Best practice in monitoring process, operation and maintenance of wastewater treatment plants
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Plan

- Safety
- Achieving compliance
- Minimise energy use and operating costs
- Maintenance
- Future trends
Health & safety

• Training
• Personal Protective Equipment
• Wash facilities, inoculations
• Gas monitors
• Harness & rails
• Single man working technology
• Visitors
Achieving compliance
Main compliance issues

• Urban Waste Water Treatment Directive and Water Framework Directive conditions:
  • Treated wastewater parameters, Biochemical Oxygen Demand (BOD), Suspended Solids (SS), Ammonia (NH3), Total Phosphorous (P), Total Nitrogen (N)
  • Discharge under storm conditions
  • UltraViolet (UV) disinfection
• ‘Lighter touch’ regulation – process-based controls
Stormwater and works flow

- Flowmetering essential to compliant operation:
  - > 3 dry weather flows (DWF) to storm tanks
  - >6 DWF to the watercourse after screening to 6 mm
- Open channel ultrasonic and electromagnetic (EM) used
- EM is better, but standard types require full pipe
- Open channel most common
Works flowmeter - maintenance

- Electromagnetic meters:
  - At least annual clean
  - Calibration 2-5 year intervals
- Open channel meters:
  - Frequent cleaning of flow structure (flume) channel
  - Monthly calibration check of level meter
- Good practice:
  - Make path as short as possible
  - Temperature sensor needs to be shaded from direct sunlight, fit shade if necessary
Primary settlement

- Desludging mostly timer-driven
- Sludge blanket level tested manually and timing adjusted, avoid septicity
- Periodic manual analysis of sludge dry solids
Activated sludge plants DO control

- Most plants use fixed Dissolved Oxygen (DO) set points, typically 1.5 – 2 milligrams/litre (mg/l)
- Periodic checks on DO profile across tank, and to check DO probe location is optimal
- Move to optical DO instruments – improved stability
Biomass management

- Good treatment needs a healthy biomass – regular checks
- Need to measure:
  - mixed liquor suspended solids (MLSS),
  - returned activated sludge (RAS) solids
  - stirred specific volume index (SSVI)
  - RAS flow
- Microscopy, respirometry
Secondary treatment – biological filters

• For hydraulically driven filter arms, fit rotation monitors to prevent loss of treatment from blockages

• Use recirculation to:
  • Maintain filter activity during low flows
  • Boost treatment for high loads
### Final settlement and final effluent

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Format</th>
<th>Comments</th>
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<tbody>
<tr>
<td>Ammonia</td>
<td>Analyser or test kit</td>
<td>Ammonium probe not used</td>
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<tr>
<td>Orthophosphate</td>
<td>Analyser or test kit</td>
<td>Not many analysers installed</td>
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<tr>
<td>Suspended solids</td>
<td>Probe or lab analysis</td>
<td>Alarm for unmanned sites Part duplicates blanket level</td>
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<tr>
<td>Chemical Oxygen Demand (COD)</td>
<td>UV absorbance surrogate</td>
<td>Unusual</td>
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</table>
Odour control

• Channels and tanks often covered
• Maintain gas scrubbing systems
• Check achieved flowrates
• Check hydrogen sulphide levels in scrubbed gases
P removal

- Both biological and chemical P removal systems in operation
- Chemical removal more common in UK
- Chemical systems commonly control dosing by using a 24 hour load cycle derived from sampling data.
- The dosing system (usually iron) adds a small excess beyond that required to remove P from the samples.
N removal

• Anoxic zone in activated sludge process
• On large sites advanced control systems can give very large improvements in energy use by optimising aeration – requires ammonia and nitrate instruments
Minimise energy use and costs
Energy input/output in wastewater treatment

Incoming wastewater

Primary Settlement Tanks

Energy

Anaerobic treatment

Aerobic treatment

Energy
Primary settlement

• Run sludge blanket as high as possible
• Some interest in using ram pumps to guarantee pumping of thick sludges
• Some use of chemical dosing to enhance settlement for high loads
Secondary treatment - activated sludge process

