Introduction to Pressure Management

Presented by:
Ronnie McKenzie & Niel Meyer,
(ronnie@wrp.co.za and nielm@wrp.co.za)
14 May 2020

Connection Burst

Photo: Courtesy Niel Meyer
4 Main Components of Burst and Background Estimate (BABE) Methodology

- Pressure Management
- Logging and Analysis of Minimum Night Flows
- Water Auditing and Benchmarking of Leakage
- Economics of active leakage control
High Pressure

Pressure variation during peak demand periods

Photo: Courtesy Ken Brothers
Pressure variation during low demand periods

1. Just upstream of PRV
2. Just downstream of PRV
3. At critical point

Pressure Reducing Valve

PRV

20 = pressure in m

Fixed outlet Control

Zone Inlet

Critical Point
Effect of maximum pressure on burst frequency

A concept to explain why different reticulation systems react differently to pressure changes. Systems with steel and iron pipes tend to have fixed area leaks while systems with plastic and asbestos cement pipes tend to have variable area leaks.

Fixed Area Variable Area Discharges (FAVAD)

- A concept to explain why different reticulation systems react differently to pressure changes.
- Systems with steel and iron pipes tend to have fixed area leaks while systems with plastic and asbestos cement pipes tend to have variable area leaks.
Influence of pressure on existing reticulation leakage

<table>
<thead>
<tr>
<th>Pressure (m)</th>
<th>Leakage Index</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Steel System</td>
</tr>
<tr>
<td>30</td>
<td>0.77</td>
</tr>
<tr>
<td>50</td>
<td>1.00</td>
</tr>
<tr>
<td>100</td>
<td>1.41</td>
</tr>
<tr>
<td>120</td>
<td>1.55</td>
</tr>
</tbody>
</table>

How can we reduce leakage through Pressure Management?
Pressure Drop through Orifice Plate

**PLUS**
- + Cheap to install
- + Robust
- + Easy to understand

**MINUS**
- - Cannot regulate
- - Only works at 1 flow rate

Pressure Drop through Partially opened Gate Valve

**PLUS**
- + Cheap to install
- + Easy to understand

**MINUS**
- - Difficult to regulate
- - Designed to be fully open or closed
- - Cavitates when partially open
Basic principle of PRV

Pressure reducing valve

Pressure Reducing Valves (PRVs)
Dorot S-300 series

Cover (Bonnet)
Diaphragm Assembly
Seal Disc
Seat
Valve Body

Graphic Courtesy Dorot

Bermad 700 series

Cover/
(Bonnet)
Diaphragm
Seal Disc
Seat
Valve Body

Graphic Courtesy Bermad / Macsteel
Pressure Pilot Valve – CLA-VAL
Pressure Reducing (2-Way)

Pressure Modulation Options

- Fixed Outlet PRV’s
- Time Control PRV’s
- Flow Modulated PRV’s
- Closed and Intelligent Loop Control
Controller selection

- Time or flow control
- Closed loop
- “self learning” smarter control
- Ease of programmability
- Compatibility with meter and PRV
- Technical support
- Robustness and security

Controller selection (Cont)

- Submersible design (IP68)
- Fully open or closed failure
- Cost
- Remote communications (GSM, telemetry, radio, etc)
- Programming/management software and hardware requirements
Fixed Outlet PRVs

- PRV is set to control a constant pressure at the PRV outlet (zone inlet)
- Simple to set up and maintain
- Allows diurnal variation at the critical point
- Must be set to the pressure required at peak demand
- Allows excess pressure at night
Conventional PRV

Pressure at Zone Inlet Point

Pressure at Critical Point

Inlet
Pressure reducing valve

Outlet
District load

Extemity

Fixed Outlet PRV

Pressure (m)

Flow (m/hr)

0 2 4 6 8 10 12 14 16 18 20 22 24

Time (hours)

Zone Inflow
Inlet Pressure
Pressure at Critical Point
Minimum Acceptable Pressure
Excess pressure at critical point
Time Modulated PRVs

• Provides a fixed time-variable PRV outlet pressure profile

• Removes excess pressure at night

• Increased leakage reduction over fixed outlet PRVs

• Cannot adapt to intermittent events, fire flows etc.
Time Modulating Controller

