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Let's Solve Water

Application note

Combi sensor or analyzer?

LONG-TERM EXPERIENCE WITH AN ION-SELECTIVE SENSOR

Continuous research and further development of ion-selective (ISE) measurement technology enabled the technology to be applied to online measurement applications for direct measurements in wastewater.
The ammonium and nitrate combination sensor for example, with automatic compensation of the main interfering ions has many advantages including low investment costs, low operating costs and ease-of-use. In the following, the long-term experience of the wastewater treatment plant Strass of the wastewater association Achental-Inntal-Zillertal (AIZ) with this sensor.

Thirty-one communities in the Schwaz district of Austria are members of the AIZ Association. The central wastewater treatment plant in Strass has a capacity of 167,000 population equivalents (PE) with a catchment area extending from the Achenpass to the Hintertux glacier. The load on the ARA sewers and wastewater treatment plant reaches its maximum due to tourism in the peak holiday season (July/August and Christmas holidays).
In 2004, the Strass wastewater treatment plant won recognition as the industry benchmark of large-scale wastewater treatment plants in Austria. Nine plants with capacities of between 100,000 and 900,000 PE participated.
Reinhard Rostek, Managing Director, knows the reason for the excellent performance in the national comparison:

"In recent years we have strived constantly for operational optimization and have developed more efficient, energy-saving processes."

As a result, the specific operating costs based on the polluting load degradation have been $ 12.63 (8.49 €)/PE-COD110 (based on one inhabitant and one year with a COD value of 110 g per inhabitant. The average value of all wastewater treatment plants is $ 18.25 (12.27 €)/PE-COD110. The wastewater treatment plant is energy self-sufficient and has been since August 2004: The fermentation gas produced in the digestion towers is utilized for generating power using GE gas engines. The amount of energy gained exceeds the energy required for the Strass operation. Where possible, maintenance work is carried out by its own personnel with little need for external services.

Modern large-scale sewage treatment plant: Strass sewage treatment plant in Austria

Initial situation and objective:
The activated sludge plant in Strass has an upstream, high-rate biological system. After intermediate sedimentation, the pre-cleaned wastewater passes through a two-lane, low-rate biological system where each lane has two tanks. The wastewater is denitrified in the first tank and nitrified in the second. Depending on the load of the wastewater, the denitrification zone can also be aerated so it can be used as an additional nitrification area. This is controlled in the joint outlet of the two activated sludge lanes by the ammonium values determined online. The recirculation pumps are also controlled by the ammonium value.

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The recirculation pumps are also controlled by the ammonium value. For further control, the oxygen measurements in the activated sludge are used for direct control of the aerators. In the past, the ammonium, nitrate and phosphate utrient parameters have been measured after an ultra-filtration by automatic analyzers. This measurement technology performed extremely satisfactorily but is "getting on in years" and had therefore to be replaced. For this reason the direct measurement ionselective probes were tested against the existing automatic analyzers in an online comparison for:

- Quality of the measured data
- Reliability of the measurement
- Availability of the system
- Maintenance and calibration costs
- Long-term experience

The plant operator considerations are:

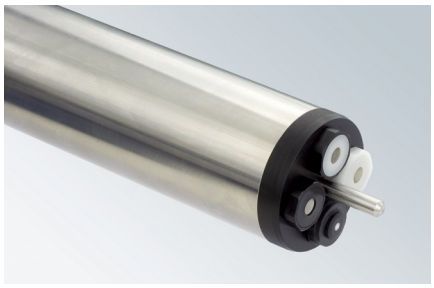
- Low investment and operating costs
- Benefits and advantages for the plant operation with new technologies available

Quality of the measured data:

The WTW VARiON® probe was installed in the combined outlet of the two activated sludge lanes. The recorded measured data were stored in the system and – if possible – also transferred directly to the process control system. This enabled a real online comparison with the available analyzer values (see Fig. 2: Day-of-the-week variation of ammonium/nitrate). Over the selected time period from the beginning of December, the transition from intermittent operation to "peak season" operation is clearly visible with a distinctive diurnal variation. The low temperatures hampering denitrification and nitrification make the control/ regulation of the process even more difficult.

High availability, good economic efficiency

Both the ammonium values and the nitrate values of the probe VARiON® 700 IQ (Fig. 1) showed excellent agreement with the analyzer values throughout the entire trial period of six months. The dynamics of the process is shown very clearly. Reference measurements performed in the laboratory (double photometric determinations and ion chromato-graphic measurements) fit well into the online measurement curves (see Fig. 3: Diurnal variation of ammonium/nitrate).



Reliability of the measurement:

During the entire period of six months reliable and accurate measurements were achieved.

