Applied Pressure Management Techniques to Reduce and Control Leakage

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Pressure Management

Questions
• Is it really necessary?
• Where can it be applied?
• How does it work?
• Is it reliable?
• Are there any limitations?

...More Questions
• What are the benefits?
• Are there any disbenefits?
• Has it been proven?
• Is there sufficient knowledge?
• What technology is available?
Leakage Increases with Pressure

\[
\frac{L_1}{L_0} = (\frac{P_1}{P_0})^N
\]
Burst Frequency Increases with Pressure

Source of Data: Welsh Water
Pressure Variations During Peak Demand Periods

- Just upstream of PRV
- Just downstream of PRV
- At critical point

20 = pressure in m
Pressure Variations During Low Demand Periods
Capping of Night Time Pressure

Inflow Analysis

Potential Savings

Flow Rate (m3/h)

Pressure (m)

10:50 12:50 14:50 16:50 18:50 20:50 22:50 00:50 02:50 04:50 06:50 08:50

[Graph showing flow rate and pressure over time with a highlighted section indicating potential savings.]
Advanced Pressure Management

Flow Modulated Controller

Pressure at Zone Inlet Point

Pressure at Critical Point

Inlet

Water meter

Pressure reducing valve

Outlet

District load

Extemity
Benefits of Advanced Pressure Management

- Water Conservation
- Reduced Pipe Bursts
- Extended Asset Life
- Cost Savings
Pressure Management Considerations

Pressure range:
- Between 20m and 40m (if possible)
- Minimum of 15 m if conditions allow

Pressure control achieved through:
- Pressure reducing valves
- Pressure regulating valves

Types of pressure control:
- Fixed outlet
- Multi point control (Time or Flow)
- Flow modulation
The ‘4 – Component’ Diagram for Managing Real Losses

Secondary Influence

Pressure Management

Secondary Influence

Unavoidable Annual Real Losses

Speed and Quality of Repairs

Current Annual Real Losses

Active Leakage Control

Pipeline and Assets Management: Selection, Installation, Maintenance, Renewal, Replacement
Advanced Pressure Management at the Water Board of Lemesos
Water Board of Lemesos

- Established in 1951
- Semi-government, non-profit organisation
- Supply of potable water
- Number of employees: 110
- Area served: 100 km²
- Population Served: 170,000
- Annual water needs: 14 million m³
- Number of consumers: 85,000
- Length of pipework: 1000 km
DMAs – Pressure Management

Total of 60 DMAS
Average length of pipework in each DMA≈15km

DMA categories
Small : <1000 properties
Medium : 1000 – 3000 properties
Large : 3000 – 5000 properties

Factors considered in re-design
- Minimum variation in ground level
- Single entry point into the DMA
- Well defined DMA boundaries
- Area meters correctly sized and located
- Continuous monitoring
Typical DMA Inlet Chamber

Pressure reducing valve
(downstream pressure control, open/close capability)

Pressure sensor
(downstream pressure monitoring)

District meter
(mechanical “Woltman” type)

Strainer
(meter protection)
Electronic Mail Support

Dedicated Computer in Control Room

Data Communication
E-mails are sent from each DMA twice a week
Alarms are also sent to Operator’s mobile phone for:
  - High/Low pressure
  - High MNF (02:30 – 04:30)
  - No flow
  - Low battery status

PSTN and GSM Network

PROGRAMMABLE CONTROLLERS IN DMAs
Flow Modulation (1/4)

DISTRICT 230

PRV

Hydraulic Modulator
Further leakage reduction achieved with flow modulation

District 230
Flow & Pressure

No Active Leakage Control was undertaken except for repairing reported leaks
Flow Modulation (3/4)
Flow Modulation (4/4)

District 230

Daily water consumption

Average water reduction: 6000 m³/101 days

Saving of €17,000 / year

Cost of flow modulation equipment: €3,000

Year 2006

Year 2007
# Flow Modulation Calculations

<table>
<thead>
<tr>
<th>DMA</th>
<th>PRV Location</th>
<th>Critical Point (CP)</th>
<th>Modulation Calculation</th>
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<tr>
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<td>D/S Pressure (m)</td>
<td>Pressure (m)</td>
<td>Network Headloss (m)</td>
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<td>Min</td>
<td>Max</td>
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Multi Point Control (1/3)
DMA 123 – Port of Lemesos

Telemetry controller and valve automation
Two Point Control (2/3)

DMA 123 – Port of Lemesos

District 123 - Flow & Pressure

MNF 12 m³/hr
Two Point Control (3/3)

DMA 123 – Port of Lemesos

District 123 - Flow & Pressure

Unreported burst repair

MNF 12 m³/hr

MNF 5 m³/hr
Advanced Pressure Management at the Water and Sewerage Company of Athens (EYDAP sa)
WATER SUPPLY NETWORK of the GREATER ATHENS AREA
# EYDAP’s Supply Network Data

<table>
<thead>
<tr>
<th>Metric</th>
<th>Details</th>
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<tr>
<td>Population Served</td>
<td>over 4 million</td>
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<tr>
<td>Customers – water meters</td>
<td>over 2 million</td>
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<tr>
<td>Mean Daily Consumption</td>
<td>1.15 million m³</td>
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<td>Storage Reservoirs</td>
<td>45 total capacity 300,000 m³</td>
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<tr>
<td>Pumping Stations</td>
<td>70 total installed power 30,000HP</td>
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<tr>
<td>Length of pipelines</td>
<td>9,000 km</td>
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<tr>
<td>Pressure Zones</td>
<td>210</td>
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<tr>
<td>Isolating Valves</td>
<td>90,000</td>
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<tr>
<td>Pressure Reducing Valves</td>
<td>550 (DN 50 up to DN600)</td>
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<tr>
<td>PRVs currently operating</td>
<td>about 400</td>
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Pressure Management in EYDAP