Pressure Management
Programming controller
**Flow Modulated PRVs**

- Provides a variable PRV outlet pressure dependent upon system demand (flow through PRV) - can cope with intermittent events
- Provides a relatively constant pressure at critical point BUT not straight line performance
- Greatest leakage reduction performance
- Higher cost of setting up and maintaining
Flow Modulating PRV Control

Flow Modulated Controller with PRV and Meter
Typical Flow Modulated Controller Installation

Photograph courtesy of Technolog UK / Pressure Management Services
Closed Loop Pressure Control

PRV's with hydraulic flow modulation

Graphics courtesy Bermad, Cla-Val, Dorot
Khayelitsha

- ± 70 000 stands
- ± 110 000 households
- Average pressure 60m to 80m
- Over 450 000 residents
Hourly: Savings = 1000 m$^3$/hr

Olympic swimming pool every 2 hours
Mitchell’s Plain Advanced Pressure Management Installation
Sebokeng Performance Based PPP based on Advanced Pressure Management
In 2005 the area had:
- Approximately 500,000 residents
- Average pressure 30m to 60 m
- Most taps and toilets were leaking
- Approximately 80% sewage return flows
- Less than 5% cost recovery
- Annual water use ± 34 million m³/yr
- Annual water cost ± R 90 million m³/yr

Minimum Night Flow = 2,800 m³/hr

2 Olympic sized swimming pools every hour
Actual Savings for 60 Months

<table>
<thead>
<tr>
<th>Year</th>
<th>Water Use</th>
<th>Saving</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Expected</td>
<td>Actual</td>
</tr>
<tr>
<td>Months 1 to 6</td>
<td>18,721,000</td>
<td>14,614,000</td>
</tr>
<tr>
<td>Months 7 to 12</td>
<td>18,751,000</td>
<td>12,785,930</td>
</tr>
<tr>
<td>Months 13 to 18</td>
<td>19,403,000</td>
<td>13,886,451</td>
</tr>
<tr>
<td>Months 19 to 24</td>
<td>19,423,000</td>
<td>13,877,370</td>
</tr>
<tr>
<td>Months 25 to 30</td>
<td>20,086,000</td>
<td>15,269,040</td>
</tr>
<tr>
<td>Months 31 to 36</td>
<td>20,206,000</td>
<td>15,633,163</td>
</tr>
<tr>
<td>Months 37 to 42</td>
<td>20,766,000</td>
<td>15,870,850</td>
</tr>
<tr>
<td>Months 43 to 48</td>
<td>20,766,000</td>
<td>15,692,825</td>
</tr>
<tr>
<td>Months 49 to 54</td>
<td>21,452,000</td>
<td>16,479,970</td>
</tr>
<tr>
<td>Months 55 to 60</td>
<td>21,438,000</td>
<td>16,874,423</td>
</tr>
<tr>
<td>Total Months 1 to 60</td>
<td>201,015,000</td>
<td>150,984,012</td>
</tr>
</tbody>
</table>
Hourly: Savings = 1000 m³/hr

Olympic swimming pool every 2 hours

Fixed vs Modulated Pressure Control Case Study
Case Study 1 - Eersteriver

Eersteriver Pressure

Eersteriver Inlet

Eersteriver Critical Point

Eersteriver Pressure - Pre Pressure Management

Pressure (m)

Time

2009/07/08 00:00 2009/07/09 00:00 2009/07/10 00:00 2009/07/11 00:00 2009/07/12 00:00 2009/07/13 00:00 2009/07/14 00:00 2009/07/15 00:00
Eersteriver Inlet Flow – Pre Pressure Management

Okiep Supply Point Flow

Max Flow = 397m³/h
Avg Flow = 265m³/h
MNF = 158.3m³/h
MNF / Avg = 60%

Eersteriver Inlet Pressure – Fixed Outlet

Eersteriver Pressure

PRV Up-Stream Press

PRV Downstream Press
Langa CP Pressure - Time Control

Langa CP Pressures - Post Commissioning of Controllers

Pressure (m)

Time

2010/05/06 00:00 2010/05/07 00:00 2010/05/08 00:00 2010/05/09 00:00 2010/05/10 00:00 2010/05/11 00:00 2010/05/12 00:00

First Commercial Pressure Reducing Valve, 1876

Graphic Courtesy Watts Industries
There’s no life without water!