

load concerns. Unit heaters gently circulate warm air to prevent temperature stratification, reduce mold and fungal disease.

Unit heaters are available in oil fired, electric, hot water or steam, and gas fired. The most popular being the gas fired unit. Unit heaters are typically suspended from the greenhouse framing. Floor mounted units are also available.

What are the benefits of a hot water system?

Hot water or "hydronics" systems are available for providing heating to a greenhouse space. Because of their initial cost, many growers have felt that they cannot justify the investment required to install hot water. However, many advancements in technology over the past decades have made these systems more affordable.

Hot water systems do require specific engineering for each and every application, and installation is complex. However, the energy efficiency advantages they offer and the potential to enhance evenness and growth in a greenhouse facility make them attractive enough to warrant researching if hot water is a logical alternative for you.

How important is insulation?

Insulate! It cannot be stressed enough that a heated concrete slab floor should be insulated around the perimeter and as deep as the frost line in your area. Some reports indicate that up to 50% of your heat can be lost out the perimeter of a heated slab if no below grade insulation is installed. Some growers have even installed insulation below the slab. The best type of insulation to use is one of the extruded styrene boards, usually 1.5"- 2" inches thick.

How does bench-top heating work?

Bench-top heating systems use conductive heat transfer to deliver heat to plants placed directly on top of a multiplicity of parallel tubes. Small synthetic rubber tubes with high UV, heat, and chemical resistance are placed on the growing surface of benches and contain warm water which is circulated to and from a hot water supply, typically a boiler.

How does infrared radiant heating work?

Any object that is warmer than absolute 0°, radiates energy. Approximately 50% of the sun's energy is infrared radiation or energy in the "far-end" spectrum. This spectrum of energy is not visible so it does not interfere with photosynthesis or photo-period sensitive plant material. Energy when absorbed by the Earth and its objects, is converted to heat.

Should I install more than one heating system?

Many growers are installing multiple heating systems in an attempt to "get the best of all worlds". For example, on temperate nights, they can rely on a bench-top system only, and on the cold nights unit heaters are utilized to carry the worst case load and melt snow. Others are installing Infrared systems in conjunction with bench-top or floor heating systems.

So, which heating type is best for me?

Every type of heating equipment has its advantages and disadvantages. Depending on the type of production you are planning, you'll need to choose the style of system that

integrates best with your production scheme. For example, growers that install mobile tray systems for benching cannot install a bench top heating system because the bench tops need to be free to move around.

There are almost endless variations and combinations that can be utilized to create the best environment for your particular production. It's simply a matter of determining your needs and researching the best options with expert industry professionals to develop the best strategy for you.

How do I find out more about heating?

Contact the NGMA for your free copy of the Greenhouse Heating Efficiency Design Considerations or download it from the web: www.NGMA.com

Please contact the NGMA office for more information and other NGMA publications.



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H E L P F U L H I N T S

HEATING SYSTEMS



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How does heat loss occur?

Heat loss occurs from a greenhouse structure whenever the interior temperature exceeds the exterior temperature. The rate at which it occurs is affected primarily by the efficiency of the covering materials (glazings) installed on each surface (roof, side walls, and end walls). The most commonly used covering materials all have published heat transfer factors called “U” factors that provide a means of calculating their impact on heat loss in different scenarios.

What is the “U” factor?

“U” factors are the inverse of the commonly used “R” factors, where “U” = 1 / “R”. The lower the “U” factor, the less ability your glazing material has to transfer heat, therefore, the lower the heat loss.

What is a British Thermal Unit?

In North America, heat loss is typically expressed in terms of total British Thermal Units per Hour (BTUH) loss. British Thermal Unit (BTU) = the amount of energy it takes to warm one pound of water 1°F (degree Fahrenheit).

Are there any special considerations for calculating heat loss?

