



# **Best practice in monitoring process, operation and maintenance of wastewater treatment plants 12 September 2011, Bucharest**

**Steve Russell WRc PLC Swindon UK**  
**[Steve.russell@wrcplc.co.uk](mailto:Steve.russell@wrcplc.co.uk)**

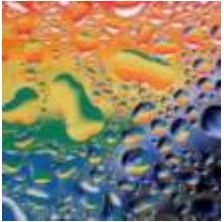




# Plan



- 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



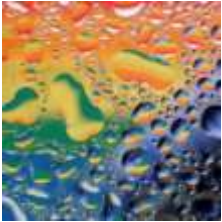


# Achieving compliance





# Main compliance issues



- Urban Waste Water Treatment Directive and Water Framework Directive conditions :
  - Treated wastewater parameters, Biochemical Oxygen Demand (BOD), Suspended Solids(SS), Ammonia (NH<sub>3</sub>), 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

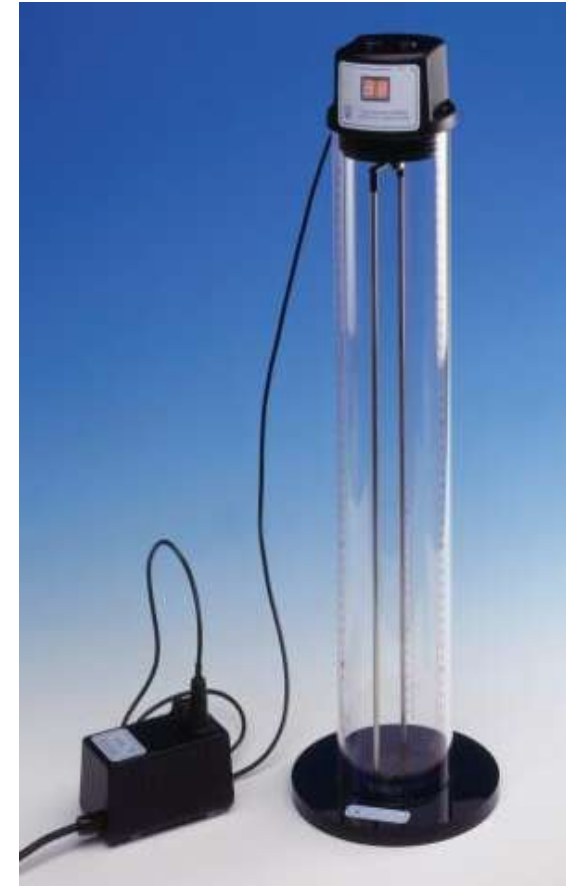
- Most plants use fixed Dissolved Oxygen (DO) set points, typically 1.5 – 2 milligrams/litre (mg/l)
- Periodic checks on DO profile across tank, and to check DO probe location is optimal
- Move to optical DO instruments – improved stability



# 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

Parameter	Format	Comments
Ammonia	Analyser or test kit	Ammonium probe not used
Orthophosphate	Analyser or test kit	Not many analysers installed
Suspended solids	Probe or lab analysis	Alarm for unmanned sites Part duplicates blanket level
Chemical Oxygen Demand (COD)	UV absorbance surrogate	Unusual



# Odour control

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



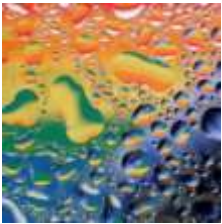




# P removal



- 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.

