Wastewater Treatment Optimisation Provides Cost Savings

The operators of wastewater treatment plants constantly seek new opportunities to improve plant efficiency and environmental performance. In order to achieve this they need to be able to maintain the effectiveness of the treatment process, producing a consistent discharge within consent limits, whilst minimising inputs such as energy, labour and raw materials.

As technology advances new opportunities materialise and this article will outline the considerable benefits that can be obtained from the latest sensors coupled with a new breed of real-time controllers. Improvements in the accuracy and reliability of sensors, coupled with a new facility providing information about the sensors' performance, in addition to the measurement itself, means that real-time control (RTC) has become very reliable which means that it has become an attractive option in a large number of applications.

HACH LANGE has developed a set of standardised control modules, enabling the application of processes improvements and optimisation strategies without the need for complex programming and expensive customisation.

In combination with HACH LANGE sensors, Nutrient Removal and Sludge Treatment Processes can now be easily optimised in order to achieve savings in aeration energy and chemical consumption, even on small waste water treatment facilities.

RTC Opportunities

Stand-alone wastewater treatment optimisation solutions (WTOS) control modules are now available to optimise individual treatment processes at treatment plants. These can be easily integrated into an existing plant structure and currently include (1) the chemical elimination of phosphorus and (2) dissolved oxygen adjustment according to the actual NH4-N load in an aeration tank. Control modules for sludge management as sludge retention time controller or desludging controller will be added in the near future.

In addition to the stand-alone modules mentioned above, it is also possible to combine different RTC modules to optimise an entire plant, as outlined in the trial below. Termed an 'enterprise solution' this activity involves a review of the plant as a whole and the creation of customised specifications for the application of different control modules for nitrification, sludge retention time, methanol dosing, and/or chemical phosphate removal to achieve the best overall performance.

Sensor Technology

In recent years, improvements in sensor technology have focused on greater resolution and accuracy in combination with longer intervals between calibration or service. However, in order for an RTC system to operate effectively it is also necessary for sensors and analysers to be able to provide information on the quality of the signal and the service status.

HACH LANGE has filed a patent application for this facility under the brand name 'PROGNOSYS'. This provides the RTC control modules with a continuous indication of a sensor's status so that if pre-determined conditions occur (sensor failure, outside calibration, service overdue, drift etc) the RTC automatically adopts an alternative control strategy, which might be a typical weekly and diurnal flow profile that has been stored in the system's memory.

Stand-Alone RTC Example: Chemical Phosphate Removal

As outlined above, the measurement technology for phosphate has advanced considerably in recent years in tandem with a reduction in capital and operational costs. As a result, an easy to integrate RTC module in the phosphate removal process can deliver pay back periods of less than one year.

The measurement of phosphate levels in combination with an RTC system can be utilised to manage the dosing of precipitant salts. This precipitates the phosphate and facilitates sedimentation and removal. Accurate continuous monitoring is necessary to ensure that (a) sufficient dosing is applied to remove the phosphate and (b) excessive dosing does not take place. Over-dosing would be undesirable on three counts; firstly, from an environmental perspective the objective is to minimise the amount of iron being added that could remain in the effluent; secondly, ferric sulphate is expensive and excessive dosing would be costly; thirdly the amount of precipitation sludge should be kept to a minimum because sludge disposal can represent a significant cost.

A unique feature of the RTC system is the continuous automatic calculation of the 'ß' value (overdosing rate), which is required to calculate the right amount of precipitant dosing for open loop control. The calculated ß-value takes into account the percentage of

