Blooming Nursery System Overview©

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Since constructing the range of five, large, gutter-connected greenhouses, it has averaged an annual consumption of 3,100,000,000 BTUs of natural gas. Air was heated by gas burners and blown into the greenhouse range. A tremendous amount of the heat rose into greenhouse gables and escaped. We were interested in installing a more efficient system of delivery as well as collecting natural heat energy to power the range. Our new system includes an in-ground radiant delivery system which conducts heat to the roots of the plants to put the heat where it can be utilized most efficiently (saving 2,160,000,000 BTUs) as well as a hybrid energy supply system including solar collection panels (saving another 700,000,000 BTUs).

Following is an overview of the major components of the system, followed by a brief summary of how the system functions. The radiant-heat delivery system is comprised of PEX (flexible tubing used in residential and commercial plumbing applications). The PEX is laid on the floor of the greenhouse, over styrofoam, insulating underneath the tubing and crushed rock over it, to produce a "heat bank." Because the heat is delivered near the roots, this improved design significantly reduces the heat needed to keep the plant root zone warm. As mentioned above, this reduces the need for input energy by two-thirds. The second and most visible component is the solar collector array. Over 350 EnerWorks solar thermal energy collector panels are connected through a closed glycol loop which transfers heat energy to a closed water system through a finned stainless-steel heat exchanger. A unique racking system was developed that made it possible to erect the collectors above the existing greenhouses as well as above the storage tank, in order to avoid interference with existing production areas. The 290,000-gal water loop consists of a large four-chambered underground storage tank, numerous pumps, as well as the in-ground delivery system underlying the greenhouse. The size of this very large tank was determined by the heat generation possible through the collectors installed, coupled with the heat storage needs to supply the range through nearly the entire winter season. The fourth component is the heat-pump system, utilized at times of marginal or no output from the solar array. The fifth component is the backup gas heaters. The system has gas-fired unit heaters hanging from the ceiling of the greenhouse that can provide enough heat to prevent freezing conditions during peak design winter conditions. In addition, the system has "on-demand" water heaters that can introduce hot water directly into the radiant heating system in the occasional scenario where weather conditions have been poor for an extended period of time preventing the solar and heat pump system from functioning as designed.

The final and most critical component is the array of sensors and controls. Sensors in the greenhouse monitor temperatures in the radiant heating system, the plant, soil, and the air above the plants. Sensors are also placed outside the greenhouse to monitor outside air temperature, wind speed, and solar radiation. The information from the sensors is used to control the performance of the solar array, the heat pumps, and the backup gas unit heaters.

The sequencing of the system is complex and involves many phases, depending on heating requirements, component temperatures, and environmental conditions. In the summer, heat is transferred to the water in the tanks to be stored for use as needed in the fall and into the winter. As the output from the solar system becomes inadequate to supply the needed heat directly to the radiant heating system for the greenhouse, the system routes warm water from tile storage tanks to the floors, and later still, to the heat pumps. The heat pumps are able to build the temperature in the supply water and deliver the appropriate temperature water to the radiant-heating system loop. In the winter season when radiation levels are at their lowest, the system shifts into another mode. Water is routed directly through the heat exchanger from the floor loop, heat being transferred to the water from one segment of the storage tank, now with water temperatures between 50 and 70 °C. The energy is extracted and the colder water is returned to the “cold tank”. This strategy allows the system to continue to run at low temperatures in the winter season, producing significant efficiencies.

We estimate energy savings from the solar and heat pump systems combined at a net 700,000,000 BTUs annually, after allowing for the supplemental load required to power the new equipment.

The combination of the system design changes and the energy supply savings will result in an approximately 95+% reduction in energy usage to heat the range.

QUESTIONS AND ANSWERS

Steve Hottovy: Grace, I salute your forward thinking on this. Who designed and manufactured the system?

Grace Dinsdale: Ra Energy in Portland.

Kristin Yanker-Hansen: I can suggest one other benefit. I bet all your employees want to park underneath the solar panels.

Grace Dinsdale: Actually, we planned to put some herringbone parking, but right now the surface isn’t prepared for auto traffic. The 8-in. carbon-steel pipe is buried right below and it has to maintain a particular slope. I’m worried about uneven settling in the soil. We’ve protected the buried pipe with large telephone poles to keep cars from driving over it.