PRV REMOTE CONTROL & AUTOMATIC OPTIMISATION
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1. INTRODUCTION

Pressure management can deliver dramatic reductions in leakage and burst frequency, asset life extension, reduced energy and manpower requirements along with improved customer service levels.

This document provides an overview of the functional capabilities of i2O Water’s PRV Remote Control and Automatic Optimisation solutions. i2O provide an integrated portfolio of precision hardware and enterprise software solutions, which deliver multiple levels of capability to manage pressure in water distribution networks.

2. BENEFITS OF SMART PRESSURE MANAGEMENT

2.1 Leakage Reduction

A typical goal for pressure management programs is to reduce leakage by reducing average pressures in a PMA. Reducing average pressures reduces the flow rates through existing leaks and decreases the rate of increase in background leakage. As well as saving water these leakage savings also reduce the pressure on leakage detection teams to find and fix leaks.

On average, in large systems a 20% reduction in pressure will have a 23% reduction in leakage. This could be much higher for networks with predominantly flexible pipe work, because increased pressure causes the leakage orifice to open further and flow rates to increase. Thus a 20% reduction in pressure could, for example, lead to a 36% reduction in leakage in such cases.

2.2 Burst Frequency Reduction

Reducing the maximum average pressure in a network has been shown to reduce the burst frequency in a PMA. The relationship between bursts and pressures is a complicated one and is dependent on several factors. However targeting pressure management in areas with significant burst frequencies can have a big impact. Reducing pressures by as little as 20% can have a 40% reduction in burst frequency in areas of the network that are prone to bursts.

2.3 Energy Savings

Pumping water consumes large amounts of energy and that energy consumption increases the higher the pumping pressures. Reducing the pressure feeding the network also reduces leakage, and therefore the volume of water that is being pumped. Reducing average pressures by as little as 20% can have a 30% reduction in pump energy consumption.
2. BENEFITS OF SMART PRESSURE MANAGEMENT

2.4 Improved Customer Service

In manually controlled networks, the pressure delivered at the critical point or points in the network may vary considerably over time. This means that pressures are either set conservatively high or too low, resulting in a risk that at peak demand pressures can fall below acceptable levels for customers. Automatic pressure optimisation can overcome these complications; ensuring levels of service are always achieved for customers.

2.5 Extended Asset Life

Reducing average maximum pressures in the network reduces the burst frequency in the network. As a consequence, pipe assets, joints, and fittings will have an extended operational life. Replacing pipes can be capital intensive and cause major disruption in urban areas. Extending the lifespan of these assets defers capital expenditure and reduces the disruption caused to customers.

2.6 Reduced Operating Costs

The remote control of PRVs greatly reduces the need for site visits to adjust pressures. Pressures can be easily adjusted remotely or automatically optimised to a target pressure at the critical point. Reducing bursts and leakage detection also ensures that there are fewer requirements for site surveying, repairs, and leakage detection. Increased visibility of the network enables operational teams to be targeted in planning site visits, ensuring the maximum return on time spent in the field.

3. PRESSURE MANAGEMENT SOLUTIONS

3.1 The Pressure Management Journey

The i2O approach to pressure management is to build from a foundation of understanding how the water distribution network performs. By initially deploying i2O smart Loggers in strategic locations in a PMA, along with the i2O Network Monitoring solution, the characteristics of the network can be better understood. For more information on this please refer to the i2O Loggers and Network Monitoring product briefs.

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This foundation of Loggers and Network Monitoring facilitates the targeting of pressure management in the water network. i2O offers different levels of functionality from its enterprise software platform, enabling users to select from a ‘menu’ of services. These solutions can be deployed in a way that is appropriate to meet the varying demands of complex water distribution networks. This approach utilises intelligent loggers and controllers communicating with a single software platform.

