TN_b determination in the municipal wastewater tre

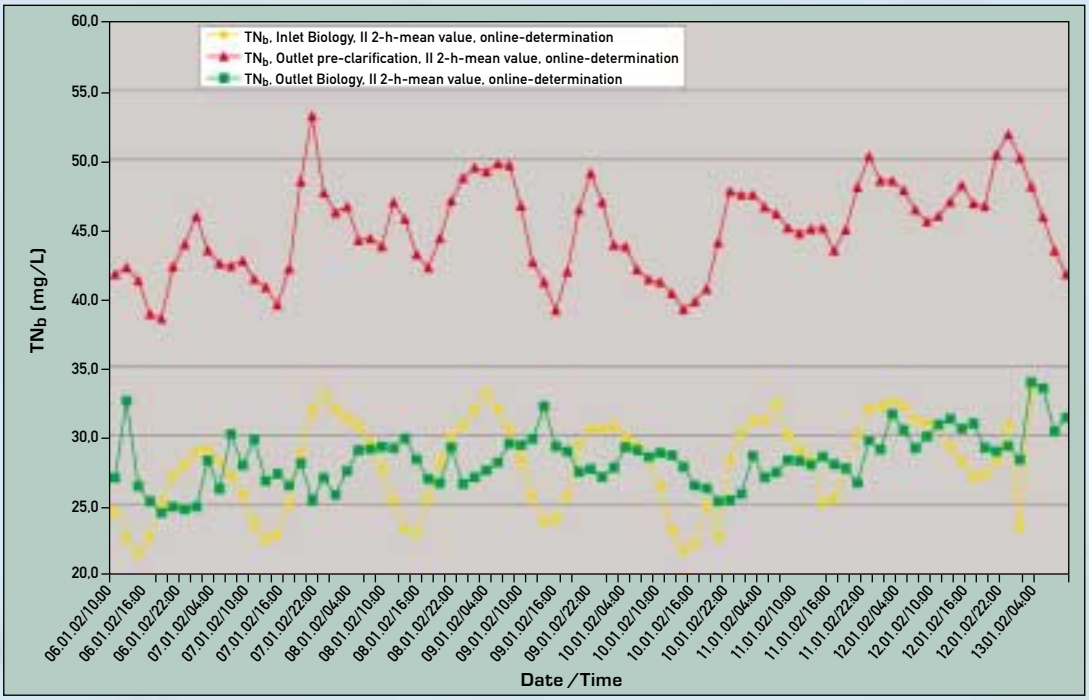

Figure 1: Weekly trends with TOCN-4100

By Joachim Schweda, wastewater treatment plant Munich (München I)

Regulations regarding continuous improvements in water protection, which accompany the changing needs of a growing metropolis, greatly increase the responsibilities and demands of municipal wastewater treatment plant operators. Since its inauguration in 1926, this task has been carried out by Munich's wastewater treatment plant on the „Großlappen" estate. Through continious expansion this treatment plant servicing 2,000,000 inhabitants is now one of the largest in Germany. In order to comply with environmental protection regulations, the plant invests in the most modern technologies and methods.

The determination of bound nitrogen has been carried out at the Munich plant since the 1980's. In addition to determining the NH_4-N, NO_3-N, NO_2-N parameters, bound organic nitrogen was measured using the Kjeldahl method. The availability of an analytical technique for the determination of total bound nitrogen (TN_b) via the chemiluminescence procedure was a marked improvement and simplification of the existing method.

Whereas the Kjeldahl method only allows the determination of NH_4-N and organic nitrogen, the TN_b method detects all relevant nitrogen parameters such as NH_4-N, NO_3-N, NO_2-N, as well as the organic nitrogen species in one single measurement and therefore provides a total assessment of the real pollution levels.

It is therefore not surprising that the TN_b determination is significantly simpler and faster than the Kjeldahl method and individual determination of the inorganic nitrogen compounds.

Actual nitrogen pollution

The availability of the TN_b method offers a great advantage not for analysts, but especially for the wastewater-processing engineer. Via consistent determination of TN_b before and after individual wastewater clean-up stages, the processing engineer can obtain an overview of the real nitrogen pollution levels and elimination performance of the treatment plant. Using determination of inorganic nitrogen (NH_4-N, NO_3-N and NO_2-N) alone this would not be possible, as the level of organic nitrogen at the intake of the wastewater treatment plant – i.e. in the raw wastewater- is relatively high (10 - 20 mg/L). During wastewater clean-up, the organic nitrogen content is reduced via chemical and biological processes (hydrolysis, conversion to NH_4-N in the sludge treatment plants or in the biological settling basins) to NO_3-N at a level of < 2 mg/L. The assessment of nitrogen using the inorganic nitrogen species inevitably leads to errors as shown in the following example: When the NH_4-N concentration at the influx of the wastewater treatment plant is for instance 30 mg/L (in which NO_3-N and NO_2-N concentrations are assumed to be zero, just as in normal municipal wastewater) then an inorganic nitrogen concentration of 40 mg/L could be measured in the effluent in the absence of denitrification. The difference of 10 mg/L originates from the conversion of the organic nitrogen mentioned above.

A process engineer who has optimised his nitrogen elimination plant at 30 mg/L NH_4-N, will be surprised to find that he may exceed his allowed values for nitrogen.

Follow-up of the nitrogen elimination

However, the real advantage of the TN_b parameter becomes evident when the TN_b is measured in real-time and online, that is to say with the influx of wastewater into the treatment plant, prior to the individual cleaning steps, thereby allowing the monitoring of the successive nitrogen elimination stages. This gives the processing engineer the ability to react to changing conditions.

