Reducing Distribution System Main Breaks and extending asset life through Model Predictive Pressure Control

A common problem in water distribution systems is aging infrastructure and the associated costly repairs that result. Windsor Utilities Commission (WUC) employed a "first of its kind" solution that utilized On Board Model Predictive Control (MPC) to extend asset life and reduce main breaks in the distribution system.

Standard Proportional-Integral-Derivative (PID) control, a mainstay in the drinking water industry, is limited in the ability to control multivariable inputs and outputs simultaneously. MPC both recognizes and then make adjustments in these multivariable environments allowing the process to be optimized while utilizing its dynamic model to anticipate future process changes.

WUC applied MPC to its high lift pumping control strategy to provide its customers with consistent supply pressure regardless of demand within the entire service area. The new strategy required a paradigm shift in the control approach utilized at the pumping stations. In the existing system, the high lift pumps were controlled by maintaining a flow set-point with fluctuating pressures. The new methodology focused on maintaining a consistent pressure, thereby ensuring that both the required flow at an adequate pressure is delivered to the end user. Model Predictive Control was deemed to be the best fit for managing the system mean pressure, since multiple inputs from the remote pressure meters (multivariable) would be used for both monitoring and control within the constraints or limits of the system. This developed into a research and development collaboration with Rockwell Automation to test a new onboard MPC controller in its Allen-Bradley® ControlLogix® programmable automation controller (PAC). In fact, this project represented the first ever installation and application of this onboard solution in any industry.

Additionally, Flow Control Valve (FCV) control was added to improve system performance and operational flexibility – and to reduce pressure variations caused during pump start/stops. The onboard MPC controller can incorporate FCV functionality due to its ability to control within the 0.5- to 1-second range.

Since the implementation of this new control strategy the following benefits have been realized:

1) 21% Reduction in main breaks resulting in approximately $125K cost savings.

2) WUC was able to reduce the average system pressure by 2.8 psi and standard deviation by 29%. Savings attributable to this reduction are estimated at $125K**.**

3) Added multi-zone control. This provided the ability to maintain system pressure in the outlying regions of the distribution system in concert with the two main pumping stations.

4) Eliminated pump start/stop system pressure variations. When a pump starts/stops, the current operating pumps will vary their outlet pressure to ensure that the system pressure remains steady, thereby eliminating pressure variations that can result in main breaks.

The overall project strategy focused on control to keep high lift pump pressure to a minimum. Additionally, incorporating FCVs into the control system reduced pressure fluctuations on pump start-up/shutdown – and lessened the stress on the aging infrastructure therefore extending its useful life. These improvements were made possible through the implementation of onboard Model Predictive Control which provided a streamlined and efficient pumping strategy.