This unique architecture delivers a highly adaptable and customisable Smart Pressure Management solution that can be tailored to fit any water network. i2O offers several different levels of control within its solutions. Changes to levels of control in a particular area of the network are handled quickly and easily through the software platform. The following section describes the levels of control available.
3. PRESSURE MANAGEMENT SOLUTIONS

3.2 Basic Remote Control

The Basic Remote Control solution enables an engineer to remotely change the outlet pressure of a PRV. When Basic Remote Control is enabled through licensing, the Control tab at that location introduces a field for setting the target P2 pressures. The Control tab also displays a graph that presents the newly specified pressure graphically overlaid on 24 hours of latest PMA data allowing users to assess the suitability and impact of any new pressure setting before committing to the i2O controller remotely.

i2O Inlet Loggers can be simply upgraded to controllers by the addition of the i2O Advanced Pilot Valve.

By controlling pressures remotely in combination with i2O’s Network Monitoring software, changes can be made progressively whilst monitoring the effect on the network. Engineers can reduce pressures, saving bursts and reducing strain on the network, knowing that they can be remotely adjusted if there is extra demand.

3.3 Timed Remote Control

The Timed Remote Control solution enables an engineer to manually configure pressure changes based on a 24 hour profile. When Timed Remote Control is enabled through licensing, the Control tab introduces a table for setting target P2 pressures against time.

Profiles can have up to 96 individual settings, allowing the outlet pressure of the PRV to be tailored through the day. The schedule is graphically overlaid on 24 hours of latest PMA data on the Control display to assist the user in reviewing the schedule before committing to the i2O controller remotely. Different working and non-working day profiles can also be configured to compensate for how demand characteristics vary depending upon working patterns.

Timed Remote Control enables engineers to remotely compensate for head-loss during known periods of high demand, or to vary the schedule of level of service in the network.

There is no need to visit site for hardware or software upgrades and the new control profile will be implemented upon remote connection of the controller. This is true for all upgrades and utilities can therefor target levels of pressure management to suit each location.
3. PRESSURE MANAGEMENT SOLUTIONS

3.4 Flow Modulated Remote Control

Flow Modulated Remote Control enables an engineer to manually configure the outlet pressure of a PRV based on flow rate to compensate for flow related head-loss. When Flow Modulation is enabled through licensing, the Control tab introduces a table for setting target P2 pressures against flow.

When the flow-modulated relationship is applied, the effect on network P2 pressures is simulated by using the latest flow data to calculate P2 values and graphically overlaying this on the latest PMA data. This enables operators to ensure that the configured pressures are appropriate before committing the change to the i2O controller remotely.

Flow Modulated Remote Control allows experienced engineers to remotely apply flow related head-loss compensation through an easy to use interface. Integration with i2O Network Monitoring allows engineers to monitor pressure performance and be alerted if network performance is sub-optimal.

3.5 Automatic Timed Remote Control

Automatic Timed Remote Control is an intelligent control system to facilitate automatic and optimised control in pressure managed areas where there is no available flow meter. The solution combines a patented, intelligently learned, time based P2 schedule with a near real-time critical point feedback feature to ensure pressures remain optimised.

When Automatic Timed Remote Control is enabled in licensing, the user specifies the target critical point pressure and the software automatically generates time based P2 pressure schedules that compensate for learned network head loss for both working and non-working days. The automatically generated schedule is graphically overlaid on 24 hours of latest PMA data on the Control display to assist the user in reviewing the schedule before committing to the i2O controller remotely. Once applied, the i2O critical point logger monitors pressures and automatically feeds back to apply correction offsets to the pressure schedule in near real-time if critical point pressures fall outside of defined acceptable boundary levels.

The algorithm can be configured to update the schedule automatically when new data is received, or semi-automatically by the user.

In order to benefit from the feedback feature, the controller is configured to poll the data management platform regularly and the critical point logger connects by exception if pressures are outside of boundary levels. Consequently both devices have a higher power consumption requiring external batteries or power source.

