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Heating FARM SHOPS

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A number of choices are available when selecting a heating system for the farm shop. This publication will help you make a more informed choice.

Types of Shop Heaters

You have three basic options with variations for providing heat in a farm shop: forced air, infrared radiant and in-floor heating systems.

- Forced air heaters generally are installed near the ceiling and burn a fuel source to heat air, which then is circulated throughout the shop (Figure 1).
- Infrared heaters hang from the ceiling and heat the objects exposed to the heater. They often are used for spot heating areas such as a workbench but can heat the entire shop (Figure 2).
- In-floor heating uses hydronic piping embedded in or below the floor to provide heat (Figure 3). Heat is provided from a boiler or ground source heat pump (geothermal). These systems often are preferred because the heated floor provides a warm surface to stand on and water on the floor dries rapidly.

Figure 1. Forced-air propane furnace.
(Carl Pedersen, NDSU)

Figure 2. Radiant heater.
(U.S. Department of Agriculture)

What is a Btu?

A Btu, or British thermal unit, is a measure of heat. Btu per hour is the heating or cooling capacity of a heating appliance or air conditioner. One Btu is about the amount of energy needed to heat a pound of water 1 degree Fahrenheit.

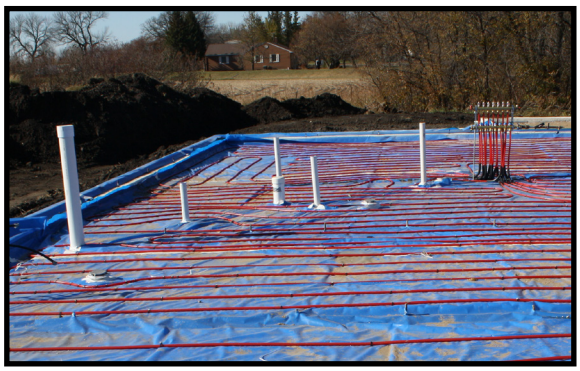

Figure 3. In-floor hydronic tubing.
(Carl Pedersen, NDSU)

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Proper Sizing

Deciding on what size heating system to buy for a farm shop will depend on the size of the shop, how the shop will be used, how well the shop is insulated and how often the large doors will be open.

The construction of a building makes a huge difference in how much heat the heating system needs to deliver. Just a few years ago, a general rule of thumb was that farm shop heating systems should provide around 50 Btu per square foot per hour. Now, with advances in insulating techniques like improved air sealing and foundation insulation, farm shops commonly need only 20 Btu per square foot per hour.

While using generalizations for simple heating system comparisons is fine, you need to do heat loss calculations to properly size a farm shop heater. With an accurate heat loss calculation, you can install the properly sized heating system, which will ensure you get the proper amount of heat from the installed system. This will save you money by not having a heating system that is too large for the space you want to heat. A good heating contractor not only will do a heat loss calculation, but will also provide guidance on the need for backup and supplemental heating systems.

Putting different areas of the farm shop on various zones in which heat can be controlled separately can save energy. If different areas of the building are to be heated at different levels, you need to include that when calculating the Btu per hour needed. An example is if the shop area is heated to 50 degrees Fahrenheit and an office is heated to 72.

Advantages/Disadvantages of Common Systems

Heating System	Disadvantages	Advantages
Used oil (forced air)	■ Noise ■ May not have enough oil ■ Requires difficult handling of oil	■ Serves as a place to dispose of used oil ■ Inexpensive ■ Quick heat recovery
Floor heat – boiler	■ Higher initial cost ■ Difficult to add to existing shop ■ Slower recovery	■ Warm floors are comfortable ■ Warm floors dry quickly ■ Floor retains heat
Floor heat – geothermal	■ Higher initial cost due to addition of ground source heat pump	■ Very efficient with very low operating costs ■ May quality for tax rebates or other financial incentives for installation
Forced air – propane, natural gas or electric	■ Noisy	■ Can add AC for summer ■ Quick recovery ■ More cost-effective for shops used infrequently in winter ■ Can provide cooling with a heat pump
Corn and biomass stoves/boilers	■ Require more regular maintenance ■ Requires adding fuel and removing ash and clinkers	■ Can be less expensive depending on corn and biomass prices
Infrared radiant heat	■ Only heats objects directly in front of heater ■ Relies on heated objects to heat the air	■ Easy to heat specific areas or zones ■ Quick recovery ■ Dries floor quicker if exposed