The operation of the water supply network has always been based on pressure management and it is achieved through pressure zones which are supplied through:

- PRVs (60% of the network = 5,400 km)
- Storage reservoirs
- Pumping stations

In 2004 (just before the Olympic Games):

A GSM Recording and Telemetry System in all operating PRVs was installed, a crucial and important step in the upgrading of the operation of the network resulting in the:

- rehabilitation of large number of PRVs to obtain constant pressure at the outlet (more effective operation and less pipe bursts)
- revaluation of the PRVs’ set points
Since 2007, Advanced Pressure Management has been applied in 25 pressure zones

- Covering 1.200 km of network (14% of the total network, 23% of the network supplied through PRVs)
- Supplying water to approx. 360.000 customers (water meters), 18% of total number of consumers
- Using available modulation technologies and testing their efficiency
Pressure Reducing Valve with Hydraulic Flow Modulation

Installed on DN 100 up to DN 200 PRVs

System Advantages:
- No power supply needed
- No extra moving parts
- Fast, real time response to demand
- Continuously variable outlet pressure
Pressure Reducing Valve with Fully Modulating Controller
(for time or flow modulation)

Installing on DN 150 up to DN 500 PRVs

System Advantages:
- Continuously variable outlet pressure
- Outlet pressure can be set remotely
- Optimisation according to flow or time
- No external power supply requirement
Pressure zone of Kallipoli at PIREUS:
(old mainly cast iron network - close to the sea - karstic quality ground - leaks hardly come to surface - frequent problems with flooding of basements)

- supplied through a DN250 PRV (+23m amsl)
- 32 km of network
- 48 boundary valves
- 15,280 customers (water meters) & 3,020 service connections
- Target Minimum Night Flow=11.5 l/sec

Application of time modulation with a max. pressure drop of 13 meters between day and night:
- a reduction in the mean daily supply by 550 m³ (equal to 200,000 m³ in a year or a saving of €190,000 compared to an investment cost of €12,000)
- a decrease in the MNF equal to 9 l/sec (from 39 to 30 l/sec)
KALLIPOLI - PRV DN250
Application of Time Modulation: 15-11-2007
Pressure zone of Halandri:
(old network – mainly A/C pipes)

- supplied through a DN300 PRV (+208m amsl)
- 36,2 km of network
- 22 boundary valves
- 7,650 customers (water meters) & 1,555 service connections
- Target Minimum Night Flow= 5,6 l/sec

Application of **flow modulation** with a pressure drop of 11 meters between day and night resulting in:

- a decrease in the MNF by 2,2 l/sec

For more than 2 years now, no bursts are reported in the zone due to excess night pressure. The levels of MNF have been maintained constant.
HALANDRI - PRV DN300
HALANDRI (Flow Modulation 2008, 2009)
Minimum Night Flow maintained seasonally constant for the last 2 years)

PRV Φ300 - HALANDRI

Flow (l/sec) vs. weeks

Temperature (°C) vs. weeks

- minQ
- maxQ
- T
Pressure zone +95m amsl (synchronized TM)
(old network mainly from A/C & cast iron, frequent bursts)

- Mixed area (domestic & industrial use)
- supplied mainly through 2 PRVs DN400 - Application of multi-step time modulation in both PRVs with a pressure drop of 10 meters in each one between day and night,
- Additional supply from a PRV DN200 only during peak demand (daytime) (the output pressure is set very low).
- network of 230 km
- 63.650 customers (water meters) & 15.574 service connections

Results

- A reduction of the mean daily supply by 7.6% for a drop in pressure of 10 m.
- For more than a year now, the levels of MNF have been maintained constant.
Zone + 95amsl (Multistep Time Modulation)
Results / Conclusions

- **Reduction even elimination of new bursts** *(usually caused until now by excess night pressure)*
  - Improved customer service level
  - Extension of network’s life

- **Impact in decreasing leakage**
  - A reduction in the MNF was observed in most cases, its magnitude mainly depending on the % of pressure reduction and the material of the pipelines.
Flow modulation is more efficient due to

- Elimination of pressure shocks (no abrupt change in pressure), therefore elimination of new bursts !!!
- Suitable for zones with good hydraulic performance
- Reduction in the mean daily supply to the zones – In Eydap pressure zone areas: decrease up to 8,5 % (compared to time modulation varying from 2,0 to 4,5%).
However, for complex networks (EYDAP):

- **Time modulation is the preferred option** *(as the initial step), applied in zones*
  - with areas with poor hydraulic performance (closed valves, unknown restrictions difficult to detect, lack of connections among overlapping pipelines).
  - where high pressure is required during consumption hours (due to high buildings) but lower pressure is desirable during the night to avoid bursts.
IMPORTANT REMARK:

- In LEMESOS there was a reduction in the volume of the water produced in 2007 compared to 2006 equal to 550,000 m³ (3.9% of the total) or a financial saving of €424,000.
  The overall expenditure to achieve the above reduction was approximately €320,000 over 4 years (2002-2006).

- In EYDAP there was a considerable reduction in the produced volume of treated water in 2009 compared to 2008, equal to 12,400,000 m³ (2.6% of the total) or a financial saving of €9,920,000.
  The overall expenditure to achieve the above reduction was approximately €1,000,000 over 3 years (2007-2009).
Thank you for your kind attention

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