Improved Operating Efficiency with the NH4D sc ISE Ammonium Probe

The idyllic scene in the photo above is deceptive, as the tranquil oxidation ditch of the Rommerskirchen-Villau sewage treatment plant (PE 5,000) could be more sparing with its oxygen transfer. The plant operator, the Erftverband (a wastewater disposer with its headquarters in Bergheim), has therefore decided to improve its operating efficiency. Many other small and medium-sized plants are in a similar situation. Without adequate modern instrumentation, they have very little insight into their treatment processes. The development of more affordable and more simply designed process meters, which require no sample preparation, will make energy savings.

Cost-saving aeration control

The Villau sewage treatment plant is one of 45 plants operated by the Erftverband (total population equivalent 1.1 million). In Villau, the sewage from a population equivalent of about PE 5,000 is treated in two oxidation ditches with rotor aerators and a secondary settlement tank. Weekly control measurements of the most important parameters (ammonium, nitrate, phosphate, etc.) provide periodic insights into the efficiency of the plant's operations. In the past, improvements were mainly carried out on the Erftverband's larger plants. This is understandable, as it enabled the greatest savings to be achieved. Now the focus is increasingly on small to medium-sized plants. However, how is it possible to know which improvements should be targeted, and which measures should be implemented where, in order to achieve these targets? The answer is simple: By looking! In the case of the small plant at Villau, this was done with the help of the new NH4D sc ISE ammonium probe from HACH LANGE. The first task of this ISE (ion-selective electrode) was to show whether purely time based control of the aerators would be sufficient to ensure consistently high degradation performance and economic energy consumption. The actual study was preceded by a reliability test in one of the two oxidation ditches (*Fig. 1 – 3*).

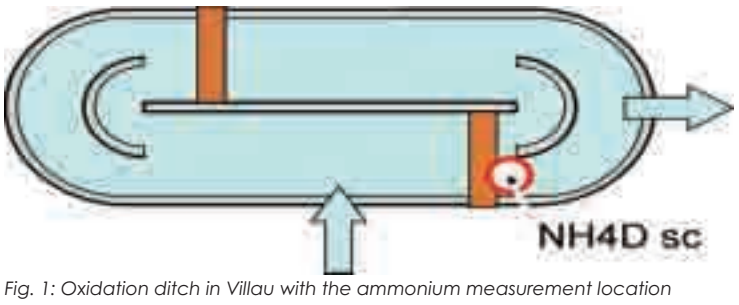

Fig. 1: Oxidation ditch in Villau with the ammonium measurement location

Fig. 2: Installation site of the NH4D sc ISE ammonium probe in the oxidation ditch

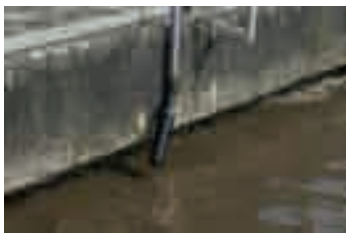

Fig. 3: NH4D sc ISE ammonium probe (above the surface)

In comparison: NH4D sc and AMTAX sc

The ISE ammonium probe was installed next to an AMTAX sc (ammonium process meter with gas-sensitive GSE electrode) and a sample preparation system (filter probe). Over a period of several months it had to demonstrate that it could function reliably and provide accurate measurement results in the tough everyday environment of a sewage treatment plant. *Fig. 4* shows an extract from the two time-course curves that were plotted. Except for a difference of 0.1 – 0.3 mg/l, the agreement between the two NH_4 sensors at this measurement location could hardly be better. With no instrument downtime or meter drift or the associated need to recalibrate. The NH4D sc ISE ammonium probe therefore passed the practical test.

Revealing day curves

In Villau, the aeration is usually switched on for about 45 minutes and then switched off for about 20 minutes. During the aeration phase, a rotor aerator tries to achieve an oxygen concentration of at least 0.8 mg/l for 10 minutes. If it is unsuccessful, a second rotor comes to its aid. Inevitably, on some days the first rotor narrowly fails to achieve the 0.8 mg/l threshold and the second rotor then raises the oxygen content well above the threshold. This situation can be seen in the two diagrams *(Fig. 5 and Fig.* 6), which show the second half-days of 7 and 11 July 2007 (12.00 – 24.00). A much more striking aspect of these two days, however, was that the oxygen transfer occurred irrespective of the actual demand, without any reference to the ammonium values. On 7 July, ammonium concentrations of up to 2.1 mg/l were measured, while the O_2 values scarcely exceeded 1 mg/l. The chance of excessive O_2 consumption occurring in a municipal sewage treatment plant on a Saturday afternoon and evening is remote. Four days later the situation was exactly the opposite; the ammonium concentration was only 0.4 to 0.5 mg/l, while the bacteria enjoyed oxygen concentrations often as high as 1.5 mg/l and sometimes up to 2 mg/l. How could the time based control system have known what the actual demand was? If such unnecessarily high oxygen concentrations are avoided, energy costs inevitably fall.

