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Optimatics

Water Systems Optimization

www.optimatics.com

OptiPressure™ - Pressure and Leakage Optimization

Managing pressure and leakage through network design

THE use of pressure management to control leakage and bursts is becoming more common. The analysis to determine how pressure reduction is managed can be greatly improved through the use of automated optimization software.

KEY POINTS

- Reduce pressure
- Reduce leakage
- Reduce pipe bursts
- Extend asset life

Background

There is a direct link between the pressure in a distribution network, and the amount of leakage that occurs. High and fluctuating pressures cause burst mains and recurrence of leaks. These may be controlled by well designed PMAs (Pressure Management Areas), where each PMA is controlled by a PRV (Pressure Regulating Valve).

The design of boundary locations to create a PMA and select settings for PRV's can be very time consuming.

In response to this challenge, Optimatics have produced software to automate this process. The benefits include:

- Faster turn around on projects
- Optimal results
- More confidence in the final design

Methodology

PMA Boundaries

A user of the software must first upload the required information into OptiPressure™, Optimatics' pressure and leakage optimization software. Required data includes the:

- Hydraulic model
- Estimated level of leakage
- Economic cost of water
- Capital cost of valve assets
- Current leakage loses in the system
- Condition rating of pipes within the system (if available).

The user then selects a number of possible valve locations within the network, allowing OptiPressure to select the best combination of valves to minimize leakage at an acceptable cost.

The estimated leakage within the network (usually measured by night flows) is spread across each pipe in a proportional manor. If the condition assessment of the pipes is available, than the pipes considered to be in poor condition will be weighted higher than those considered to be in better condition.

Once all this information is entered, OptiPressure will optimize how a pressure zone can be best divided into PMA's and what pressure settings each PRV in the network should be configured to. OptiPressure can even select a varied PRV setting throughout the day to adjust for day-time and night-time flows.

The analysis process is very quick, taking only a few minutes for average sized models which is much more efficient than the trial and error method of selecting boundary and pressure settings by hand.

Selecting different economic costs of water also results in different solutions, as the software adjusts capital outlay in respect to the savings in leakage.

Selective laying of new mains

Closed boundary valves prevent free flow of water, and can create poor pressures in parts of PMAs that have high pressures at lower elevations. High friction losses within PMAs require high inlet pressures to ensure all customers receive strong supplies at all times.

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The best combination of boundaries may not be feasible unless additional mains are laid to provide new links to the inlets of PMAs, and also to reduce head losses within them. These cross connection may be included within the OptiPressure software where required.

PRV locations and control settings

Existing networks which are overloaded or experience high friction losses need higher inlet pressures during the day, which would be considered excessive at night. Modulating PRVs may be used to provide the minimum pressure required at different times of the day. The hourly control settings for PRVs will change depending on the boundary options selected.

Customization

Both the underlying software and the user interface can be adjusted and tailored to suit the exact requirements of the client. If extra features are required, for example including an estimate of the savings associated with extended asset life due to lower pressure, these may be included within the software.

