HAVE YOU entered a greenhouse during the cold of winter? If so, you were probably met with thick, humid air. Even with snow outside, the greenhouse was full of greenery. Maintaining ideal growing conditions in the dead of winter is not a simple task, but today’s technology has made it much easier to control greenhouse temperatures.

**Objective:**

Analyze greenhouse climate control systems.

**Key Terms:**

- analog controls
- computer controls
- computerized environmental management systems
- energy curtains
- environmental controls
- fan-and-pad cooling system
- fog system
- hot-water heating system
- infrared heating system
- polyethylene tubes
- short-day curtains
- steam heating system
- thermostats
- unit heaters
- vents

**Greenhouse Climate Control**

Temperature is one of the most important factors in the production of horticultural crops. Often pinpoint control of the temperature in a greenhouse is the key to producing high-quality crops. The ability to heat a greenhouse is important on cold, cloudy days and at night. Solar energy on sunny days is often enough to keep a greenhouse warm, even in cold weather. Several different methods are used to heat greenhouses.
HEATING SYSTEMS

Hot-water heating systems are the trend in modern greenhouses. A hot-water heating system involves heating water in a boiler and pumping the hot water through pipes located in the greenhouse. The pipes are often placed under the benches. Such a system has low maintenance and delivers even heat.

A steam heating system involves a boiler that brings water to a boil and pipes through which steam flows in the greenhouse. Steam heat is not as even as hot-water heat.

A small greenhouse is often heated by unit heaters. Unit heaters heat air within the units, then blow the air throughout the greenhouse. Polyethylene tubes attached to the units help distribute the airflow evenly. Unit heaters are inexpensive but cost more to operate than other systems. Unit heaters are commonly used as backup systems.

An infrared heating system produces heat energy that is absorbed by the plants, media, benches, and floor. An infrared heating system does not heat the air. Since the system must be placed at the peak of the greenhouse, it is best suited to a high greenhouse structure so the energy can radiate throughout the house.

COOLING SYSTEMS

To maintain optimal temperatures for plant growth, it is important to keep the greenhouse cool when outside temperatures are warm or when the sun is shining. Sophisticated cooling and ventilation systems have been developed for this purpose.

The number one cooling system used today is the fan-and-pad cooling system. The fan-and-pad cooling system is based on evaporation of water. Cellulose or aspen pads at
one end of the house are kept wet, while fans at the other end of the house pull outside air through the pads. Air entering the house is cooled as water in the pads evaporates.

A less common cooling system is the fog system. The fog system involves an atomizer that produces water vapor. The flash evaporation of this water cools the greenhouse.

Natural cooling is made possible with vents. Vents consist of panels that open and allow air exchange with the outside.

**ENERGY CURTAINS**

The use of energy curtains in modern greenhouses helps maintain temperatures and reduce heating and cooling costs.

**Energy curtains** are automated systems using fabrics that can insulate a greenhouse at night and shade the crops during the day. The curtains are installed from gutter to gutter. They are opened and closed by computerized systems.

**Short-day curtains** are similar to energy curtains. However, the function of short-day curtains is to provide darkness that will simulate a short-day effect. They also retain heat and must be opened if the sun is shining brightly.

**ENVIRONMENTAL CONTROLS**

Climate controls give the grower the power to control temperatures within the greenhouse. Environmental controls are devices used to turn greenhouse systems on and off, including heating and cooling systems.
Thermostats are low-cost, easy-to-install, environmental controls. There are two types. On-off thermostats control fans, heaters, and vents with the change of temperatures. Proportioning thermostats provide continuous control of systems with the change of temperature.

Analog controls use proportioning thermostats to run amplifiers and electronic circuitry. The heating and cooling operations are integrated, resulting in better performance than provided by just a thermostat.

Computer controls use microprocessors to make complex judgments based on information from a number of sensors.

Computerized environmental management systems are accurate and can control all the automated systems together. They are more expensive than the other environmental controls.

Summary:

Some different methods used to heat greenhouses are hot-water heating systems, steam heating systems, unit heaters, and infrared heating systems.

The number one cooling system used today is the fan-and-pad cooling system. A fog system involves an atomizer that produces water vapor. Natural cooling is made possible with vents.

The use of energy curtains in modern greenhouses helps maintain temperatures and reduce heating and cooling costs. Energy curtains are automated systems using fabrics that can insulate a greenhouse at night and shade the crops during the day. Short-day curtains are similar to energy curtains, but their primary function is to provide darkness.

Environmental controls are devices used to turn greenhouse systems on and off, including heating and cooling systems. Thermostats, analog controls, computer controls, and computerized environmental management systems are used.

Checking Your Knowledge:

1. Why is greenhouse temperature control important?
2. What systems are used to heat greenhouses?
3. What systems are used to cool greenhouses?
4. What are energy curtains?
5. What environmental controls are used to operate climate control systems?
Expanding Your Knowledge:

On a hot, sunny day, turn off the cooling system in the school greenhouse. How quickly does the greenhouse heat up? On a cold, cloudy day, turn off the heating system in the greenhouse. How quickly does the greenhouse cool down?

Web Links:

Greenhouse Energy Efficiency (PowerPoint Slide Show)

Greenhouse Energy Conservation Checklist
http://www.umass.edu/umext/floriculture/fact_sheets/greenhouse_management/jb_energy_cklst.htm

A Review of Greenhouse Energy Conservation (PowerPoint Slide Show)