Heating Costs

Typical energy sources for farm shops are propane, electricity, fuel oil, and biomass such as corn or wood. Deciding which fuel source is most cost-effective depends on the current and future fuel prices, including off-peak electricity rates, the efficiency of the heating system and the amount of energy each heating system will require.

Insulation

Insulating properly is just as important, if not more important, as choosing a heating system to ensure a comfortable and efficient building.

Heat will find the path of least resistance to escape a building. If one portion of the building is not air sealed (Figure 4) or insulated properly, the result will be cold spots, as well as wasted money during the entire life of the building.

Heat loss will occur through the ceilings, walls and the floor. With proper insulation, that heat loss can be minimized and the insulation will pay for itself in energy savings in just a few years. Insulation recommendations vary depending on internal temperature.

For cost-effective insulation levels in Northern climates, heating experts recommend you have at least an R-30 value in ceilings if the insulation is continuous insulation over the roof deck (Figure 5). For metal buildings (Figure 6), a standard recommendation is to have insulation installed to a value of at least an R-25 draped over the purlins. Also, there should be an additional R-11 parallel to the purlins, and the roof deck and purlins and roof separated by R-5 thermal blocks. An R-49 should be installed for roofs with attics or other insulation applications.

Figure 4. Air leaks resulting in wasted heat. (Carl Pedersen, NDSU)

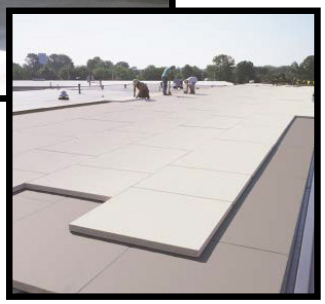

Figure 5. Continuous insulation on roof deck. (U.S. Department of Energy)

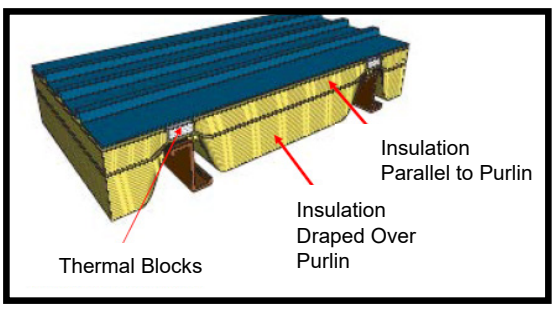

Figure 6. Insulated metal roof. (North American Insulation Manufacturers Association and U.S. Department of Energy)

Walls in the shop should be insulated to at least an R-13 between framing members, with continuous insulation to at least an R-7.5. Energy code for residential walls recommend to be insulated to an R-21.

Perimeter foundation footings should be insulated to at least an R-10, with an additional R-5 added if the slab is heated (Figure 7). The insulation should extend at least 24 inches below an unheated slab and at least 48 inches below a heated slab.

Heat loss from the perimeter of a slab hydronic heated building can be huge. The soil around the perimeter is continually being cooled by the outdoor air, so insulating the perimeter is critical. Insulation under the concrete slab will reduce the rate of heat flow into the soil and direct more of the heat into the shop. Insulation is generally not used under the floor if the soil is used as a heat reservoir. A high water table can transfer heat away from under the floor. Hydronic tubing can be either placed in the concrete or in a sand bed below the concrete (Figure 8).