Conventional closed loop solutions are prone to loss of control when either the controller or critical point logger is unable to communicate over the GSM network. The i2O Automatic Timed Remote Control solution addresses this by applying an intelligently and automatically derived confidence based pressure time schedule, which is downloaded to the controller. The controller will continue to use this schedule autonomously and indefinitely in the event of GSM connectivity issues.
3. PRESSURE MANAGEMENT SOLUTIONS

3.6 Automatic Optimisation

Automatic Optimisation is an intelligent control system that provides full automation of pressure optimisation within a PMA. The solution uses a patented algorithm that automatically creates and updates a flow modulation control model held locally in the controller. The controller uses the model to react in real-time to compensate for changes in demand whilst getting regular model updates to ensure pressures remain at optimal levels if head loss characteristics change in the network.

When Automatic Optimisation is enabled in licensing, the user simply specifies the target critical point pressure required. The software automatically generates flow modulation control models that compensate for learned flow related head loss to achieve the specified pressures. The algorithm can be configured to update the control model automatically when new data is received, or semi-automatically by the user.

Optimisation can be smoothly and progressively implemented and maintained without user intervention simply by setting rate of change, upper and lower pressure limits. An anomaly detection algorithm monitors the network pressure and flow characteristics and pauses optimisation with an alert to the user if significant changes are detected. Being integrated with i2O’s Network Monitoring allows engineers to monitor pressure performance and be alerted if network performance is sub-optimal.

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3.7 Realising the Full Benefit of Pressure Management

Traditional methods of pressure management are largely manual and have a number of inherent drawbacks, which adversely affect the return on investments and benefits realisation. They typically involve costly site visits to adjust PRVs or controllers. This makes it impractical to implement incremental adjustments across multiple PMAs, so they are often set with excessive safety margins to accommodate this lack of agility.

By implementing Basic Remote Control capabilities the safety margin can be reduced as engineers now have the ability to monitor the network pressures and make changes if the critical point pressure falls due to demand or variation in network characteristics. It also provides the ability to increase pressures for known increased demands as might be experienced in locations with large seasonal demand variations.

With a fixed outlet PRV the outlet pressure of the PRV (P2) remains constant and the pressure at the critical point (P3) will vary based on the flow related head loss in the network. A safety margin is usually applied when setting the pressure to ensure that the minimum observed P3 (Min P3) remains well above the minimum level of service (Target P3) in order to ensure changing demand or network characteristics don’t generate low pressure issues.

Pressure at night may be higher than necessary. Excess night pressure can be removed from the system utilising Timed Remote Control where the outlet of the PRV can be set according to the time of day. Thus morning peaks and reduced night time demand can be compensated for.
3. PRESSURE MANAGEMENT SOLUTIONS

A more sophisticated approach is to use Flow Modulation Control to modulate the P2 pressure of the PRV using flow rate to compensate for head loss in the network. Flow modulated pressures increase and decrease with flow variation to reduce excess network pressures when demand reduces. Manually configured flow modulation should be regularly adjusted and a safety margin applied in order to ensure changing demand or network characteristics don’t generate low pressure issues.

For optimal control, i2O’s patented Automatic Optimisation solution constantly monitors the network and automatically updates a flow modulation relationship model to smoothly deliver optimal P2 pressures and consequently the lowest possible P3 pressures. At the same time as minimising network pressures, the solution also removes the need for manual review, adjustment and application of a safety margin above the minimum P3 level of service.

The Automatic Optimisation solution ensures maximum pressure reductions giving the greatest leakage savings and burst reductions, reduced energy consumption and increased operational life of network assets. All this is achieved at minimum operational expenditure and assured levels of customer service.

4. THE i2O SYSTEM

4.1 Smart Pressure Management

This diagram below shows the architecture of the i2O Remote Control and Automatic Optimisation solutions. It illustrates the locations of i2O devices in a DMA and the data flows between the devices and the i2O software platform.
4. THE i2O SYSTEM

i2O has built and deployed a secure enterprise level software platform, based on the cost-effective software as a service (SaaS) delivery model. The solution embeds the intelligence provided by the i2O Network Monitoring solution. The platform also enables easy integration with SCADA and regulatory reporting systems.

i2O’s Network Monitoring application receives, manages and interprets data provided by logging devices in the network and presents it in a comprehensive and user-friendly graphical user interface. The Network Monitoring solution has been designed as a proactive tool for network engineers and managers to perform everyday network management activities such as leakage management, network optimisation, service level management, network integrity and operability monitoring, and problem diagnosis.

