DYNASONICS

Intelligent Design Enables Conservation

Open ditch irrigation replaced by closed piped system with precise flow control

Gerald W. Knudsen, PE
General Manager, AgriTech Consulting
303-697-2123
knudsen@wispertel.net

As we progress into the 21st century, water promises to be one of our most precious resources. Wise management and proper conservation of this resource will become increasingly important, and innovative methods will have to be employed to save water.

Automation coupled with intelligent design has greatly increased manufacturing productivity worldwide while cutting waste and improving quality. A similar approach was taken in a recent project implemented by the Montezuma Valley Irrigation Company (MVIC, www.mvic.us) in Cortez, Colo. in the western United States.

The MVIC is a private non-profit company that is owned by and provides irrigation water to 1,400 shareholders who are farming and ranching 37,500 acres in Southwestern Colorado. The MVIC water distribution system provides water to the shareholders from the Dolores River via two reservoirs, two main canals and 17 distribution laterals. The canals and laterals cover a distance of 124 miles.

The MVIC recognized that an opportunity existed to save substantial amounts of water by replacing the open ditch irrigation canals with a closed poly pipe water distribution system (Figure 1). Towards that end, they retained the services of our company, AgriTech Consulting of Morrison, Colo.

Waste Not Want Not

As much as 60% of the water that enters an open ditch irrigation canal is wasted via evaporation, seepage and losses at the end of the canal. This waste presented an opportunity for the MVIC to not only save water and money for its shareholders, but to also conserve one of the most precious resources in the arid western U.S.

Figure 1: Open ditch irrigation canals were replaced with a closed poly pipe water distribution system. The piping system saves water by reducing evaporation, cutting seepage and eliminating end of channel water losses.

Our company worked with the MVIC on a study to determine the best method to minimize water loss in the May Lateral Canal. A decision was made to replace five miles of open ditch irrigation canals with a poly pipe water distribution system. Projected savings were on the order of 1,000 acre-feet of water per year.

The pipe system has 45 branches off of the main supply line. The main supply line High Density Polyethylene (HDPE) pipe ranges from 12” to 36” in diameter, and is pressurized from 30 to 50 psi as required for shareholder sprinkler irrigation systems. The turnout pipes that serve each shareholder are also HDPE with a transition to polyvinyl chloride. Turnout pipe diameters range from four to eight inches.

Each branch turnout from the main header to a farm is supplied with an ultrasonic flow meter and two butterfly valves. The meter measures the amount of water passing through the turnout. The first butterfly

Figure 2: The transit time flow meters use two transducers mounted on the outside of the pipe, both of which function as an ultrasonic transmitter and receiver.

valve is controlled by the MVIC and is used to set flows according to the number of shares of water allocated to that particular shareholder. The second butterfly valve can be used by an owner to shut off or reduce water volume.

Each flow meter is either solar or battery powered, providing substantial savings by eliminating power wiring. This green feature not only saved on installation, but will also provide ongoing savings in the form of lower energy use. The key component of each branch turnout is the flow meter, and the MVIC was exacting in its requirements.

Reliable Flow Measurement

On older parts of the system, the MVIC is using impeller flow meters that require annual maintenance and are subject to plugging with sticks, moss and other loose material in the irrigation water. To reduce maintenance and eliminate plugging problems, a decision was made to use a non-intrusive flow meter.

"After extensive review of many types of meters from various manufacturers, a decision was made to purchase ultrasonic flow meters from Dynasonics," says Jim Siscoe general manager of the MVIC. Dynasonics is a division of Racine Federated (www.racinefed.com), and a number of factors entered into the decision to purchase their Model TFXL meters.

The transit time flow meters use two transducers mounted on the outside of the pipe, both of which function as an ultrasonic transmitter and receiver (Figure 2). The flow meters operate by alternately transmitting and receiving a frequency modulated burst of sound energy between the two transducers.

These particular meters were found to have the lowest installed cost, especially for larger pipe sizes. Because one meter could be used for many pipe sizes, design was simplified and the MVIC was able to minimize stocking requirements.

Prior flow measurement was made via Parshall Flumes or weir boxes with 5% to 20% accuracy, while the new meters provide an accuracy of 1%. Relatively high accuracy is important because tight control of flow guarantees sufficient yet not excessive water delivery to each shareholder.

Smaller turnouts aren't solar powered or

provided with continuous power by any other means. The MVIC ditch riders instead power the flow meter with a portable 12-volt battery. “While the flow meter is under battery power, the measured flow rate is used to manually adjust flow via the butterfly valve immediately downstream from the meter, according to that shareholder’s allowed rate. Most of these smaller turnouts require only one setting per season, although some turnouts are adjusted during the season based on our company rules and weather conditions,” explains Siscoe.

Larger turnouts and main distribution lines are being equipped with solar powered flow meters, allowing the MVIC staff and shareholders to read continuous or totalized flow at any time. Long-term goals are to fully automate the system by installing wireless flow meters and an automatic control valve downstream of the meter. See the Sidebar for more details on this wireless system.

