State University
Charles M. Stanislaw, North Carolina State University
John Thomson, South Dakota State University

Ventilation air-to-air heat exchangers are used in swine housing facilities to reduce supplemental heating cost and to preheat incoming fresh air. There is potential for heat exchanger use in some swine barns, since as much as 90 percent of the total heat loss from an insulated swine nursery facility occurs through the minimum ventilation air exchange. Heat exchangers recover a portion of this loss, depending upon design and maintenance. In addition to reducing fuel use, heat exchangers preheat the incoming ventilation air thereby reducing the potential for drafts on piglets and reducing frosting problems when air enters directly from outside. Heat exchangers also improve air distribution, because warmed inlet air will not drop as rapidly as cold inlet air.

Heat exchangers are not economical in all swine housing facilities. It is unlikely that there will be an economic benefit in warm climates or for units housing large pigs, i.e., hog finishing. Even in small pig facilities, other energy saving methods, such as accurate control of minimum ventilation rate, are often more economical than adding a heat exchanger. Also, the addition of a heat exchanger will not make up for poorly insulated walls and ceilings.

## Heat Recovery Process

In an air-to-air heat exchanger the heat recovery process is accomplished when warm, moist room air is moved past cold, fresh inlet air, separated by a heat conducting plate or surface (Fig. 1). Heat transfers across the plate because of the difference in temperature, often cooling room air to the dew point causing moisture condensation. While condensation releases large amounts of heat, it also causes a need to drain water from the unit and, during extreme cold temperatures, the need for a defrost cycle to remove frozen condensate.

In a heat exchanger the two airflows may be in opposite directions (counter flow), at right angles to one another (cross flow), or in the same direction (parallel flow). Most units use the counter flow design since it is most efficient, but some employ the cross flow method because it allows for a more compact unit. Although the basic design of an air-to-air heat exchanger is simple, selection and design of heat exchanger components (fans, ducts, etc.) which are functional and compatible make a home-built unit less likely to perform properly.