For example, the concentrate from the sludge treatment can be added to the wastewater in well-defined amounts and in accordance with the nitrogen load from the raw wastewater in order to meet the required control values.

monitoring and control of atment plants

TOCN-4100 to solve legal guidelines

Legal authorities have also recognised the benefits of TN_b determination and have ruled to include this procedure in the adaptation of the guideline 91/271/EWG on the treatment of municipal wastewater („Reinhalteordnung kommunales Abwasser – Rok-Abw“) in treatment plant 4 (Requirements on discharge from municipal wastewater treatment plants in sensitive areas which are prone to eutrification). The guidelines include a TN_b of 15 mg/L for treatment plants for 20,000 – 100,000 inhabitants or a TN_b of 10 mg/L for treatment plants for more than 100,000 inhabitants on the one hand and the decrease of nitrogen load by 70 – 80 % on the other hand. In most cases it will only be possible to comply with these regulations via a decrease in nitrogen load, and the use of an online TN_b method is therefore required.

In order to meet all these requirements, the potential of the Shimadzu TOCN-4100 process analyser was applied. In addition to the possibility of simultaneous TOC/TN_b determination, the instrument offers effective integrated sample preparation options for wastewater with suspended particles, which allows for an even filtration of all measured process streams. Extreme deviations which result from the various suspended particle concentrations will thereby be avoided.

Exemplary measurement results

The weekly data of the process measurements, shown in Table 1, represent the 2h- average values from the effluent from the initial purification step, the influx to biology II and its effluent, which was continuously measured with an instrument via the 3-flow option. This clearly demonstrates the synchronous course from effluent of the initial purification, the influx to biology II as well as the time-delayed nitrification in the outflow of biology II.

In order to verify the measured results, we tested the reliability of the data via simultaneous TOC and TN_b determination. The simultaneous determination of the TOC value offers the advantage to distinguish between contaminations originating from organically-bound nitrogen or NH_4-N, when a significant increase of the TN_b is observed. In the first case, the TOC would increase concurrently since organic nitrogen compounds include a proportional amount of carbon.

But if we deal with purely inorganic ammonium compounds, the original TOC value would remain constant. The wastewater process engineer can therefore react quickly, and efficiently control the nitrification and denitrification processes.

Excellent validation results

For validation of the instrument a laboratory TN_b analyser was used. As shown in Table 2, the measured values strongly concurred. The slight deviations observed are essentially due to the different sample preparation methods (manual homogenisation with an Ultraturrax for the laboratory TN_b instrument versus integrated online filtration for the Shimadzu TOCN-4100) and the fact that the sampling time was not identical. In one case (14.3.02) the higher values measured via the Shimadzu TOCN analyser pointed towards a faulty calibration curve of the laboratory instrument, which was corrected accordingly.

Summary

In summary, internal nitrogen cycles (denitrification, drainage water, decantate-concentrate-inflow) are better monitored online to determine the nitrogen elimination potential of an individual wastewater treatment plant. The Shimadzu TOCN-4100 proved to be an efficient and reliable instrument for monitoring and control of nitrogen determination in municipal wastewater plants.

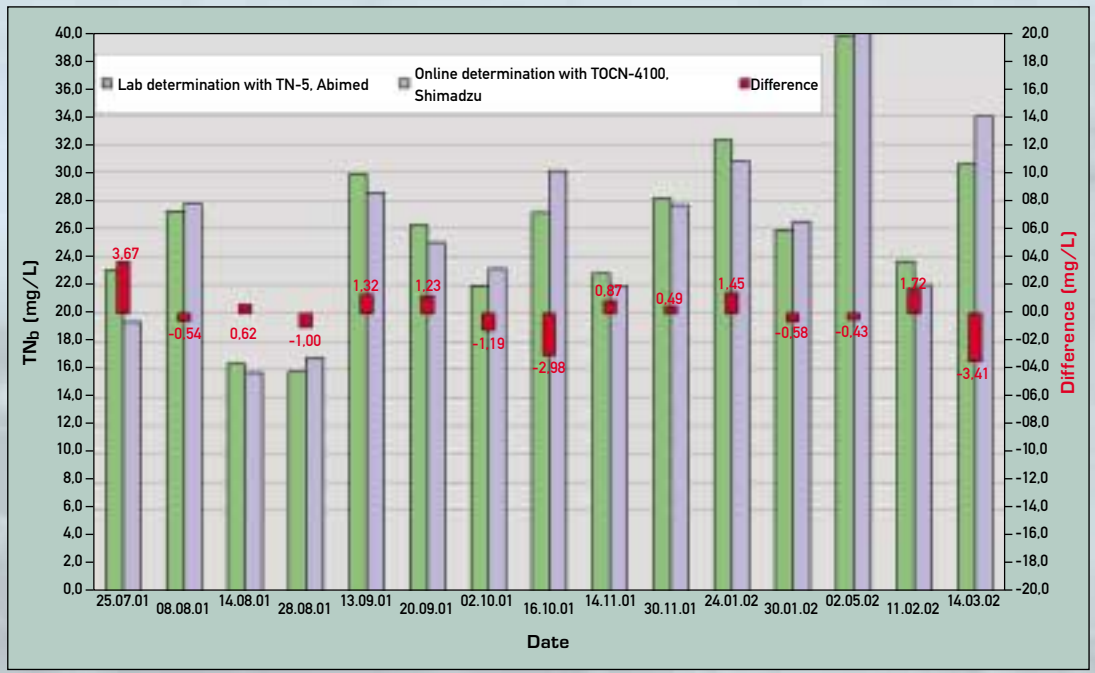

Figure 2: online determination and lab values in comparision