PRACTICE REPORT
PROCESS ANALYSIS
AERATION CONTROL
WITH SC 1000 / AMTAX SC / LDO

Aeration control technology

"When we go home in the evening, we want to feel that we have done a good job for the environment" says Harald Heins, Operations Manager of the sewage treatment plant in Harsefeld (Germany). With **N_{tot} <5 mg/L** and a COD of **30 mg/L** in the outflow, he can go home feeling satisfied. Since the spring of 2007, his **SC 1000**-based **aeration control system** has also reduced the **hours of operation of the** horizontal axis aerators by up to 20 %. "Although we intend to install a process control system in the near future, we will continue to operate this small, functioning unit. Why should we change anything?"

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HACH LANGE

UNITED FOR WATER QUALITY

Optimising the operation of the horizontal axis aerators

Fig. 1: Oxidation ditch with volume of 1,400 m^3

Fig. 2: The new aeration controller saves energy and improves the quality of the outflow

From the start to SC 1000

The sewage treatment plant at Harsefeld went through three construction phases; in 1975, 1988 and 2000. Initially designed for a population equivalent (PE) of 9,000, the water quickly passed through the screens, a circular degritter, an aeration tank and a secondary settlement tank. In 1988, it was expanded to cope with a population equivalent of 16,000, gaining a grit channel, upstream denitrification and another secondary settlement tank. In 2000, the plant reached its current size, acquiring a primary settlement tank, a third secondary settlement tank, a complete sludge treatment phase and a block-type thermal power station. The level of utilisation was 23,000 PE, just below maximum capacity and the aeration controller had almost reached the limits of its capability.

Although the outflow values for ammonium (1–2 mg/L NH_4-N) and nitrate (5–7 mg/L NO_3-N) were sufficiently low, Harald Heins, Operations Manager in Harsefeld, was not satisfied. “In the 13th week of 2007 we started a test. A SC 1000 controller took control of the aeration system, activating the two horizontal axis aerators on the basis of the ammonium and oxygen values in the oxidation ditch. Previously, the first horizontal axis aerator ran continuously and the other was only switched on when the oxygen value was between 0.5 and 1.5 mg/L. Tests with time switches were also unsatisfactory.”

Three relay-contacts

After the new controller started operation, some time was needed to find the correct settings. Today three relay contacts in the SC 1000 controller activate the two horizontal axis aerators and an additional diffused air aeration in the denitrification tank (Fig. 3). One of the relay contacts switches on the two horizontal axis aerators in the oxidation ditch when a value of 1.0 mg/L NH_4-N is reached (and switches them off again at 0.6 mg/L). During the aeration, another relay prevents an excessive increase in the oxygen concentration from occurring by switching off the second horizontal axis aerator at 2.5 mg/L O_2 and allowing the oxygen value to fall to 2.0 mg/L. These switching points can be clearly recognised in the two time-course curves up to 8am, although the actual measured values always go a little beyond the target due to the “bacterial reaction time” (Fig. 4). With clearly increased loading, the ammonium content can no longer be reduced below 1 mg/L NH_4-N even with continuous aeration in the oxidation ditch (Fig. 4, from 9am). The maximum aeration time of 1.5 h is therefore retained,

Harsefeld sewage treatment plant	
Design capacity	23,000 PE
Structure	Screen, grit channel, primary settlement tank, upstream denitrification (1,760 m^3), oxidation ditch (1,400 m^3), three secondary settlement tanks
Inflow values	800–850 mg/L COD Approx. 60 mg/L NH_4-N 11–12 mg/L PO_4-P
Outflow values	30 mg/L COD <1.5 mg/L NH_4-N (>12 °C) 1–3 mg/L NO_3-N (>12 °C) <1.0 mg/L PO_4-P
Reduction in horizontal axis aerator running times	Approx. 20 %

