

SMALL GREENHOUSE HEATING

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Heating of commercial greenhouses is accomplished with a variety of different systems, the choice of which is usually made by the grower based on the type of plants being grown. For a small “backyard” type greenhouse, among the simplest heating systems is the hot water unit heater. This device consists of a hot water coil with a propeller fan attached. Air distribution is normally through a “poly tube”—a thin clear plastic tube perforated with holes. The tube is normally hung from the ceiling, but can also be installed on the floor. Unit heaters are a practical method of greenhouse heating at supply water temperatures down to approximately 140°F to 150°F. Below this range, heat output is reduced by more than 50% and the cost of larger equipment becomes an obstacle.

GREENHOUSE HEATING REQUIREMENTS

The first step in the process is to determine the heating requirement for the greenhouse. The heating requirement for a greenhouse is a function primarily of the temperature difference between the inside and the outside, the materials of construction. One of the most common small greenhouse structures is a 30-ft wide, Quonset-style covered with a double layer of plastic sheet. The length of the house can be adjusted to accommodate the needs of the grower, but 96 ft is a common length. Assuming a 65°F inside temperature and a 10°F outside temperature, this house would have a heating load of approximately 90 Btu/hr per square foot of floor area. To adjust for other construction, multiply by 1.6 for glass, 1.65 for single plastic and 1.4 for single fiberglass. For other inside or outside temperature differences simply ratio, the heat loss per square foot above by the 55°F used for this example. These values are valid for small greenhouses. As floor area increases, the unit heat loss (Btu/hr/ft²) decreases due to the lower impact of walls and infiltration of cold outside air.

UNIT HEATER EQUIPMENT

Unit heaters are sold based on heating capacity. This heating capacity, appearing in many greenhouse equipment catalogs, is based on 60°F entering air and assumes that the unit will be supplied with either 2 psi steam or 200°F water. Operation of these units at lower water temperatures, as is the case in most geothermal applications, will result in reduced capacity. As a result, the first step in the selection of the equipment is to adjust the catalog capacity to the conditions present at your site. To do this select, the correction factor from Table 1 that corresponds to the water temperature available to the unit heaters. If the catalog data is based on steam, use the values in the left column. If it is based on hot water, use the values from the right column.

To determine the heating capacity of a unit heater, multiply the capacity shown in the catalog by the appropriate factor from the table below. For example, if 155°F water is available to the unit heater and the catalog is based upon 2 psi steam, the correction factor would be 0.62 (between 150 and 160°F), the capacity of a unit heater rated at 121,000 Btu/hr would actually be $0.62 \times 121,000 = 75,020$ Btu/hr at the supply water temperature available.

Table 1. Unit Heater Temperature Correction Factors

Water Temp °F	Correction	
	2 psi Steam	200°F Water
110	0.32	0.36
120	0.39	0.43
130	0.45	0.50
140	0.52	0.57
150	0.58	0.64
160	0.65	0.71
170	0.71	0.79
180	0.77	0.86
190	0.84	0.93
200	0.90	1.00

For small greenhouses, equipment selection is simply a matter of determining whether the heating requirement of the structure can be met by a single unit or whether more than one will be necessary. For the example 30 x 96' greenhouse, with a heating load of 260,000 Btu/hr and an available water temperature of 160°F, the selection would be as follows:

Table 2. Manufacturers Catalog Data

2 psi Steam Capacity	Corrected Capacity (160°F)	Fan hp	List Price \$
18,000	12,800	1/60	300
33,000	23,400	1/25	400
47,000	33,400	1/12	525
63,000	44,700	1/12	565
86,000	61,100	1/8	740
121,000	85,900	1/6	820
165,000	117,000	1/3	900
193,000	137,000	1/3	1,200
290,000	206,000	½	1,500

Since the heat loss of the structure is greater than the largest unit, this application will obviously require more than one unit. In this case, two of the units with a corrected capacity of 137,000 Btu/hr would together have a capacity of 274,000 Btu/hr, slightly more than the required load of 260,000 Btu/hr.

