Examining Pressure Management Methods in Water Distribution Systems (Part 2 of 2)

White Paper

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Overview

The first paper in this two-part series identified the key pressure management problems faced by water utilities. Uncontrolled water pressure can result in increased system leakage, shortened pipe life, and an increase in line breakages. This paper outlines methods used in helping to curb pressure-driven problems, including remote wireless pressure monitoring. By monitoring multiple points throughout a potable water system, remote wireless pressure monitoring anticipates and helps to mitigate dangerous pressures that could denigrate the water system.

Methods of Reducing Water Pressure

A broad range of pressure management methods have been developed over the course of several decades. Each method offers a specific set of advantages and disadvantages depending on the needs, priorities, and budget of a water utility.

Fixed Outlet Pressure Control typically employs a pressure reducing valve (PRV) with no additional equipment; it is considered to be the most straightforward form of pressure management. PRVs are easy to install and require little with regard to operation and maintenance. However, most PRVs lack the flexibility to adjust water pressures at different times of day. Excessive pressure in pipes downstream of the PRV can increase the chance of leakage or breakage if pressures are not decreased when necessary. This leads to diminished savings due to water loss, potential contamination, and expenditures related to repairing leaks and breaks.

Similar to fixed-outlet pressure control, **Time-Modulated Pressure Control** includes an additional control which provide a further reduction in pressure during off-peak periods. This method is particularly useful in areas where water pressures build during off-peak, non-use periods. The controller provides greater flexibility by allowing for the reduction of pressures at specific times of day, resulting in greater savings. Additionally, the system's components are less expensive than those used in flow-modulated pressure control. Because time-modulated pressure control does not react to the demand for water, it can present a significant liability in times of needed fire flow; this problem can be mitigated by the installation of a flow meter. When compared with fixed outlet pressure control, time-modulated pressure control is more expensive and requires a higher level of expertise to operate maintain.

Flow Modulated Pressure Control provides greater control and flexibility than time-modulated pressure control. This method uses an electronic controller which interacts with a properly-sized meter and PRV to ensure adequate water pressure in the event of needed fire flow. The increased flexibility of flow modulated pressure control offers more savings than fixed outlet and time-modulated control methods; these savings may be offset by the increased equipment expense associated with the electronic controller and properly-sized meter. Flow modulated pressure control is often beyond the employee skills base of many water utilities.

In **Closed-Loop Pressure Control**, a flow modulated controller is employed with the water meter and PRV. Additionally, beyond the supply area, a pressure sensor is placed at the critical node of the system; live data is supplied to the pressure controller at the inlet to the zone via a communications link. Closed-loop pressure control has historically been considered the best available form of pressure control, resulting in maximum savings to the water utility and consumer. This method is the most complicated form of pressure control, involving many integrated components; this presents a greater likelihood of equipment failure and requires a level of skill for maintenance and operation that is often too challenging for a water utility.

The most advanced solution for every water distribution system is **Remote Wireless Pressure Monitoring**. As indicated by increasing numbers of reticulation system failures, real-time monitoring is critical to prevent costly and often unnecessary water system interruptions. Developed as a result of intensive research, remote wireless pressure monitoring offers an end-to-end integrated hardware and software system for monitoring, analyzing and modeling a water distribution system in real-time.

Understanding Remote Wireless Pressure Monitoring

The typical remote wireless pressure monitoring system consists of:

- **Sensor Node or Controller and Reporting Unit:** A remote pressure sensor consisting of an embedded single-board computer with custom-designed sensor hardware is attached to a port in the water distribution system, enabling the continuous collection and analysis of data. The device provides real-time reporting of pressure conditions outside of user-defined parameters. Sensor nodes at critical locations in the field are able to communicate along the network and provide full data sets suitable for centralized online and offline analysis.

- **Remote Servers:** Connected to the entire network, remote servers consist primarily of a browser-based user interface and an Integrated Data and Alerts System (IDEA). The IDEA server performs data acquisition, analysis, and other integral tasks to modulate pressures within the water distribution system and keep them at safe levers; the wireless sensor network supplies data to the remote servers. The browser interface provides users with a way to interact with the functions of the remote servers and reconfigure the sensor nodes. The remote wireless pressure monitoring system may be used either as a stand-alone system or as a unit of an integrated water distribution system. When used as a stand-alone system, a map-based web user interface and dashboard are provided; this interface is accessible via web browser on desktop PCs or via tablet or smartphone, enabling in-field analysis and validation. No special hardware or software is required.

- **Transmission & Reception Platform for Wireless Data:** This platform can be integrated into a network's existing supervisory control and data acquisition systems. The wireless system can also be used as a stand-alone monitoring platform hosted either locally within a water utility or in the Cloud.