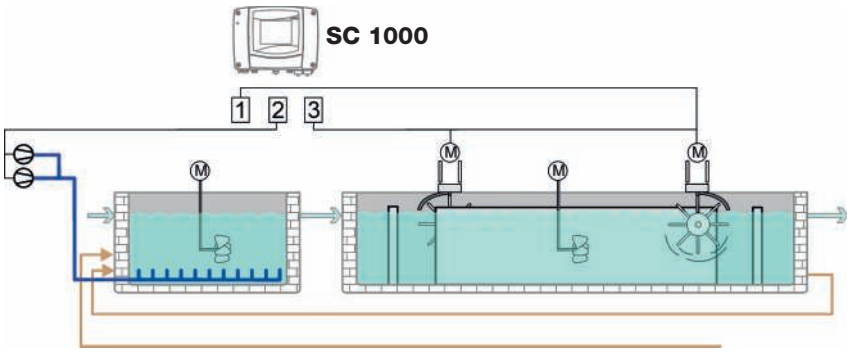

Fig. 3: Diagram of the plant and the SC 1000 relay connections
1 Activation of horizontal axis aerator 2 in the oxidation ditch
2 Activation of diffused air aeration in upstream denitrification
3 Activation of both horizontal axis aerators

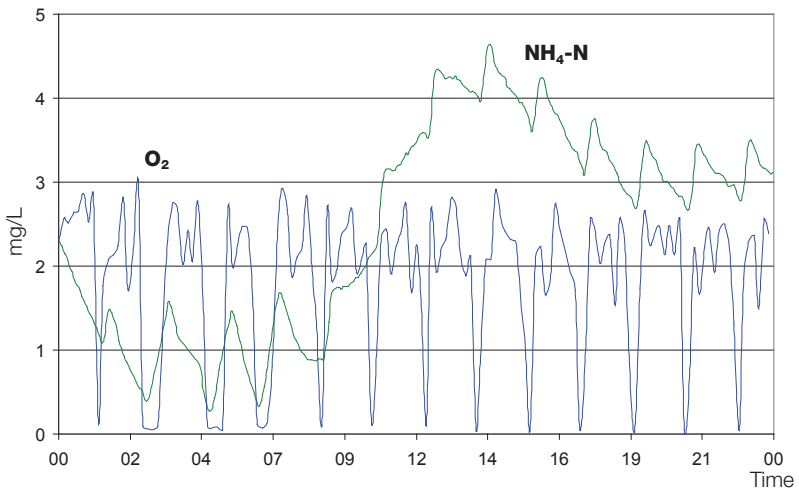

Fig. 4: Typical time-course curve of the 2 point control in the oxidation ditch.

Relay contacts in the SC 1000	
RELAY 1	(mg/L oxygen)
UPPER LIMIT	2,5
LOWER LIMIT	2,0
RELAY 2	(mg/L ammonium)
UPPER LIMIT	2,2
LOWER LIMIT	1,0
RELAY 3	(mg/L ammonium)
UPPER LIMIT	1,0
LOWER LIMIT	0,6

In low-load periods, the ammonium values fluctuate between 0.5 and 1.5 mg/L NH_4-N; only when the load increases are the concentrations higher.
In previous, "non-controlled" times, oxygen values sometimes rose above 5 mg/L; now even the peaks remain below 3 mg/L.

followed by a break of 15 minutes (easily identifiable in the oxygen time-course curve), while a third relay contact ensures that additional nitrification can occur when the NH_4-N concentration reaches 2.2 mg/L: in the denitrification tank, when diffused air aeration is switched on for 15–30 minutes.

Successful strategy

The outflow values of <1.5 mg/L NH_4-N and 1–3 mg/L NO_3-N (at water temperatures of >12 °C) speak for themselves. In addition, the horizontal axis aerator operation times could be reduced by about 20 %, not inconsiderable in the context of the electricity costs, given the power consumption of 30 kW (Fig. 5).