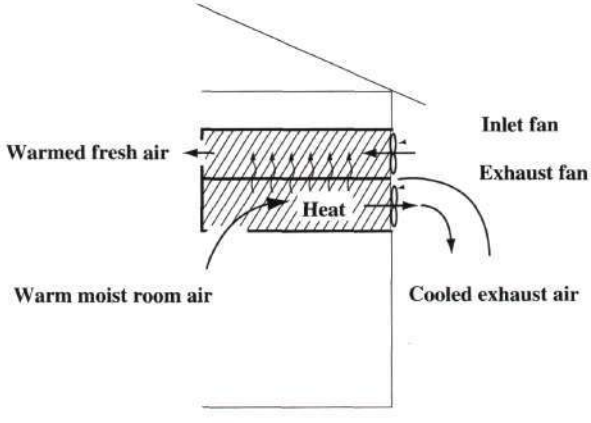


**Figure 1. Schematic cross-sectional view of a heat exchanger with an exhaust and an inlet fan.**

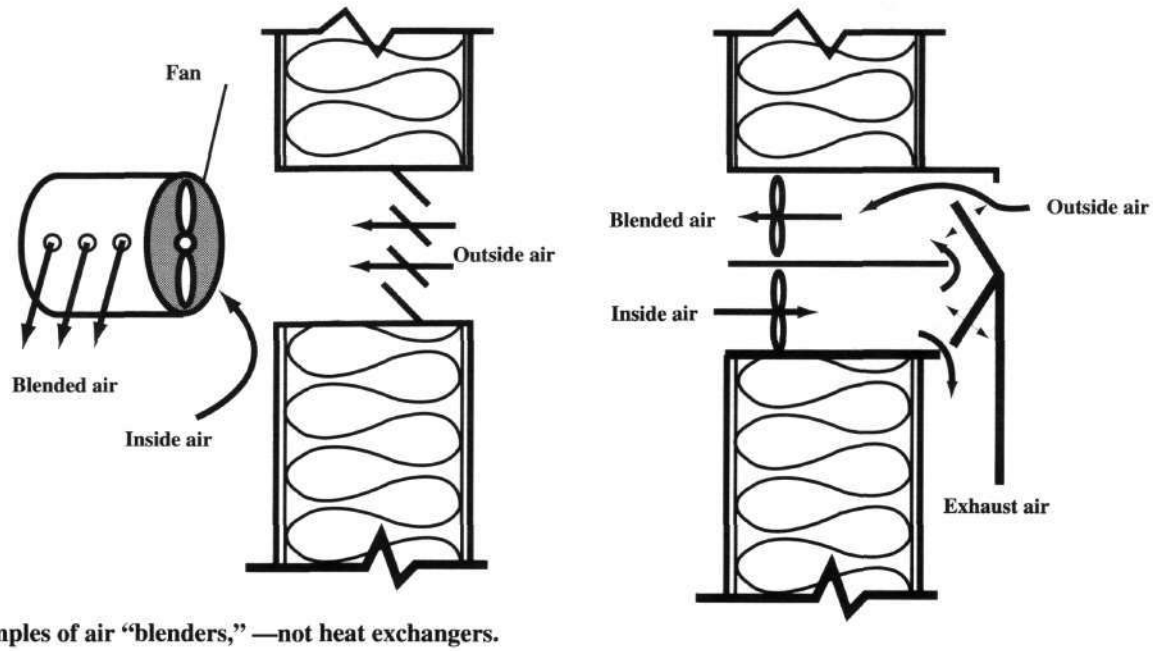


**Figure 2. Examples of air "blenders," —not heat exchangers.**

Heat is transferred through a solid surface thereby avoiding mixing of the two airflows. This is a very important characteristic when comparing heat exchangers to "blenders," devices that resemble heat exchangers. Blenders physically mix warm room air with cold fresh air (Fig. 2), a process, which under certain conditions can create fogging unless additional supplemental heat is supplied to the barn. Improperly adjusted blenders can result in inadequate fresh air. Underventilation also will result in poor indoor air quality.

## Deciding on a Heat Exchanger

Factors such as air flow rate, efficiency and initial cost of the heat exchanger, plus fuel costs, size and number of pigs, and climate all influence the decision to use a heat exchanger in a swine housing facility. A computer model at the University of Wisconsin suggests that fuel savings from a heat exchanger in swine farrowing or nursery facilities in Wisconsin will pay for the initial investment in four to ten years. Heat exchangers require periodic cleaning and more attention than most conventional ventilation systems.

## Selecting a Heat Exchanger

An air-to-air heat exchanger should be an integral part of the ventilation system. A unit should be sized according to its rated air exchange capacity, rather than its "heat" output. The air exchange rate of the exchanger, rated in cubic feet of air per minute (cfm), should be at or slightly above the recommended minimum ventilation rate for the number and size of pigs in the facility. Minimum ventilation rates are listed in Table 1.

The minimum ventilation rates are generally sufficient to remove moisture, manure gases and other airborne contaminants from a swine barn. By selecting a heat exchanger that delivers an air exchange level at or slightly above these rates, adequate air quality can be provided. Ventilating higher than twice the minimum rate shown in Table 1 in very cold weather unnecessarily increases supplemental heat costs.

**Table 1. Minimum ventilation rates for swine.**

| Pig Type and Age | cfm/pig |
|---|---|
| Sow and litter (400 lb) | 20 |
| Prenursery pig (12-30 lb) | 2 |
| Nursery pig (30-75 lb) | 3 |
| Growing pig (75-150 lb) | 7 |
| Finishing pig (150-220 lb) | 10 |
| Gestating sow (325 lb) | 12 |
| Boar (400 lb) | 14 |

Most heat exchangers have two fans, one exhausting moist, stale air and one blowing fresh air into the barn. Two fans are preferred over a single fan system (exhaust fan only) because the narrow airflow channels on the inlet side of the heat exchanger create significant resistance to airflow that large amounts of air enter through "leaks" or unplanned inlets rather than through the heat exchanger. Heat exchangers in which the exhaust fan has slightly more capacity than the inlet fans are desirable, especially in remodeled facilities, since it is difficult to seal building shell leaks.

## Compatibility with Ventilation Systems

Installing a heat exchanger involves more than simply selecting a unit with the proper air exchange rate. The heat exchanger must match the rest of the ventilation system.

The use of a heat exchanger does not affect the design of mild or hot weather ventilation fans. When thermostatically controlled exhaust fans are activated, a negative pressure, or vacuum, is created. Inlets are needed that automatically open to allow air into the room when these fans operate (Fig. 3). One choice would be a weighted baffle or curtain which would close only when the heat exchanger runs, and open slightly when the

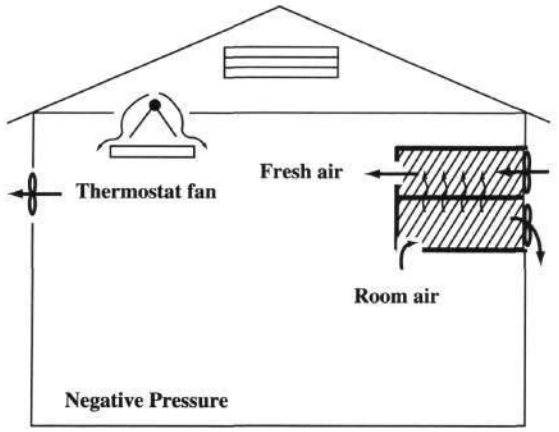


**Figure 3. Facility with additional thermostatically controlled fan operating, resulting in a negative pressure or vacuum in the barn and the need for an "automatic" open baffle on the inlets.**

