Respirometry provides full-scale control

On-line respirometry has been shown to be an effective means of controlling aeration of an oxidation ditch to ensure strict effluent standards can be met. By Hans Draaijer, Annette Buunen **and** Johan van Dijk.

Strict new standards in the Netherlands mean that from next year, in principle at least, water authorities have to achieve a 75% reduction in the nitrogen load of their sewage treatment plants. This means a large number of plants will have to achieve a yearly average for effluent total nitrogen of less then 10 mg/l.

In order to meet the standards, new control strategies for nitrogen removal are needed and these control strategies may also reduce the costs of extending treatment plants. In such an initiative, the Dutch water authority Hoogheemraadschap van Uitwaterende Sluizen in Hollands Noorderkwartier (USHN) and Grontmij Consulting Engineers tested an on-line respirometer of Minworth Systems at Beemster treatment plant, a 96,300 population equivalent oxidation ditch receiving a dry weather flow of 15,000 m^3/day.

The on-line respirometer measures the Oxygen Uptake Rate (OUR) of the biomass and is located in the oxidation ditch itself, so there is no question as to whether the biomass being measured is that of the plant itself and under the same environmental conditions.

The reactor vessel, which is controlled pneumatically, is a plastic ball that floats in the biomass. An oxygen probe in the reactor vessel measures the increase and decrease of oxygen in the aeration and depletion cycle. Using multiple reaerations on a single sample, a typical OUR curve for nitrifying activated sludge can be created (see Figure 1).

The area under the curve (AUC) is calculated automatically by software (AUC=A+B+C) and represents the amount of oxygen required to oxidize less readily biologically oxidizable carbonaceous material and ammoniacal nitrogen. The total area under the curve (TAUC: area D in Figure 1) represents the amount of oxygen required to obtain complete treatment (including endogeneous respiration). 'T' is the time that is required in order to achieve endogeneous respiration.

The experiment at the Beemster plant comprised three elements:

- testing of the respirometer
- development of a control strategy for nitrogen removal using respirometry
- full-scale testing and optimisation of the developed control strategy

During the first stage of the experiment the respirometer only was used to monitor the treatment plant. Data was also available at the plant from on-line ammonia, nitrate and phosphate analyzers. The AUC results showed a very good correlation with the ammonia measured in the oxidation ditch so it was concluded that the data generated by the respirometer could be used for control.

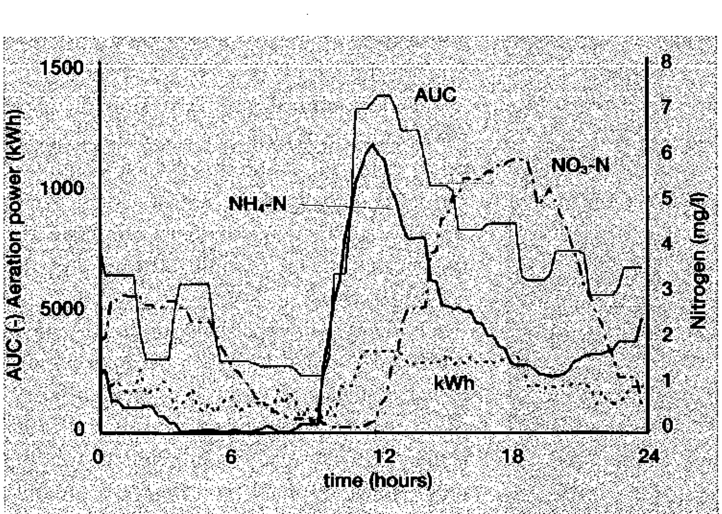


Fig. 2. Results of the control strategy

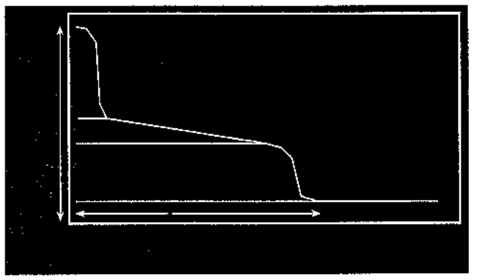
The respirometer also proved to be a reliable instrument, and its operational costs are low when compared to other on-line analyzers.

In the next stage of the experiment an aeration control strategy was used based on the data from the respirometer alone, with the AUC used as a direct input for control of the plant. When the AUC increased, the amount of aeration was automatically increased by turning on more aerators. When the AUC decreased, the amount of aeration was automatically decreased. This showed (see Figure 2) that it is certainly possible to control an oxidation ditch by using a respirometer as the sole control instrument. The figure also shows a good correlation between the AUC and ammonia nitrogen.

On the strength of this short term test it was decided to optimise the control strategy by using dynamic simulation (the last stage of the experiment). For this, Grontmij developed a dynamic model of the respirometer and this was connected to the model of the treatment plant.

During dynamic simulation (based on IAWQ model no.1) the possibility for further

Fig. 1. Typical OUR curve for nitrifying activated sludge



improvement of the system was tested by using two different sets of setpoints, one set for increasing AUC, one set for decreasing AUC. The simulation results showed more stable effluent concentrations for ammonia and nitrate nitrogen. This control strategy was subsequently tested at full-scale by USHN and here also the effluent concentrations in the outlet of the carrousel were more stable, especially in case of peak-loading. ■

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