If 3rd party loggers are in place, then the i2O Network Monitoring software can be extended to provide monitoring of this data through 3rd party data integration tools.

The i2O Remote Control and Automatic Optimisation solutions build on the Network Monitoring platform, providing all the benefits of network visibility to assist users to configure and monitor remote and automatic optimisation of the network.

The i2O solutions offer a range of features:

- Easy to use software functionality to develop and deploy optimal pressure management strategies over time
- Tailored PMA control profiles to meet the specific needs of each area
- Easy upgrade process allows transitions between control levels through the instant activation of functional licenses
- A blend of basic, time based, flow modulated or automatic optimisation pressure control can be applied across different times of day, night and week in the same PMA
- Precision engineered, robust hardware devices deliver high-quality consistent data capture and accurate, smooth pressure control

- Rapid service deployment, remote control and high levels of network visibility offer unique levels of operational agility
- An integrated enterprise wide (multi-user) solution, which provides access to network monitoring and pressure management information for any user that needs it within a utility
- A resilient solution with control profiles which will continue to optimise pressures without relying on continuous GSM network coverage
- Automatic Optimisation provides the most precise control of pressure available

4.3 Licensing

When licenses are purchased they are introduced into the customers license pool and are immediately available for the customer to apply to any location in their network where i2O devices are installed. Once applied, the license unlocks the appropriate level of Remote Control and Optimisation functionality enabling users to take control of pressures in the network.
4. THE i2O SYSTEM

4.4 Auditing

i2O auditing automatically captures who made what changes and when. The user also has the opportunity to document why the change was made. This enables tracking and interrogation of the changes for general reporting and in the case of an incident.

[Change confirmation screen]

4.5 Alarms

The Network Monitoring solution provides comprehensive software and hardware alarm functionality. Alarms can be configured to be generated by devices in real time and a comprehensive software alarm management interface is provided within i2O Network Monitoring.

[Alarm monitoring screen]
4. THE i2O SYSTEM

4.6 Hardware

The hardware elements of the solutions consist of an i2O Controller, an Advanced Pilot Valve (APV) retrofitted to the PRV and one or more remote point pressure Loggers.

Remote Loggers provide accurate data collection from key locations within the water network including critical points (P3). The i2O Controller captures upstream (P1) and downstream (P2) PRV pressures along with the flow (Q). All data is then uploaded by a secure protocol over the GPRS network to the i2O Data Management Platform.

The controller and APV have been designed to be easy to install by network technicians. After installation, active control can be enabled remotely when the desired pressures and profiles have been defined. The controller uses the i2O patented APV for accurate, smooth and frequent adjustment of the outlet pressures to ensure the PRV delivers the required scheduled pressures. Hardware control settings can also be remotely adjusted (e.g. rate of pressure change ensuring appropriate adjustment speed of the PRV).

5. SUMMARY

i2O’s PRV Remote Control & Automatic Optimisation solutions enable users to manage the pressures in water networks remotely and proactively, without the need for site visits.

This reduces operational cost by removing the need to physically check or change pressure settings on the PRV, or manually re-programme controllers. Excess pressures can be driven out of networks, reducing leakage levels and burst frequency. The end customer experience is improved by smoother, more managed pressure transitions and an improved ability to meet target service levels without placing additional strain on the network.

i2O’s PRV Remote Control & Automatic Optimisation solutions form part of an integrated portfolio of solutions for Smart Pressure Management that enable water companies to provide a better service to their customers, while saving money.

To find out more about Remote Control & Automatic Optimisation or about other solutions i2O can offer, please contact us today through our website, by phone or email, or through your existing i2O or partner account manager.
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