Flow Control Yields Savings

Water projects like this one are finding their way to the top of state and federal project lists because they fit two categories for stimulus funding, namely Conservation and Public Works. Another reason for prioritizing these projects is savings in annual operating costs.

Final project costs were $2.9 million. Annual savings are projected to be $2 million, calculated from using 1,000 acre feet less of water each year at an average price of $2,000/acre foot. These numbers would yield a payback period of about 18 months for the project, but the company is also realizing immediate savings with creative financing.

The project was funded with a low-interest loan from the Colorado Water Conservation Board, a grant from the Colorado River Salinity Forum and company resources. By using innovative financial management and by self performing the work, the MVIC has been able to provide the improvements with no costs to the shareholders.

Operating experience over the past two years has been excellent. “Our shareholders were skeptical at first, but we’re now realizing the full potential of the system. We especially like the non-intrusive aspect of the flow meters which results in no maintenance, low cost, flexibility and ease of installation. The Dynasonics flow meters are now our standard for both new and retrofit applications, particularly replacement of our impeller flow meters,” relates Siscoe. For calibration purposes, the MVIC purchased a Dynasonics portable ultrasonic flow meter for both the new Dynasonics meters as well as older existing flow meters.

Based on positive operating experience, the MVIC is converting troublesome sections of other open canals to pipelines. Two miles of pipeline have been installed this fall and others are in the planning stage. “We plan to install flow meters on all the main pipelines, and hope to eventually connect the flow meters into a wireless supervisory control and data acquisition (SCADA) system,” notes Siscoe.

Racine Federated, Power Controls and AgriTech Consulting are developing a standard solar power package that will lower cost and simplify future installations. Using this standard solar power package, the MVIC is encouraging its shareholders to retrofit all of the turnouts with solar power to provide continuous flow as well as totalizer readings. The USDA Natural Resources Conservation Service has approved these meters for their on-farm irrigation improvement projects, easing the way for future stimulus funds and grant approvals.

The closed pipe network project has been so successful that the US Bureau of Reclamation is providing $2.1 million in stimulus grants to the MVIC for construction of a second similar 7-mile pipeline project. “Positive operating experience, ongoing savings, and government approvals and grants show us that we made the right decision to proceed with this project – and also encourage us to continue expansion and improvements,” concludes Siscoe.

Advantages of a Closed Pipe System

- **Reduces evaporation**
- **Cuts seepage**
- **Eliminates end of channel water losses**
- **Enables more precise flow measurement**
- **Allows installation of automated control valves**
- **Enables automation of entire system**

Wireless at work

The Montezuma Valley Irrigation Company (MVIC) and AgriTech Consulting have received a $75,000 Conservation Innovation Grant (CIG) from the USDA Natural Resources Conservation Service to automate portions of the newly installed closed pipe irrigation network. Scope items for the CIG grant include a solar-powered gate to control water level in the feeder canal, and a wireless flow control and measurement system.

The solar-powered gate has been installed and is operating successfully for the second irrigation season. Solar power eliminated the need to spend $25,000 for an electrical service line to this remote location. The gate automatically compensates for increased flow in the canal and creates a constant head pressure for a lateral pipeline inlet. Estimated savings are 1,000 acre-feet of water per year. Based on the success of the first gate, the MVIC has ordered an additional solar-powered flow control gate that will be installed in another canal next winter.

Flow control and measurement at two turnouts will be implemented via a wireless supervisory control and data acquisition (SCADA) system. This portion of the project will demonstrate flow control and measurement at a remote location where flow needs to be changed frequently throughout the irrigation season.

The SCADA system consists of a telemetry receiver and master control center in the main MVIC office connected to the two turnouts via a wireless data link. Each turnout has a telemetry transmitter connected to a flow meter, along with a modulating control valve that can be adjusted from the office with the SCADA system (Figure 3). All of the equipment at each turnout is solar-powered.

The meter reads the water flow rate and wirelessly transmits this data to the master control center. Based on the flow reading, a wireless signal is sent to the valve to control water flow. Wireless automation at these two turnouts will demonstrate to the MVIC and its shareholders the benefit of remote flow measurement and control.

Figure 3: Flow control and measurement is implemented via a wireless supervisory control and data acquisition (SCADA) system. The SCADA system consists of a telemetry receiver and master control center in the main office connected to field equipment via a wireless data link.

The telemetry and computer equipment with associated software has been ordered and installed at the master control center.

All of the turnouts on the newly installed closed pipe network have ultrasonic flow meters fitted with electronics capable of transmitting flow measurement data to the master control center at the MVIC office. The equipment installed to date has been extremely well received by the shareholders and has laid the groundwork for further automation of the MVIC system. This SCADA system itself is expandable and will provide a framework for automation of other parts of the MVIC system.

Wireless supervisory control and data acquisition (SCADA) systems are ideal for this and many other measurement and control applications distributed over a large geographical area. Possible future applications include mandated metering due to water compacts and court decrees, data collection from remote locations, and metering of irrigation equipment such as center pivots, side rolls and gated pipes.