Remote wireless pressure monitoring is an intelligent technology that outperforms all other pressure control methods available on the market. Proprietary technology is retrofitted easily to existing pressure ports or dedicated corporation valves; combining the latest advances in sensor technology with a user-friendly web interface, remote wireless pressure monitoring provides an intelligent, proactive operations base.

Advantages of Remote Wireless Pressure Monitoring

- Can monitor pressures anywhere along the pipe distribution network.
- Is integrated with existing network infrastructure.
- Allows for customizable pressure and condition alerts to field and office personnel.
- Provides constant intelligent monitoring for out-of-normal pressure conditions.
- Offers immediate communication of data via the most reliable cellular services.
- Includes pressure sensor and communication system in one box.
- Operates safely and securely, making data available to as few or as many personnel as desired.

The Profile of an Intelligent Water Distribution System

Monitoring real-time water pressures can produce benefits across the entire spectrum of a water distribution system:

- **Pump operations:** The knowledge of monitored pressures in specific pipelines directly impacts pump operations through the transmission of accurate pressure data which may pinpoint the pump as a source of pressure-driven problems. Additionally, any analysis conducted alongside critical pump operations in an intelligent water distribution system will help to determine whether a pump is robust enough for a job, or if a higher-pressure pump is needed.

- **Water Quality Management (WQM):** A real-time remote wireless pressure monitoring system and associated analytics help to provide crucial water quality parameters, enrich distribution processes, and paint a fuller picture of water quality management within the infrastructure. Intelligent WQM software establishes a baseline pattern of expected parameters under normal conditions in the distribution network. These parameters can include quality markers such as pH, turbidity and conductivity, and they are measured both individually and in correlation to one another; certain cases of contamination can be detected through this software.

- **Reduced Operating and Maintenance Costs:** The adoption of an intelligent water system leads directly to improved operating efficiency and reduced costs. Smart solutions for leakage reduction allow utilities to easily identify the location of water losses, reducing the cost of field personnel deployment. Additionally, water utilities are able to reduce energy costs and emissions through the optimization of operations.

- **Expedited Compliance in Regulatory Matters:** Local, state and federal regulatory bodies constantly seek to improve the level and quality of services to consumers; water utilities are front and center with respect to such initiatives. Performance benchmarks and water quality standard targets can occasionally be delivered with a short timeline for compliance; in these cases, intelligent water technology is vital to identifying and implementing the adjustments needed for fast compliance.

- **Security:** As demand grows and water resources become more scarce, water distribution systems are tasked with ensuring the security of their water supplies. Intelligent water technology empowers managers and planners to make decisions for the future, helping to reduce waste, improve efficiency, and plan for the expansion and revitalization of a system while avoiding unnecessary costs.

Conventional monitors do not capture the full range of pressures within a water distribution system

Eight months (August 2011 to February 2012) of test monitoring was conducted to determine the effectiveness of remote wireless pressure monitoring technology at zones varying from high-pressure/low elevation to low pressure/high elevation. Both conventional (using SCADA) and newer, wireless optimized pressure monitoring methods were employed in the testing. The following was observed: Conventional monitoring showed an average of 55 psi, while optimized monitoring ranged from 40 to 120 psi. When testing was concluded, the hosting utility determined that the following benefits would be realized with the new, more accurate technology in place:

1. *The cost to implement the new pressure reduction technology was minimal*
2. *A water loss reduction of ~10-15% was easily assumable*
3. *The new technology would help reduce main break frequency*
4. *Due to lowered pumping energy usage, costs could be further reduced*

Testing within other District Metered Areas (DMAs) using the same conditions and criteria was conducted between April 2005 and December 2009. The result: remote wireless real-time distributed pressure monitoring turned the water pressure profile upside-down — leakages were effectively eliminated, outlay of funds for maintenance were no longer a significant factor, and water pressures were minimized, resulting in further cost savings through less energy use.

Conclusions

Through the implementation of remote wireless pressure monitoring technology, a water utility is able to enjoy significant gains in a variety of areas. When combined with appropriate data processing techniques, the increased density and availability of accurate pressure monitoring with real-time data and remote sensing results in:

- Improved management, prediction of, and response to infrastructure failures
- Improved public safety
- Reductions in energy costs, including pumping costs, system maintenance costs, water quality problems, unaccounted-for non-revenue water and customer complaints

Water distribution systems are essential components of civic infrastructure, and each one must competently managed and maintained to provide optimal service to consumers. Because of this, each water distribution system has the immediate need for online decision-support systems based on the continuous, accurate monitoring of parameters within the system. By deploying the type of monitoring, water utilities can begin to improve system operations, manage leakage control more effectively, and reduce the duration, cost and disruption of repairs and maintenance.

The state of water safety, quality and delivery hinges upon the ability of each water utility to consistently meet customers needs. If water qualities can commit to updating and optimizing the potable water infrastructure in a manner similar to that of the recent trend towards bolstering and updating the power grid, we can continuously serve the best interests of every water customer for decades to come.

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