Yes, there are unique crop considerations. Many growers do not use the total volume of their structures to grow crops. Consequently, they may not need to have the total conductive heat load available in their heating system. While the standard means of calculating heat loss are well accepted and documented, considerations should be made as to whether your crop requirements justify installing the total number of BTUH indicated by this calculation.

What is zone heating?

A zone heating system is one that places the BTUs in a specific portion of the structure.

How important is good ventilation?

Ventilation essentially provides the same benefit regardless of the season. Ventilation, in addition to removing excess heat in the summer, replenishes carbon dioxide and assists in the control of humidity levels.

How is air circulation effected by cold weather?

During cold weather, when greenhouses are virtually closed in, there is often insufficient air circulation to maintain desired conditions. The appropriate type of air circulation equipment will help obtain a more uniform relative humidity and provide the proper air movement. Continuous circulation produces gentle air movement and has been reported to maintain better leaf surface microclimates and prevent pockets of disease-producing high humidity. This gentle air circulation may result in slightly higher heating demand, yet many regard it as advantageous from a plant production and quality standpoint.

When do I need perimeter insulation?

A substantial amount of heat energy can be lost out of the perimeter of a greenhouse through the ground below the perimeter walls and ends. This is conductive heat loss that can be minimized by installation of perimeter insulation below the frost line.

Does a thermal blanket save on heating bills?

Installation of a thermal blanket system can impact the total heating requirement of your greenhouse by reducing the heat loss. These systems are typically designed to automatically retract in the daytime and close in the nighttime to trap energy.

What are the different heating types?

All forms of heating fall into one or more of three basic principles: convection, conduction, or radiation. Since all three methods of heat transfer are common and effective in greenhouse heating, it is important to understand the fundamentals of each.

What is convection heat?

Convection heat utilizes the forces of natural air circulation currents to transfer heat. Convection involves two basic principles: First, cold air displaces warm air and second, warm air rises in the presence of cold air. With convection, heat is transferred by air currents, which transport energy throughout the structure. When these air currents pass by plant material, energy is transferred to the plant. Because of this, it is very important that some means of air circulation is used (HAF fans, perforated polyethylene duct tubes, or ceiling fans) to assure the maximum amount of warm air is transferred to the plant environment to evenly distribute heat throughout the structure.

What is conduction heat?

Conduction heat utilizes direct application to transfer heat energy to the plant. Physically touching any warm object demonstrates the principle of conductive heating.

In greenhouses, this type of heating is most commonly distributed with hot water tubes, and occasionally electric resistance strips, which are placed directly on the growing surface or in the growing media. The soil, containers, and growing surface in direct contact with the warm tubes or strips are heated and subsequently transfer that heat energy to adjacent material.

What is radiant heat?

Radiant heat utilizes electro-magnetic infrared waves to transfer heat energy. Since this is a little understood form of heating, it bears detailed explanation. Anyone who has warmed themselves by a hot wood stove or warmed their hands at a camp fire has experienced radiant heat. It is also demonstrated by standing in the sun on a winter’s day; or walking near a brick wall that has been exposed to the sun during the day. In both examples, although the air may not be warm, you are able to feel the heat energy radiating from these surfaces.

What are the main functions to heating a greenhouse?

The conversion of fuel to heat energy is typically accomplished through combustion with a burner installed in a boiler or heater combustion chamber. That heat energy is then distributed through the greenhouse through pipes, ducts, tubes, or air. Once the energy is distributed through the house, it must then be transferred to the plants and soil by convection, conduction, or radiation. Finally, once transferred to the plants and soil, they must in turn absorb its energy and convert it to usable heat. How each of these functions is accomplished has a significant effect on both the efficiency and effectiveness of the heating system.

What is a unit heater?

The definition of a unit heater is a fan equipped device with a means to heat the air being provided by the fan. They are the most commonly used greenhouse heating equipment. Unit heaters are valuable in that they provide warm air temperatures which are imperative for leaf transpiration and snow