The heating capacity of this equipment is also influenced by water flow rate. Manufacturers ratings are normally based upon a temperature drop (entering water temperature - leaving water temperature) of 20°F. Using a larger temperature drop (lower water flow rate) will reduce the output of the unit since the average water temperature is lower. To correct for other than a 20°F drop, multiply the temperature corrected capacity by 0.93 for a 25°F drop, 0.87 for a 30°F drop and 0.72 for a 40°F drop.

INSTALLATION OF UNIT HEATERS

The standard installation of unit heaters consists of hanging the unit at one end of the structure and discharging the supply air toward the opposite end. In longer houses (>125 ft), it is advisable to install units at both ends to assure even heat distribution. For the example house, the two units could be installed at one end. Figure 1 provides a diagram of a typical installation.

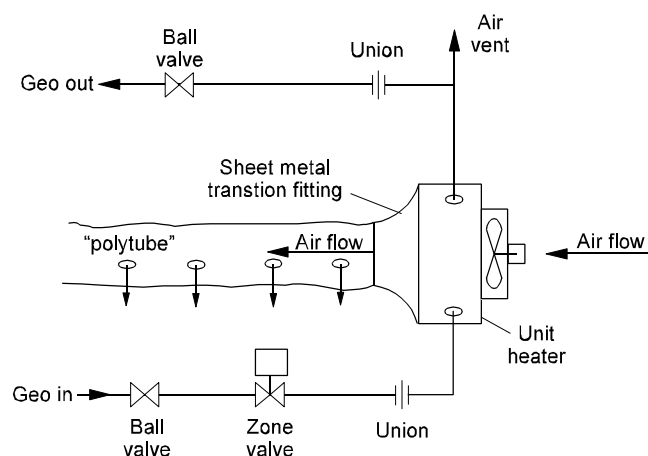


Figure 1.

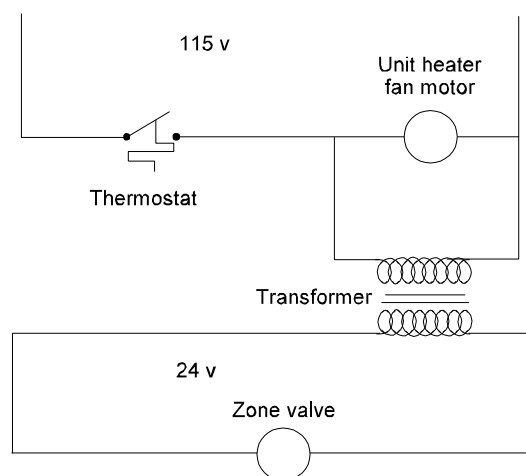


Figure 2.

MAJOR COMPONENTS AND FITTINGS

1. Unit heater(s): hot water, horizontal type, propeller fan, 115-v motor, copper water coil suitable for operation at 150 psi/350°F. Size and number as required. See Table 2 for approximate pricing. Similar to Dayton 1H200 series or Modine HS model.

\$170
2. Motorized zone valve, 3/4" connections, 24-v coil, see note regarding closing against pressure in the space heating components list,

0.30 \$/ft
3. Air distribution poly tube - clear plastic, minimum 3 mil thickness, 18" diameter for air flows to 3000 cfm, 24" diameter for greater flows, 3" diameter holes located at 30° from the horizontal (4:00 and 8:00 positions),

\$120
4. Poly tube adapter for unit heater. Attaches poly distribution tube to unit heater. Can be fabricated locally by a sheet metal shop or ordered by a greenhouse supply firm. Dimensions vary with unit heater manufacturer,

\$6
5. Union, copper, steel or CPVC depending upon piping material choice. Size equal to water connections on water heater. 2 required per unit heater.
6. Ball valve, as per description in earlier components list, 2 required per unit heater, size varies with unit capacity,
7. Air vent manual, brass construction, 1/8" connection,

\$46.
8. Thermostat, heating only, low voltage, similar to White Rogers model 1E30,