A decision support framework for proactive maintenance of water and wastewater systems: Operational optimisation study

World Water Congress, Edinburgh
27 May 2015

Kamila Nieradzinska1, Christos Tachtatzis1, Robert Atkinson1, Jakub Konka1, Alison Cleary1, Amar Seeam1, Lina Stankovic1, Ivan Andonovic1, Robert White2, Mark Haffey2

1Centre for Intelligent Dynamic Communications, Department of Electronic and Electrical Engineering, University of Strathclyde, Glasgow G1 1XW, Scotland, UK
2Scottish Water, 6 Castle Drive, Carnegie Campus, Dunfermline, Fife, KY11 8GG, Scotland, UK
Overview

• Monitoring of pumps and station performance

• How to tell if a pump is operating at its most efficient?
  − Can modifications be made?

• Optimisation of operational parameters
Site under examination

- Large wastewater pump station
- Three pumps
  - Duty, standby and spare
  - Switched on based on well level
- How can we optimise the pump operation regime?
  - Cost saving and load-distribution
  - Balance the risk of overflow with efficient use of pumps
Pumps

- Same make and model, different age
- Fixed speed
- Fixed power
  - Ideally - same flow and power drawn
- But…performance dependent on wet well level, and which other pumps are running
Station schematic
Visualising the raw data for each pump

Trips and faults overlaid
Cumulative Distribution Functions for flow rate analysis
CDF of flow rates for all pumps

Cumulative probability likelihood that a pump flow rate will be under 30 l/s is ~30%
Wide distribution of flow
Operating pump combinations
CDF of flow rates for pump 1 vs other pumps
CDF of flow rates for pump 2 vs other pumps
CDF of flow rates for pump 3 vs other pumps
How many pumps should be used?

Site load power is divided into periods where pump 1, 2, 3 are working in isolation and combinations of 1, 2, 3 pumps.
Efficiency measures – making the best use of available pumps
Power drawn for different combinations of pumps

<table>
<thead>
<tr>
<th>Pump</th>
<th>Power drawn (kW)</th>
<th>Pump flow (l/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Summary

- Individual ‘identical’ pumps do not exhibit identical behaviour
- Efficiency can vary widely depending on exact operation conditions
- Operational optimisation possible
  - pump selection and switch-on conditions