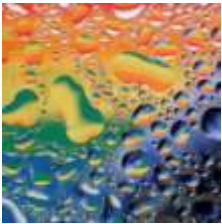




# N removal



- 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

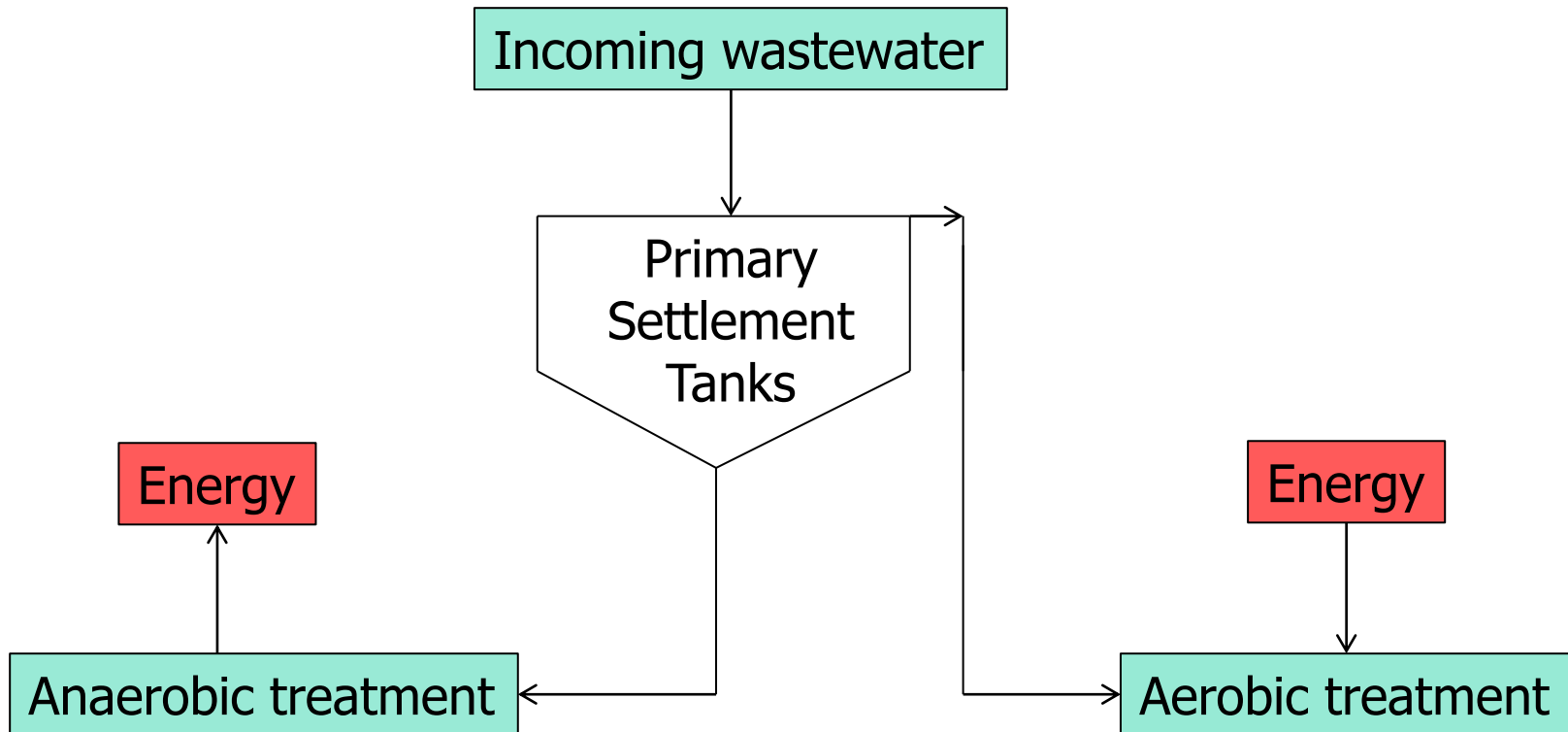




# Minimise energy use and costs



# Energy input/output in wastewater treatment



# 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<sub>2</sub>/kilowatt hour (kWh) for surface aeration, 2.5 kgO<sub>2</sub>/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



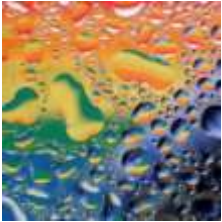
# Activated sludge process control systems

- 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

Power /kW	Planning horizon/ years	2000 hours	3000 hours	4000 hours
20	10	5	2	2
40	15	4	2	1
60	15	3	2	1
80	15	3	2	1
100	15	3	2	1
150	20	3	2	1
200	20	3	2	1
400	20	3	2	1
1000	20	3	2	1
1500	20	3	2	1





# 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)



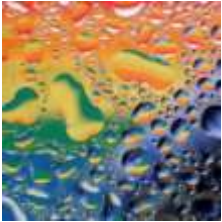


# Maintenance





# 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

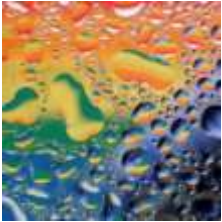
- Vibration sensors for machines above 40 kW rating to warn of approaching failure
- Periodic oil analysis for CHP engines, standby generator engines, gearboxes on screw pumps, aerators, blowers



*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