- Typically 50-70% of site energy use
- Install sub-metering
- Carry out periodic overall efficiency measurements. Target values: 1.5 kilograms O\textsubscript{2}/kilowatt hour (kWh) for surface aeration, 2.5 kgO\textsubscript{2}/kWh for fine bubble diffused aeration
- Use Variable Speed Drives (VSD) rather than throttling flows to control aeration
- Minimise necessary biomass to treat full load to avoid aerating excess sludge
Activated sludge process control systems

- For simple feedback DO control:
  - minimise DO set point(s)
  - understand DO profile in tank, avoid over aeration
- For plants >200,000 population equivalent consider advanced control system (Kruger, Hach-Lange, Perceptive Engineering, active in UK)
Sludge treatment

- Maximise biogas production:
  - Monitor digester temperature control and mixing
  - New processes
  - Co-digestion with other wastes

- Minimise disposal costs:
  - Dewatering chemical costs
  - For land disposal, balance of drying costs against transport costs, and acceptability of product
  - Incineration often used
Polymer dose automation

- Cost savings on polymer for dewatering by centrifuge:
  - Measure sludge flow and dry solids concentration
  - Calculate optimum dose
  - Good where sludge feed quality is consistent, avoids high cost of overdosing polymer
- Key is the use of an optical sludge solids probe which performs well on a range of sludges
Sewage pumps

For pumps >15 kW consider replacement after 4 years life.

Table shows optimum **full** refurbishment times for different hours run per year

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<th>Power /kW</th>
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<tr>
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<td>20</td>
<td>3</td>
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Electricity costs

- Site performance judged from monthly meter readings as well as treatment performance
- UK electricity costs can be 3-5x higher at peak times
- Efforts made to reduce power consumption during high tariff periods, typically 16.30 – 1900.
- Further investment in combined heat and power (CHP)
Maintenance
Maintenance

• UK drive is to reduce manpower to absolute minimum
• Instrumentation uses cleaning systems to extend maintenance intervals > 1 month
• All but largest sites maintained by visiting teams
• Visit frequency varies from daily to every 2 weeks
• Supervisory Control and Data Acquisition (SCADA) and alarm systems and telemetry to 24/7 control centres, used to bring staff to deal with problems
Screens, grit removal

- Any problems, including shortfall in capacity, in the screens and grit removal will cause downstream problems
- Need effective alarms for blockages, high levels, machine failures
- Need for regular visual inspection, cleaning and greasing
Settlement tanks

• Regular sweeping of channels
• Ensure scrapers and scum removal in good order
• Periodic drain down and cleaning
Secondary treatment – activated sludge

- DO probes still need careful cleaning, weekly is good practice, monthly calibration check
- Regular cleaning of diffusers/membranes and replace when pressure loss excessive
- Check pressure drop across air filter, replace when pressure loss excessive
- Inspect tank surface patterns for signs of blocked/damaged diffusers
- Maintain blowers, often supplier contract
Secondary treatment – biological filters

• Regular cleaning of distribution arms and nozzles
• Periodic clearing of moss and other growths from media
• Emptying of COPA sacks where used on siphon/distribution chambers
Condition monitoring

• Vibration sensors for machines above 40 kW rating to warn of approaching failure
• Periodic oil analysis for CHP engines, standby generator engines, gearboxes on screw pumps, aerators, blowers

Photo courtesy of South West water
Future trends

- Recognition that better wastewater treatment costs carbon – need to maximise benefits
- Move towards whole catchment operation:
  - Rainfall prediction
  - Active control of pumping stations
  - Varying wastewater treatment according to demand and receiving water status
  - Feed forward control of sewage treatment from sewer network models
  - Minimise overall impact of discharges across the catchment – controllable Combined Sewer Overflow (CSO) discharges
Questions