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# Simple optimisation solutions to control aeration in small WWTPs

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**Abstract:** There are more than 12,000 wastewater treatment plants in Europe, ranging from 2,000 to 10,000 PE. These small plants are often hard to optimise due to site age/configuration and modest ROI. However, their electrical consumption offers great potential for reducing carbon footprint and energy bills.

Hach, with over 15 years of experience, offers 60+ control modules for WWTPs. This expertise is now in the SC4500 controller, enabling small plants to access advanced control solutions, reducing costs and improving treatment visibility.
One SC4500 module controls intermittent aeration in activated sludge plants. This paper presents two RTC-N/DN implementations:

1. ORP and oxygen-based controller: used in 50 Veolia France WWTPs.
2. Ammonium and nitrate-based controller: used in an 8000 PE plant in Germany.

The presentation will detail the solution, its implementation, functionality, and performance.
**Keywords**: optimization; aeration; wastewater

## 1 RTC-N/DN based on redox and oxygen

### 1.1 The solution

The RTC-N/DN Redox on SC4500 optimises aeration in activated sludge plants with intermittent aeration. It calculates the duration of aerobic (nitrification) and anoxic (denitrification) phases based on continuous ORP and oxygen measurements. With a variable frequency drive (VFD) on the aerator, the RTC can also control aerator speed during nitrification.
The SC4500 transmitter (see figure 1.1) serves as the interface for $O_2$ and redox measurements, setting aeration parameters, and communicating sensor and calculated data (aeration start/stop command and speed variation setpoint for VFD aerator) to site equipment. The RTC Redox uses inflection point detection for maximum performance, beyond simple threshold regulation.

**Figure 1.1** RTC-N/DN on SC4500 with associated online measurements

Developed over a year with Hach and Veolia, the product was tested on three plants. In 2023, Veolia Water France decided to deploy it on 50 small plants (2,000 to 5,000 PE) as part of Veolia's green Up plan to reduce environmental impact and electricity consumption.

### 1.2 The results

Once the Eagle-one units are started, a parameter optimisation phase may be needed to fine-tune settings for treatment performance and aeration times. This involves analysing oxygen/redox curves and some ammonium/nitrate lab measurements. The 50 units were installed on sites initially controlled by fixed intervals or simple redox controllers. Savings of 10-15% in electricity consumption for aeration were generally observed, with some sites seeing up to 30% reductions in aeration times.

Table 1.1 shows energy consumption improvements on 3 of the 50 sites. The first two sites used simple redox controllers, while the third used fixed intervals.

**Table 1.1** Examples of energy consumption improvements at different Veolia WWTP

| | Centre-West region WWTP | South-West region WWTP | North region WWTP |
|---|---|---|---|
| **Ratio before RTC-N/DN** | 0.70 kWh/kgCOD | 1.08kWh/kgCOD | 0.54kWh/m$^3$ |
| **Ratio after RTC-N/DN** | 0.45 kWh/kgCOD | 0.87kWh/kgCOD | 0.37kWh/m$^3$ |

The centre-west site, in a tourist area, saw gains of 35% outside summer and 6% during summer. The south-west site reduced its kWh/kgCOD ratio by 20%, with other optimisations like compressor technology changes.

The installation of Eagle-one units also promotes overall optimisation of small facilities, reducing energy consumption through actions like activating frequency variators on boosters, reducing sludge levels, and updating aeration technology.

## 2 RTC-N/DN based on ammonium/nitrate

### 2.1 The solution

The RTC-N/DN, based on ammonium/nitrate, optimizes intermittently aerated zones at activated sludge plants. It calculates the operational time for aerobic and anoxic phases using continuously measured water quality parameters and operation time. The intervals for aerobic (nitrification) and anoxic (denitrification) phases are based on continuously measured ammonium ($NH_4$-N) and nitrate ($NO_3$-N) concentrations. Optionally, the RTC can be combined with a DO controller (DO-RTC) to control oxygen supply with variable speed during nitrification.

In $NH_4/NO_3$ mode, the RTC-N/DN adjusts the time intervals for nitrification and denitrification phases to reach $NH_4$ and $NO_3$ target values, as illustrated in figure 2.1. The DO setpoint for nitrification is calculated based on the $NH_4$ concentration measured at the beginning of the nitrification phase.