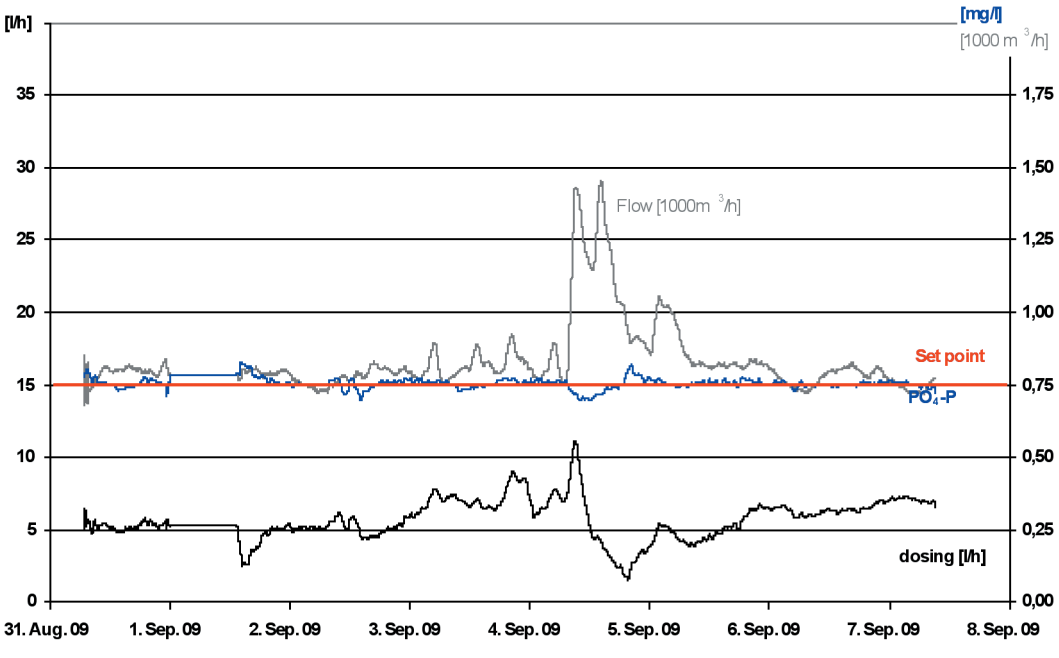

Figure 1: Example for Stand Alone P-RTC performance

RTC Control and display unit

phosphate which has to be removed. The less phosphate there is; the more difficult removal becomes and the more precipitant is required to eliminate the same amount. For example, more precipitant is required to lower phosphate concentrations from 4 to 2 mg/l than from 6 to 4 mg/l.

Wastewater treatment plants operating an open loop real time control system for phosphate removal have demonstrated considerable savings – a UK works has saved approximately 37% of the ferric sulphate cost and 57% of caustic chemical costs and a plant in Italy has shown 50% cost savings in comparison with a constant dosing system, which represents a 7 month payback.

If closed loop control is applied, the RTC system requires a measurement of phosphate levels immediately after dosing. As a result, the Phosphate concentration can be held at a fixed desired level and the control performance is monitored as indicated in figure 1.

UK RTC Trial – Activated Sludge Process Control

The results of a trial investigating the benefits of an RTC system on the management of the activated sludge process (ASP) have been published by Thornton, Sunner and Haeck.[1]

Managed by MWH UK Ltd and employing monitoring instruments from HACH LANGE, the trial employed online sensors and control

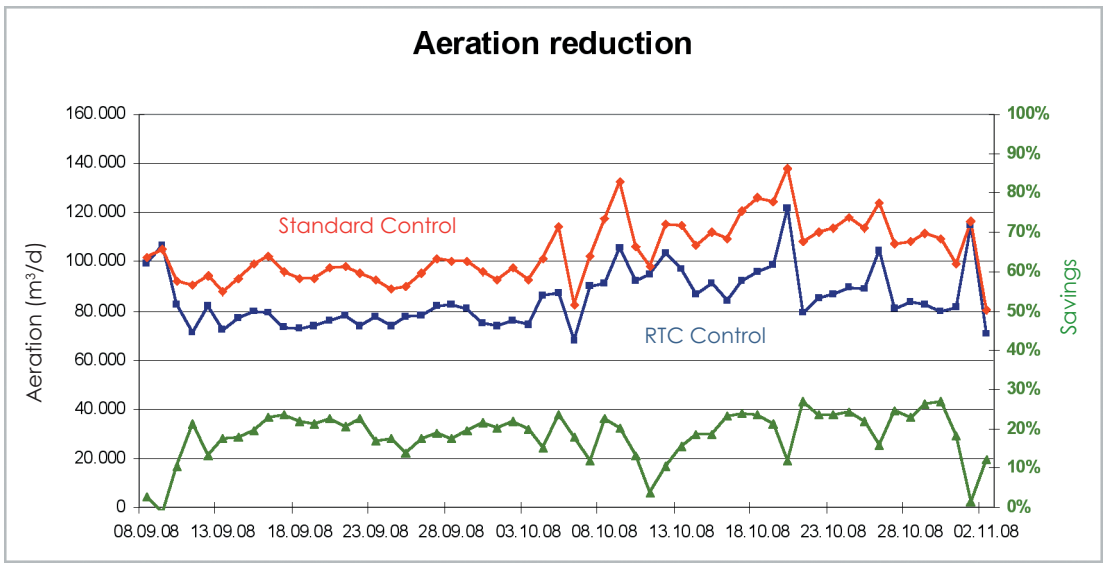

Figure 2: RTC savings

algorithms to optimise the operation of the ASP, leading to greater efficiency and sustainability. Undertaken at full scale, the trial assessed the benefits of RTC at a 250,000 population equivalent (PE) works in the UK and consisted of two identical ASPs (each with four lanes) configured as a 4-stage Bardenpho plant with methanol addition in the secondary anoxic zone.

Standard aeration lanes (fixed DO set-points with fluctuating NH4 effluent concentration) were compared with lanes running an RTC system operating variable DO set-points based on actual load. The RTC lanes deployed extra sensors for dissolved oxygen, ammonium and nitrate.

The trial demonstrated that the RTC system was able to respond quickly to ammonium influent spikes and to maintain a stable effluent ammonium level. The trial also demonstrated that the RTC system was able to reduce methanol consumption by 50% and energy (measured as air flow) by 20% (figure 2). The system has now operated successfully for more than one year.

Summary

The HACH LANGE optimisation system combines process measurement technology with advanced RTC control modules to provide substantial savings in operational costs at wastewater treatment plants, whilst maintaining compliance with consent values.

Recent advances in sensors, analysers and controllers mean that wastewater treatment no longer has to be managed on a 'worst case scenario' basis. Processes can now be monitored and adjusted instantaneously to maximise efficiency and improve process stability. Cost reduction is obviously a key benefit, but the ability to reduce energy consumption is becoming an important objective in many countries.

[1] Thornton, Sunner and Haeck, 2010. Real time control for reduced aeration and chemical consumption: a full scale study. Water Sci. Technol.61, 2169–2175

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