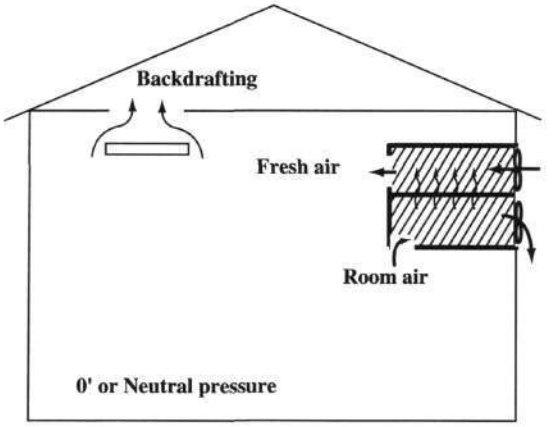


**Figure 4. Facility with no baffles in the inlets and resulting backdrafting when only the heat exchanger is running.**

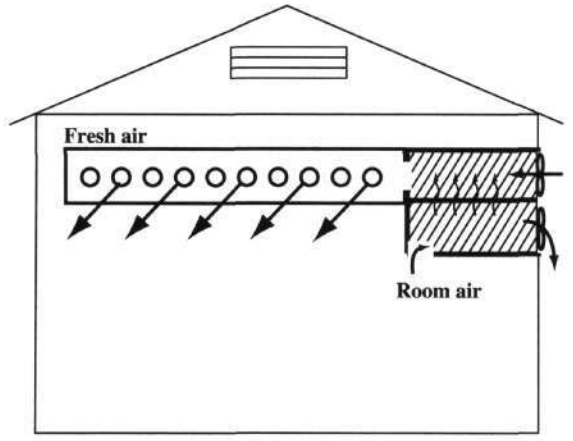


**Figure 5. Facility showing duct on inlet fan of heat exchanger to distribute incoming air.**

fans operate. If no baffle or dampers are present in inlets (unrestricted openings such as slot or ceiling inlets), backdrafting of warm moist air into the attic can occur causing serious deterioration of building materials (Fig. 4).

Since it replaces the continuously running fan in a swine facility, a heat exchanger should operate 24 hours a day. Manual control is recommended. It is essential that thermostatically controlled fans be on separate electrical circuits in the event of heat exchanger circuit failures. Supplemental heat is needed with heat exchangers during cold weather and when the barn is not filled to capacity.

Many facilities where air-to-air heat exchangers are used have only one location for incoming fresh air (inlet side of the unit). Poor distribution of air can result unless the room being ventilated is small. An exception would be in a facility where more than one heat exchanger (inlet) is present. A single heat exchanger should have a distribution duct attached on the inlet side to provide adequate mixing of air within the ventilated room. This generally would be a rigid duct, either PVC or plywood, permanently attached to the heat exchanger (Fig. 5) with openings along the length for even distribution of air. A polyethylene tube is sometimes used.

## Cleanability and Durability

A major disadvantage of air-to-air heat exchangers is clogging of exhaust air channels with moisture and dust. Although this limits the heat transfer process and the unit's efficiency, the primary concern is air flow restriction. Since heat exchangers supply minimum ventilation, even a small reduction in air exchange affects the room's air quality. Heat exchangers must be cleaned on a daily, weekly, biweekly, or monthly schedule. Therefore, consider the ease and frequency of cleaning when selecting a heat exchanger.

Environments in swine barns contain corrosive gases. Heat exchanger manufacturers typically use materials that resist corrosion, such as wood, plastic, fiberglass, stainless steel or aluminum. Although materials such as steel have a higher thermal conductivity, the overall heat transfer rate is not much greater than with noncorrosive materials.

## Summary

Benefits of air-to-air heat exchangers in swine facilities are preheating of the inlet air and reducing heat requirements. The feasibility of heat exchangers is highest in swine nurseries and farrowing barns, where warmer room temperatures are needed, drafts are a problem, and fewer animals require supplemental heat. Other potential uses of heat exchangers are in grower and in individually stalled gestation units, which in the upper-Midwest also require supplemental heat. Swine finishing barns benefit little from heat exchangers, because auxiliary heat in these facilities is not necessary except in extreme or special cases.

One needs to consider the feasibility of an air-to-air heat exchanger carefully. Certainly, the economic costs and returns of a heat exchanger are important, but other items, such as correct air exchange, compatibility with the ventilation system, and durability of the unit, must be considered. Heat exchangers are one of several energy saving alternatives available to pork producers. They can provide a good environment in facilities with proper design and management.

Major revision, destroy previous editions - 1M - 7:97 - FP/KMF, price 45¢, single copy free to Michigan residents