Figure 7. Frost-protected shallow footing foundation for heated slab. (Larry Mayer, Solution Design Inc.)

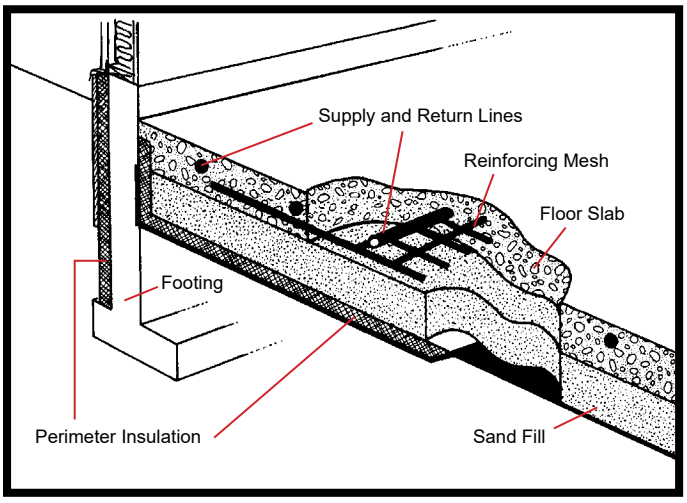

Figure 8. Hydronic floor and space heating. (NDSU)

Ground-source Heat Pumps (Geothermal)

Ground source heat pumps, often referred to as geothermal, are one option for heating farm shops as a result of the high efficiency of the systems. Heat pumps heat or cool a building by moving heat from one location to another. While ground source systems are very efficient, they have a higher installation cost.

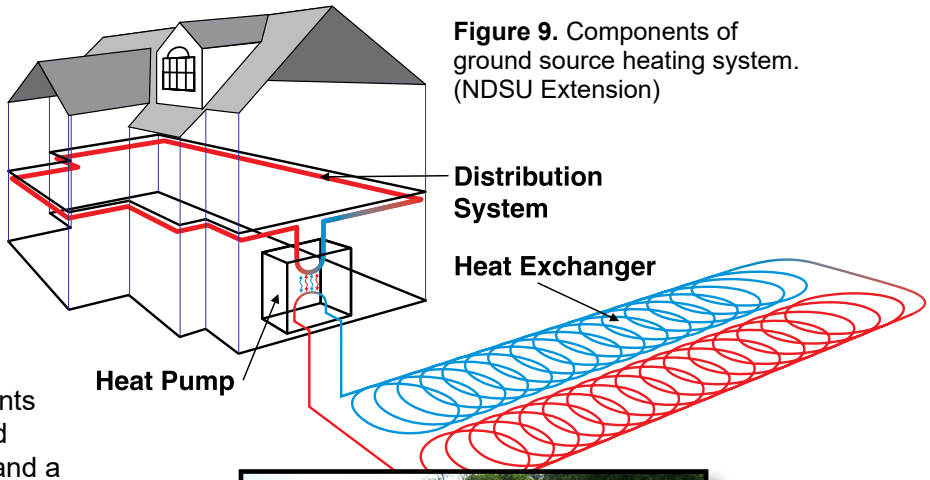

Figure 9. Components of ground source heating system. (NDSU Extension)

Ground source heating systems generally require three main components (Figure 9): the heat exchanger (ground loop), a heat pump (condensing unit) and a distribution system such as in-floor tubing (Figure 3).

The heat exchanger or loop (Figure 10) is simply a length or coil of tubing placed underground and used to transfer the heat from the ground to the heat pump.

The heat pump concentrates the heat using a condensing unit. In the winter, that heat is transferred to the distribution system and released through the building's forced-air systems or in-floor hot water (hydronic) heating system.

Figure 10. Loops for ground source heat pump. (Dennis Wiesenborn, NDSU)

Majority of publication written by Carl Pederson former energy educator.

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For more information on this and other topics, see www.ndsu.edu/extension

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