Fig. 6: Controls everything. The SC 1000 digital controller

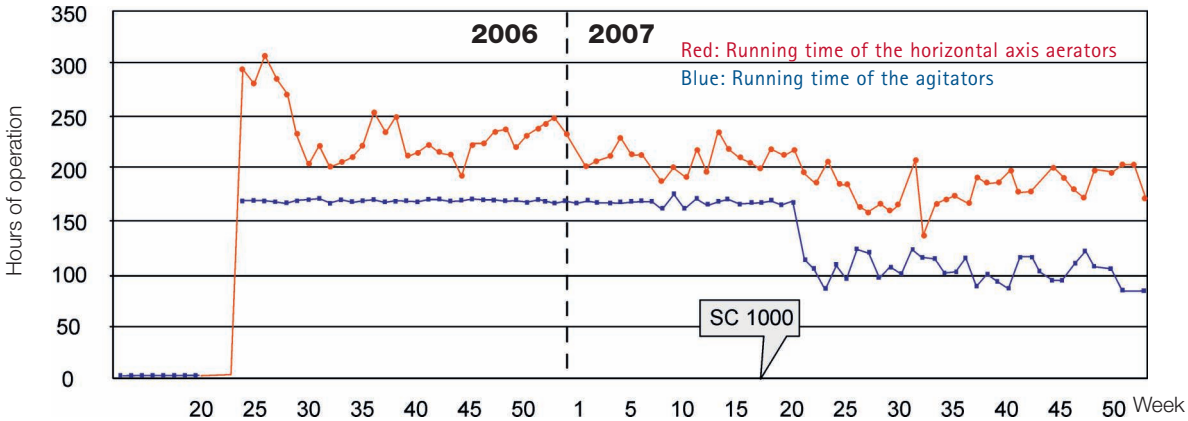

Fig. 5: From week 17/2007, the SC 1000 controller reduced the run time of the horizontal axis aerators and agitators in the oxidation ditch by up to 20 %.

The individual components of the SC 1000 aeration control system

Installed process instruments

AMTAX sc ammonium process photometer

Highly precise process measurement instrument for the continuous determination of the concentration of ammonium. Sample preparation via integrated filter probe. Insulated, weatherproof housing for outdoor or indoor installation. Evaluation and operation via SC 1000 controller. Measurement method: GSE (gas-sensitive electrode); measuring range: 0.05-20 mg/L NH_4-N

ISE ammonium probe with CARTRICAL plus

ISE probe for continuous in-fluid determination of the ammonium concentration (AISE sc) and nitrate concentration (AN-ISE sc). The measurement is carried out using an ion-selective electrode (ISE) with automatic potassium and chloride compensation. Especially easy handling thanks to the CARTRICAL plus sensor cartridge.
Measuring range: 0–1000 mg/L

LDO optical oxygen sensor

Calibration-free sensor for measuring dissolved oxygen by the luminescence method. Digital transmission of measured values to the controller. No interference by H_2S or reducing or oxidising substances. Evaluation and operation via SC 200 or SC 1000 controller. Measuring range: 0-20 mg/L

SC 1000 digital controller

A complete controller system for connecting and operating SC sensors consists of a single SC 1000 display module and one or more SC 1000 probe modules.

Probe module

The probe module can be used to connect up to 8 SC sensors. Several SC 1000 probe modules are connected via the SC 1000 network; field bus capability.

Display module

Portable graphics display module for the operation of the SC 1000 controller system. A SC 1000 probe module is needed to operate and connect the display module. Intuitive user guidance and time-course graphs; service interface, slot for multimedia card (MMC).
Triband data telephone to the GSM standard (GSM900, EGSM900, GSM1800, GSM1900) for remote data transmission and remote operation with built-in antenna. A SIM card (to ISO 7816-3 IC, GSM 11.11) is needed to enable the data telephone to be used. SMS and data services must be available.

AMTAX sc ammonium process photometer

LDO optical oxygen sensor

SC 1000 digital controller

New ammonia probes with sophisticated controllers have enabled staff at United Utilities' Macclesfield wastewater treatment works to ensure that the plant does not exceed its discharge consent. Following installation, the monitoring systems initially generated around 40 alarm texts per day (mostly night!) but significant improvements have now been implemented.

The Macclesfield WwTW is a relatively large plant (PE 87,000) treating industrial and domestic waste from a large area drawn from a network of pipes and drains that extend for hundreds of miles. Historically, the industrial waste influent at the plant has been most problematic, particularly as a result of illegal discharges from unknown sources which have resulted in highly variable ammonia levels that, in April 2007, caused the plant to exceed its discharge consent.

Environmental improvement is fundamentally important to United Utilities; the company recognises that its investment in wastewater treatment is a major contributor to enhancements in river and coastal water quality. So, it is clear that reliable control of discharge quality is extremely important at Macclesfield and for this reason, the site was chosen to trial the benefits of a HACH LANGE monitoring system that is able to issue instantaneous alarms by SMS text message to key UU staff.

Barry Sherwood, Macclesfield's Process Controller, says:
"This site was chosen because of its strategic importance and because we were anxious to gain a higher level of understanding of the ammonia levels throughout the plant."

Barry Sherwood
Process Controller, United Utilities

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