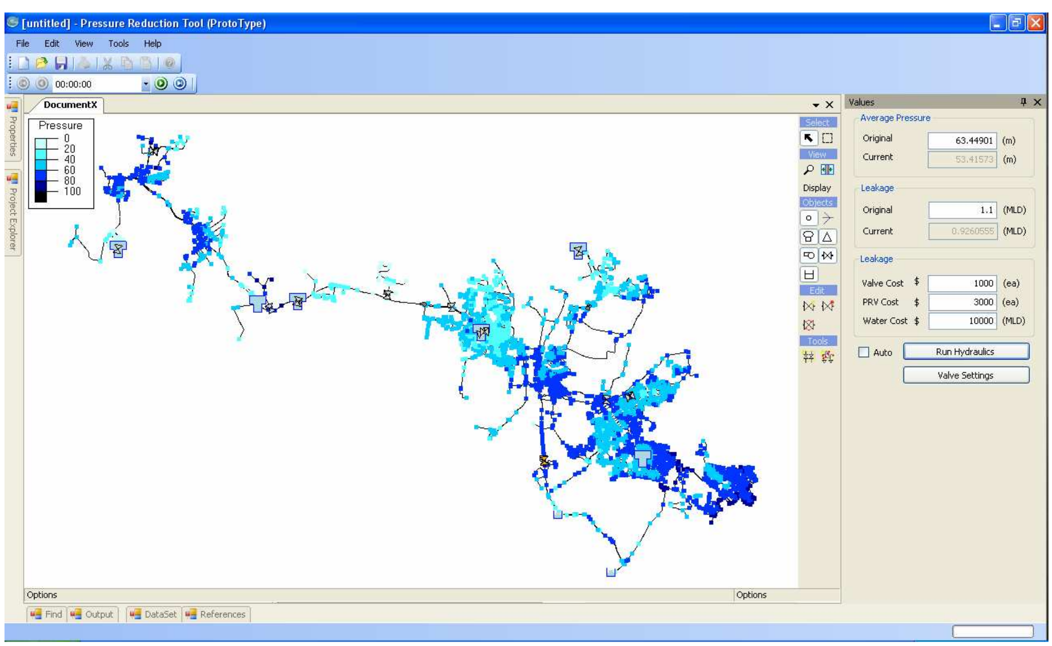
Consulting or leasing

The Optimatics approach is to work with clients in a way that best suits the clients needs and will deliver the optimal results.

As such, this service is available either as a consulting service or as leased software to use in-house.

Training

Optimatics provides training services to ensure that users are fully qualified in the application of the software, ready for use in-house.



OptiPressure user interface - tailored to meet the individual needs of every client

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Project Snapshot #1

Boundary locations selection

Chigwell, London, United Kingdom
Chigwell Pressure Reduction, Thames Water

Background

The Chigwell area is typical of many parts of London, enduring high leakage, frequent pipe bursts and ageing mains. This particular zone was selected for the project as it was known to suffer from a combination of high pressures and poor pressures in varying areas, that had so far prevented effective pressure management.

The Project

An existing DMA was investigated to find where the optimal boundary line should be to divide and supply the zone through two inlets with PRVs. This technique can be applied to find the outer boundaries of a number of PMAs.

A number of different possible boundary lines were simulated, together with possible PRV locations and outlet pressures. Optimization was used to determine the best combination of boundary line and hourly PRV settings that would minimize the leakage from the entire DMA.

The effects of pressure management at each node was weighted to account for the demand and estimated existing leakage at each.

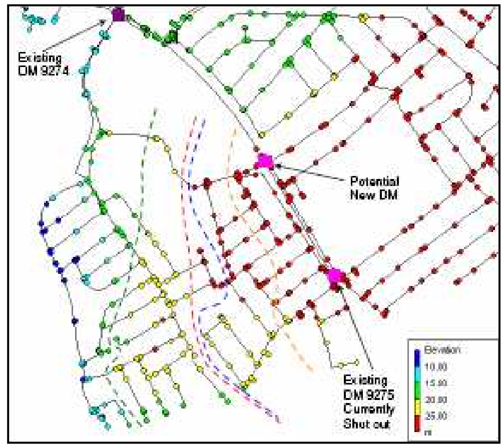
Key Outcomes

The maximum difference in elevation in the two new PMAs was reduced from 23 metres to 14 metres, with corresponding reduction in pressures.

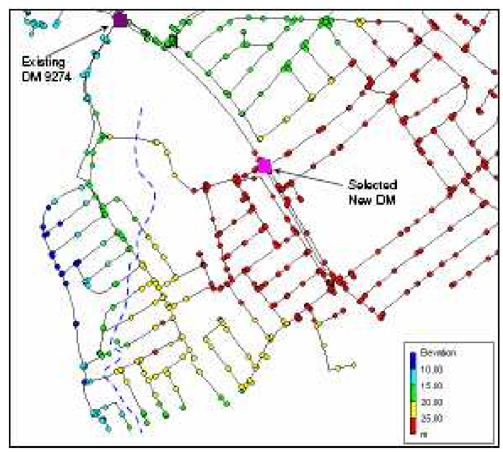
By simultaneously optimizing which side of the new boundary line each node should be and the hourly pressure settings for two new possible PRV locations, it was possible to find a solution that reduced the existing average pressure across the whole existing DMA from 64 metres to 25 metres in one new PMA and 21 metres in the other.

