

SURFACE-HEATING GREENHOUSES WITH WASTE HEAT

Paul N. Walker - *American Vegetable Grower and Greenhouse Grower*,
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"Doesn't the greenhouse turn into a giant ice cube?" That is the initial response of many people when they hear about the system for heating greenhouses with waste heated water being developed by the Department of Agricultural Engineering of the University of Illinois.

Surface-heating is quite simple and low cost. The outside of the greenhouse is covered with a thin layer of warm water. This water is applied to the greenhouse through small holes drilled every few inches in a plastic pipe which is attached on the outside of the greenhouse at the ridge. Water flows from the holes, down the roof, and into the gutter on gutter-connected greenhouses. At the sidewalls on either single-connected houses, the water running off the roof is deflected so it flows down the wall and into a gutter located at ground level. This completely covers the roof and sidewalls with warm water. The ends of the greenhouse can be covered with water using a similar technique. The flow rate of the water is adjusted so its temperature drops only a few degrees. The water temperature never comes close to freezing.

The University of Illinois Department of Agricultural Engineering with support from Illinois Power Company and the U.S. Department of Energy has constructed a 28 x 42 foot test greenhouse at the Baldwin Power Plant 50 miles southeast of St. Louis. This greenhouse is being used to determine the effectiveness of the surface heating system for various water flow rates, water temperatures, greenhouse temperatures, and weather conditions. Based on this research, a greenhouse designer will be able to select the optimum water flow rate for any particular set of conditions. It is desirable to keep the water flow low in order to minimize the amount of energy used in pumping the water. Although the test greenhouse is glass, there appear to be few problems in adapting this technology to a double layer poly house.

Adequate Supply

Waste heated water is plentiful. For every unit of electrical energy produced at a fossil fueled or nuclear plant at least one unit of energy is discharged in the form of waste heated water. Enough waste heated water is produced at a typical 1800 megawatt power plant to surface-heat more than a hundred acres of greenhouses and there are no competing uses for this water. Power companies are generally anxious to use this water for heating greenhouses because it gives them a good public image and it provides a chance to get some economic benefit

from this waste energy. Plenty of other industries produce waste heated water too, and often at higher temperatures.

A few years ago in Minnesota it was demonstrated that a greenhouse could be heated with waste heated water by using large numbers of conventional heat exchangers inside the greenhouse. In fact a few commercial greenhouses are now being heated this way. One problem with that technique is the water must be very warm. Otherwise, such a large amount of heat exchanger area is required that the system is not economically feasible. A large majority of power plants do not produce water hot enough to use that system.

The surface-heating system can use water with a lower temperature because the entire surface of the greenhouse serves as a heat exchanger. This system, of course, works best when the temperature of the water is above the temperature at which the greenhouse is to be maintained. Even so, considerable heating benefit can be derived from water which is at a temperature below that to be maintained in the greenhouse. Supplemental conventional heat would be required with this cooler water. For example, suppose the outside temperature is 0°F and you wish to maintain the greenhouse at 65°F and the warm water available to you was only 60°F. Using a conventional heating system, the outside surface of the greenhouse might be about 10°F. But by applying 60°F water, the outside surface would be warmed to an average temperature of about 55°F, therefore considerably reducing the amount of heat leaving the greenhouse, and reducing the amount of conventional heat required to keep the greenhouse warm.

The layer of water does not significantly reduce the amount of light entering the greenhouse. After all, aquatic plants do very well submerged in several feet of water and the greenhouse is covered with less than a tenth of an inch of water. Another, more definite, benefit of surface heating is that it eliminates snow and ice buildup on the roof and therefore allows the greenhouse to be less expensive to construct.

It should be stressed that this is not a solve-all solution to greenhouse heating costs. But for those greenhouse operators willing and able to locate greenhouses next to a waste heat source, surface-heating promises to reduce energy costs with a minimal capital investment.

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