The automatic compressed-air cleaning functioned without any problem; the initial cleaning period of four hours was adjusted during operation to three. Generally, additional manual cleaning was not necessary. Both the ammonium and potassium values as well as the nitrate values were consistently plausible.

As the ammonium analyzer was subject to failures in December 2005, the ammonium values of the sensor were used directly for control and regulation purposes from that time on.

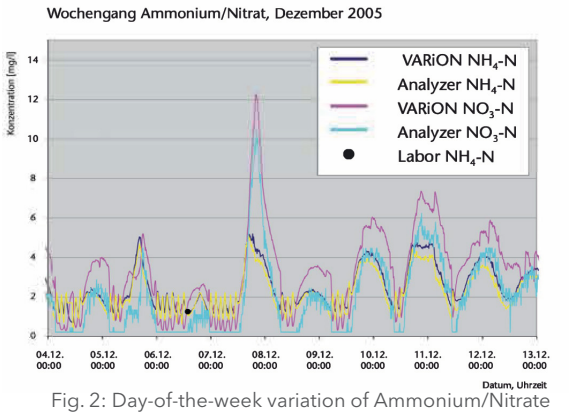


Fig. 2: Day-of-the-week variation of Ammonium/Nitrate

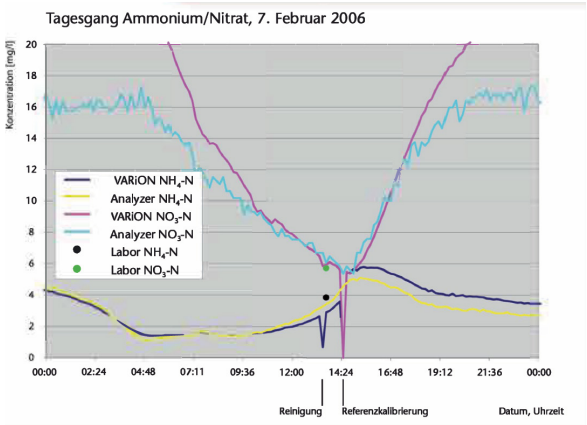


Fig. 3: Diurnal variation of Ammonium/Nitrate

Availability of the system:

The measuring system was continuously available with no single failure during the entire period of time. Even during sporadic checks and reference measurements, the measuring system was continuously vailable since the sensor remained constant within the medium. Therefore, the availability was virtually 100 %.

Maintenance and calibration costs:

The probes were routinely subjected to a preventative visual check. Due to the dependable automatic cleaning by means of compressed air, generally no additional manual cleaning was necessary. From time to time the measured values were validated using comparative measurements in the laboratory. The slight deviations were tolerable most of the time. Altogether, the ammonium and the nitrate electrodes were readjusted for the first time after approximately three months of use. The overall time required for a check or calibration is at maximum half an hour. This time is well spent as it assures reliable, accurate data needed for optimal control and regulation purposes. Finally, every tenth of a milligram too much or too little oxygen entering into the biological processes can be costly.

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Further experiences:

- The installation and commissioning has proven to be very simple. The additional sensor was simply clamped to the already existing WTW IQ SENSOR NET system of the plant consisting of a number of oxygen, pH and turbidity sensors.
- The comparative measurements of sludge samples that were filtered directly on-site and the permeate used to feed the analyzers showed an exact match.
- The system proved to work reliably even under extraordinary conditions: Due to its high overvoltage protection, the IQ SENSOR NET system even withstood two lightning strikes, although the lighting contributed to a complete failure of other plant systems.

Long-term experiences:

Measurements worked well over a period of six months after commissioning and the electrodes showed no ageing degradation. The measured data quality was so good that the ammonium values were used directly for control and regulation purposes.
In terms of the measured data quality as well as the reliability and availability of the measurement, the direct measurement probe can be retrofitted seamlessly with the analyzers used at the plant. This means that the system is extremely well suited for the control and regulation purposes of the nitrification/denitrification processes.

Summary:

The maintenance effort is low. Depending on the requirements for absolute accuracy, a regular check with laboratory reference values is useful for meeting the plant's quality standards for process management and sensor technology. Even after months without matrix adjustment, the analyzer and probe values continued to match perfectly.
Measurement disturbances from interfering ions such as potassium and chloride could not be detected. The automatic compensation of either potassium or chloride works invisibly in the background – without a single failure.

Prospects:

The probe technology offers a great advantage over the analyzers: With approximately identical measuring values, nitrate and ammonium can be measured directly and displayed without any time delay. This process control and regulation can be further optimized through the cost savings incurred by eliminating the costly analyzer reagents required as well as significantly lower investment costs making this a cost effective alternative for smaller wastewater treatment plants.

In this specific case, separate measurements will also be possible in each individual activated sludge lane for future expansion and, consequently, its individual control and regulation can be optimized.

Do you have further questions?
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