KEY POINTS

- 18 existing DMAs studied to date
- Average pressure reductions of 21 metres identified
- Average leakage reductions of 38% predicted
- Network improvements identified to resolve existing poor pressure areas



Possible options for new boundary lines



Final Solution
Selected boundary and PRV location

DMA	Existing Average Pressure (m)	New Average Pressure (m)	Reduction in Average Pressure	Existing Leakage (Ml/day)	New Leakage (Ml/day)	Average Elevation	Max Elevation (m)	Min Elevation (m)	Range (m)	Standard Deviation (m)
18a (proposed)	74.6	24.7	49.9	0.13	0.04	12.8	19.8	9.0	10.8	2.6
18b (proposed)	55.5	21.8	33.7	0.15	0.06	25.1	32.0	17.1	14.9	3.9
18 (original)	64.3	23.2	41.1	0.28	0.10	19.5	32.0	9.0	23.0	7.0

Alternate solutions based on different possible boundary locations

Project Snapshot #2

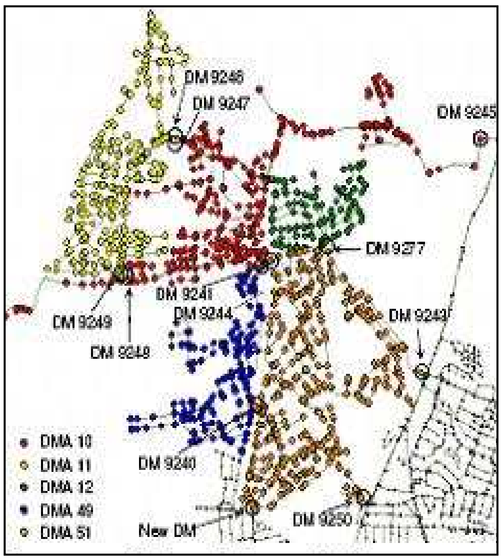
PRV settings selection

Chigwell, London, United Kingdom
Chigwell Pressure Reduction, Thames Water

Background

A group of five existing DMAs (District Metered Areas) were investigated to find the pressure reductions that could be achieved by installing new PRVs (Pressure Regulating Valves) with modulating controls at District Meter locations, without changing boundaries.

The group of DMAs were highly interconnected and the pressure in some of the DMAs had to be kept high enough to supply to others downstream. The higher areas within the DMAs also experienced unacceptably low pressures at peak times.



Pressure and leakage reduction by optimization of multiple PRV settings

KEY POINTS

- Pressure reduction using modulated PRVs
- 5 DMAs optimized at one time
- Large pressure reduction for very little cost
- Suitable for highly interdependent networks

The Project

Optimization was used to find the optimal pressures for each PRV hour by hour. Pressure reductions of up to 36% were shown to be possible without any significant expenditure.

Most existing poor pressure areas were resolved by the proposed solution and opportunities for investment were identified to reinforce the network, providing all customers with constant satisfactory pressures. This demonstrates that it is possible to identify significant improvements in the operational aspects of a network at minimal cost. In a complex, highly interdependent network the changes are very difficult to identify by hand. However, a powerful search algorithm can greatly assist, identifying the optimal changes and providing the best results.

Key Outcomes

The benefits of optimizing network pressures include:

- Networks reconfigured to manage pressures to minimize leakage and bursts
- Poor customer pressures rectified
- Lowest cost network improvements identified to resolve high friction losses
- Robust solutions identified that deliver Fire Flows and maintain supplies in emergencies.

DMA	DMA	NRW (L/s)	Total Prop	Existing Average Pressure (m)	New Average Pressure(m)	Reduction in Average Pressure (m)	Pressure Reduction %age >15m	Hour-Day factor	Existing Leakage (ML/day)	New Leakage (ML/day)	Leakage Reduction (ML/day)	Leakage Reduction
10	**10**	11.6	3,204	37.7	27.8	9.9	44%	0.70	0.70	0.52	0.18	26%
11	**11**	2.4	2,954	45.2	29.1	16.1	53%	0.70	0.15	0.10	0.05	36%
12	**12**	3.4	1,355	37.7	30.6	7.1	31%	0.69	0.20	0.16	0.04	19%
49	**49**	9.4	2,691	48.9	38.7	10.2	30%	0.76	0.62	0.49	0.13	21%
51	**51**	*7.7	3,366	46.6	40.0	6.6	21%	0.75	0.50	0.43	0.07	14%
Totals									**2.17**	**1.69**	**0.47**	**22%**

Leakage calculations for each DMA