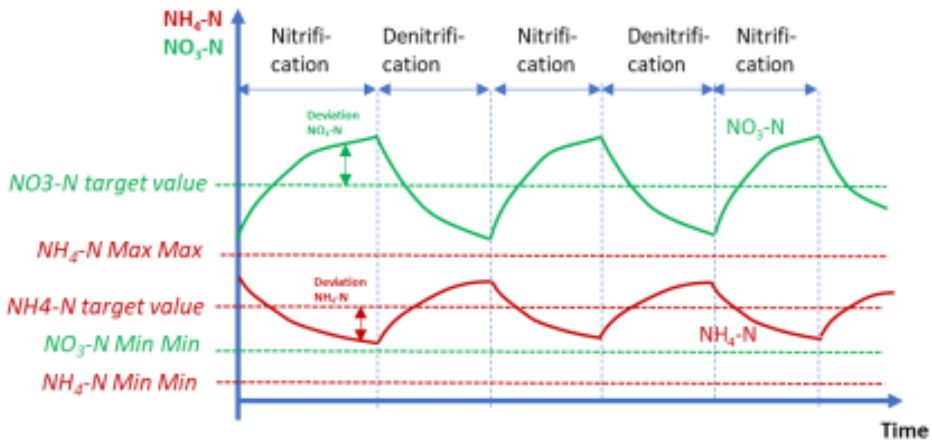


**Figure 2.1** RTC-N/DN : theory of operation

A 8.000PE plant in Germany has chosen this solution to optimize energy consumption and secure treatment performances. Aeration was initially controlled on time (1 hour aeration on, 1 hour aeration off).

The technology chosen for ammonium and nitrate measurements is the AN-ISE sensor. This sensor carries out continuously direct measurements using an ion-selective electrode which do not request any reagent or sample preparation.

### 2.2 The results

The implementation of the RTC-N/DN ammonium nitrate at this 8000 PE wastewater treatment plant in Germany has led to more stable effluent quality. One of the key benefits observed is a 15% reduction in aeration times, which directly contributes to lower energy consumption. Additionally, other optimizations, such as the renewal of diffusers and the replacement of turbo blowers, have been carried out in parallel to further reduce electrical energy usage. These improvements not only enhance the plant's operational efficiency but also contribute to more sustainable and cost-effective wastewater treatment processes.

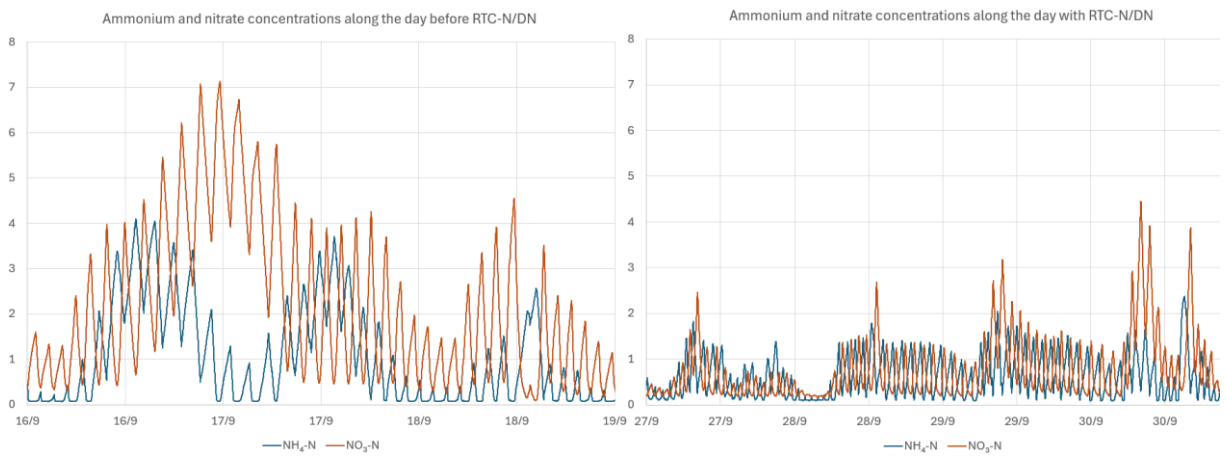


**Figure 2.2** Ammonium and nitrate concentrations along the day before and after RTC implementation

## 3 Conclusion

The deployment of RTC-N/DN embedded on SC4500 on small WWTPs is enabling operators to make significant energy savings, at an optimised and limited investment cost, with the added benefit of operational control and peace of mind on sites that are often isolated.

The integration of the algorithms within the measurement transmitters themselves simplifies the implementation of this optimisation. Finally, the modularity and flexibility of its modules means that operators retain total control over processing and performance.