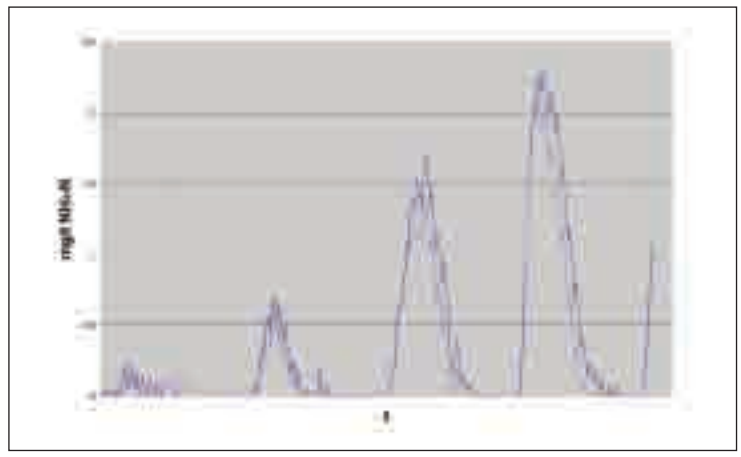

Fig. 4: Comparative measurements with NH4D sc (dark blue) and AMTAX sc (red)

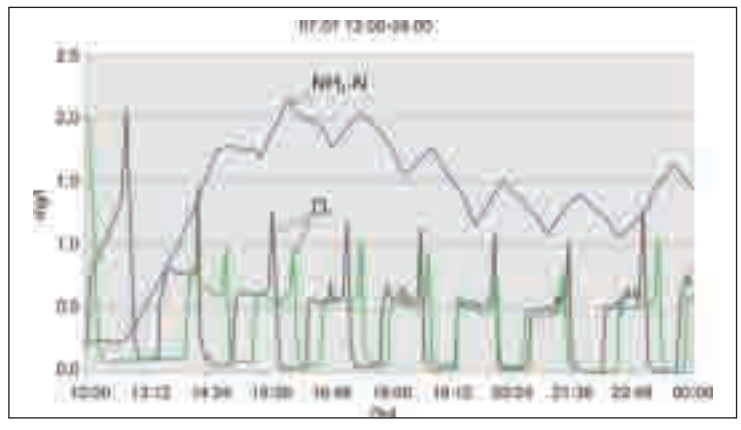

Fig. 5: 12h time-course curves from 7 July showing high ammonium and low oxygen values

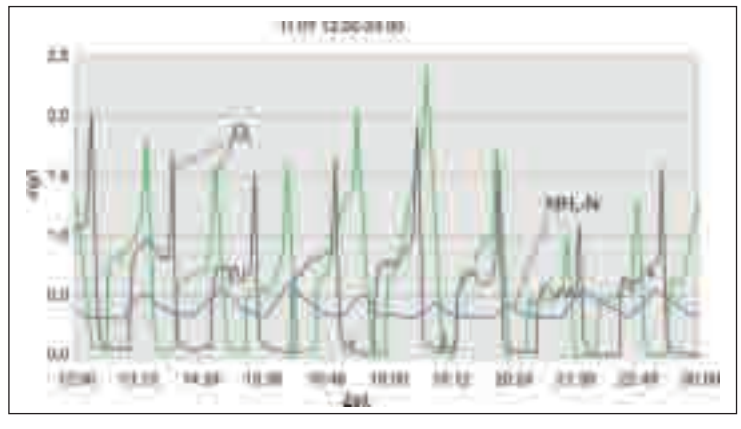

Fig. 6: 12h time-course curves from 11 July showing unnecessarily high energy consumption due to excessive oxygen transfer

