Irrigation Modernization

An engineer transforms antiquated irrigation into automated irrigation at Florida Tree Source.

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In the late 1990s, the owners of a large citrus farm just outside of Plant City, FL, decided to clear out 90 acres to start a tree farm called Florida Tree Source. They bought 7-gallon container trees and grew them up to 25 gallons before selling them to the landscape market.

The new tree farm came with many challenges, especially an antiquated irrigation system. Problems included:

- The diesel engines at the two pump stations often broke down.
- Pipes had burst due to age and lack of hydraulic safety equipment. Pipe fatigue due to an increased rate of pump starts further complicated the issue.
- Water volume demand went up due to closely spaced containers, which impacted the uniformity of distribution.
- Pump runners raced around the farm to turn valves in order to avoid water runoff under the tree containers.
- Usage of small pipe diameters in the larger sections led to significant losses of pressure and inadequate watering of the trees.
- Iron bacteria clogged sprayer heads on a regular basis.

Putting A Plan In Place

The first step in remedying the problem was to develop a scaled map of the farm using an aerial photo. Selwyn Davis, former farm manager, helped in providing drawings and sketches of the existing irrigation layout. The master planning came next. The objective was to engage the farm owners and manager in a discussion on present and future needs of the operation. It was Carmel International Inc.'s (CII) responsibility to turn their ideas into an efficiently operating irrigation system, automated, with the capabilities of remote access and monitoring.

Soil-moisture sensors in containerized trees provide accurate data for irrigation planning.

Sensors in the acid, chlorine, and fertilizer tanks detect low liquid levels and transmit a signal through the ESI controller to the chemical suppliers via e-mail.

The next step was to analyze the water demand for each of the 19 sections by studying the existing drawings of the irrigation system and proposing modifications. In some sections, flow distribution was divided. In others, the existing water network pipes were used to group valves together. These steps were taken to create uniformity of water distribution to all pots, increase efficiency, and encourage uniformity in tree growth.

To achieve a cohesive system, allowing the option for one or both pumping stations to operate simultaneously, a new water network was designed for the entire farm. The goal was to utilize as much of the existing pipes as possible, abandon the problematic areas, and add new pipes to handle operation expansion.

Simultaneous with this process, manual valves were upgraded to fully automatic, pressure-regulating units. A pressure-reducing pilot and a solenoid were added to these valves. Electrical wires were also installed inside the same trenches as the water network pipes.

Detailed computer-aided-design drawings were generated to assist contractors in understanding their scope of work and for bidding purposes. The installation work was coordinated around the daily activities of the farm, so that water was not cut off from the plants.

The next step was to overhaul the pumping stations. Use of the check valves and filters was continued, since they were still good. A 10,000-gallon pressure tank was installed at each pumping station. Plumbing was modified; pressure-relief and surge-anticipator valves were installed to protect the water network. Wires from irrigation valve solenoids were terminated at pumping stations, and the stage was set for automation.

In designing the automation system, several factors were taken into consideration. The objective was to increase the efficiency of the system by minimizing water use, improve water quality, inject fertilizers, and observe and operate the system remotely.

Key Controllers

To this end, two types of controllers were installed: an Environmental Sensors Inc. (ESI) controller and an Eldar Shany Fertijet FA.

The ESI controller was dedicated to all the inputs and outputs, including soil-moisture sensing with two field controllers (one at each pumping sta-

A fully automated irrigation system allows Florida Tree Source's team (left to right: Kyle Simmons, maintenance supervisor; Sean Phelps, sales and marketing manager; and Jeff Blackwell, farm manager) to run a more efficient operation.

tion) and a remote soil-moisture sensor. Each field controller communicates by radio with the central controller. The central controller — a desktop computer in the farm manager's office — is the brain of the system. It runs the field controllers and valves, reads the flow meters, gets the depth-sensor signal in the chemical tanks, observes the data from pressure sensors, and receives and stores pH and electrical conductivity (EC) readings from the FertiJet FA.

The FertiJet FA injects acid, chlorine, and fertilizers into the irrigation water at each pumping station. The two wells have a normal pH of around 7.5. Sulfuric acid is injected to lower the pH to about 5.9. This is an optimal pH range for uptake of minerals at the root zone. Also, reduced pH saves considerable quantities of chlorine. Chlorine is injected to kill the iron bacteria, and the goal is to have 0.5 parts per million of free chlorine at the end of the furthest irrigation line in the system.

Sensors And Switches

The farm's managers made the decision to use soil-moisture sensors in pots to collect soil-moisture data over time and ultimately activate the irrigation system based on low moisture levels. With help from the University of Florida's Dr. Richard Beeson, trees were divided into five main categories, based on their water-consumption characteristics. Soil-moisture sensors were directly connected to the controllers and placed inside five representative pots. Data on the soil-moisture sensors are collected daily and stored in the central computer.

Another innovative approach was to install pressure switches downstream of every irrigation valve. The idea was to send a signal back to the controller when a valve closes. This can be an indication that water is applied based on a pre-programmed schedule and allows for failure detection during system operation.

CII is often asked why it does not use flow meter readings to determine proper operation of the irrigation system. The answer is simple: On a tree farm, trees are constantly moved around, resulting in changes to the flow rate values. Also, when valves are turned on simultaneously, the system has to be reprogrammed to adjust for the new flow value everyday — a cumbersome task. Using a pressure switch, which closes a circuit once a section is pressurized, monitoring daily irrigation is simplified. If a valve is left on manually, the central controller picks up a signal and displays it graphically.

Monitoring Made Easy

Pressure transducers were installed at pumping stations to keep the new farm manager, Jeff Blackwell, informed of the pressure in the tank and in the system. Depth sensors were placed next to chemical tanks to signal low chemical levels and pH and EC readings downstream of the injection point, collecting and storing valuable information in the central controller.

With wireless Internet access, Blackwell can now operate and monitor the entire irrigation system remotely using his laptop computer. He can modify the irrigation program, identify when and how long valves were left on manually, monitor moisture levels in the tree containers, and order chemicals. How about that for automation! ■

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