A control system based on a NH4D sc probe pays

Control is the future

With the new NH4D sc ISE ammonium probe, the plant control system responds to the real-time situation, continuously, reliably and online. The progress of the NH_4 concentration round the clock can be regarded as the pulse of the plant, which defines the targets for the aeration system. In slack phases, when the ammonium load is low, the oxygen target value for simple COD degradation is set to a minimum. An O_2 concentration of more than 1 mg/l is only necessary when the NH_4 value rises. Unusually wide temperature fluctuations in the transition periods of spring and autumn make continuous measurement data necessary in order to enable the system to respond quickly to changed conditions and "automatically adjust the O_2 target values to the current situation. Ammonium peaks in the outflow are avoidable," says Reinhold Kiesewski, head of process measurement and control technology at the Erftverband. He is also responsible for process optimisation, in an Interview for the H_2O Newsletter (Oct. 2007 issue, see box). "The NH4D sc ISE probe opens up considerable opportunities for cutting costs. It functions even at higher concentrations, with a good recovery rate. The handling is perfect, thanks to the automatic cleaning. The ISE probe makes no work demands on the operations personnel. We will integrate the probe in a new plant control system via SPC."

Installed process instruments

ISE ammonium probe: NH4D sc with CARTRICAL®

Affordable ammonium process probe for use in municipal sewage treatment plants. Ion-selective electrode (ISE); integrated potassium electrode; enclosed cartridge design, patented CARTRICAL® reference system, no electrode poisoning. A soil-insensitive salt bridge reduces cleaning work and prevents dilution of the electrolyte. 0.2 – 100 mg/l NH_4-N; stainless steel; PVDF (Ryton); 350 × 44 mm (length × diameter).

SC 100 controller

Digital controller for two digital sensors; wall, rail or control-panel mounting. Two analogue power outputs, three potential-free changeover switches (5 A 115/230 V AC, 5 A 30 V DC), digital interface for bus connection (ModBus, ProfiBus, LonBus).

Fig. 7: The precalibrated CARTRICAL® sensor cartridge can be changed very quickly.

Fig. 9: Digital SC 100 controller

Fig. 8: The NH4D sc ISE probe with CARTRICAL®

"NH4D sc ISE probe opens up considerable opportunities for cutting costs"

Reinhold Kiesewski, head of process measurement control technology

The Erftverband, a wastewater disposer for a population equivalent (PE) of 1.1 million to the west of the Rhine in Germany, intends to examine potential savings in small sewage treatment plants. One of the affected plants will be Villau (PE 5,000), where the new ISE probe with CARTRICAL® technology from HACH LANGE carries out on-site measurements of NH4-N online. Reinhold Kiesewski, the man responsible for process measurement and control technology and process optimisation, explains why this probe is a worthwhile investment for Villau.

Q: Why do you measure ammonium at Villau?

A: After the technical upgrading of the large plants, the focus in future will be on realising potential savings in small plants with a PE between 2,000 and 10,000. They are now still operating without the benefit of online analysis. "Mini" plants with a PE of 1,000 will be unaffected. The Villau plant has so far been controlled in accordance with the German Self-Monitoring Ordinance. With continuous NH4 monitoring, the NH4 values could be used to ensure that the ideal O2 value corresponding to the outside temperature is maintained automatically when winter sets in. In other words, without waiting until someone reduces the target value a month later.

Q: Where exactly is the ISE probe installed?

A: It has been in operation in the oxidation ditch since the autumn of 2006. The installation and start-up via the SC 1000 controller posed no problems.

Q: How does it function in practice?

A: Since the start-up it has run smoothly; it functions even at higher concentrations, with a good recovery rate. Even the astonishing drop in the potassium value caused by heavy rainfall was compensated. The handling is perfect, thanks especially to the automatic cleaning. The ISE probe makes no work demands on the operations personnel. In view of the wide measuring range up to 1,000 mg/l, I can also see major benefits for operators of large sewage treatment plants in the context of industrial dischargers.

Q: What was the clinching argument for deciding in favour of the NH4D sc?

A: The aim was clear: to identify potential savings. For small sewage treatment plants, of course, that means operating with smaller budgets. By the end of 2007 the outdated relay technology should make way for a SPC switchboard. The integrated NH4D sc ISE probe will then prevent NH4-N peaks in the outflow.

Thank you for talking to us Mr. Kiesewski.

AUTHOR DETAILS

Uwe Karg, Dipl-Ing. Chemie
HACH LANGE Application Process Measurement Technology
HACH LANGE GMBH
Willstätterstr. 11
D-40549 Düsseldorf
Tel: +49 (0) 211 5288-168
uwe.karg@hach-lange.de
www.hach-lange.com