Leading edge applications of s::can's ON-LINE UV-VIS-SPECTROMETERS

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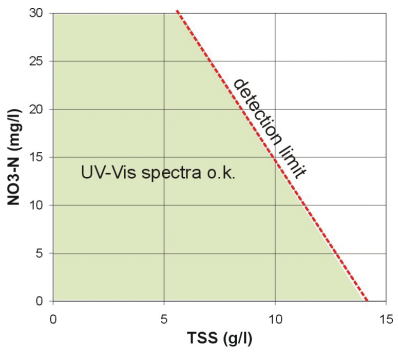
WATER
Waste Water

5 years after market introduction, s::can´s "spectro::lysers" have not only proven in several hundred applications world wide their great accuracy, reliability and neglectable maintenance costs. Since 1999 they have also established in a wide variety of new applications, like for drinking water protection, for the control of complete wastewater treatment plants, at industrial applications like the control of paper mill or diary WWTPs, or in hydrocarbon alarm systems for the (petro)chemical industry.

Monitoring of NO3, TSS, and COD in an SBR reactor

Viennese scientists used a submersible UV/VIS spectrometer from s::can, Vienna, with an optical pathlength of 1 mm for the control of an SBR tank (Langergraber et al., 2004*). The instrument measured in-situ - directly in the reactor - and communicates the results in real-time to the PLC system. The auto-cleaning system which is operated by pressured air prevents trends from windows fouling over several months of operation.

There is no need for chemicals, membranes, pumps, filters, or wipers - nothing but 12 V low power energy and compressed air or water for the automatic cleaning. There are no moving parts - it is not even serviceable - and it is built to run at a max. rate of 4 meas. / minute, without ever leaving the water at almost zero operating costs.



In addition to nitrate nitrogen also TSS and $COD_{soluble}$ were measured simultaneously with just one single instrument.

High correlation coefficients of R_ = 0.98 and 0.995 were obtained for NO_3-N and TSS respectively by running an advanced local calibration. The measurement of NO_3-N was possible for high TSS concentrations also.

Figure 1: Measuring range of NO_3-N in relation to TSS concentration

For extreme TSS, i.e. in membrane reactors, NO_3 can be monitored at TSS of up to 20 g/l by using the new 0,5 mm pathlength instrument.

The obtained correlation coefficient for $COD_{soluble}$ was satisfying (R_ = 0.90) when taking into account the error of the reference methods.

Several characteristic points of an SBR cycle were monitored using on-line UV/VIS spectrometry. Compared to a fixed time schedule the times for settling, denitrification and nitrification can be minimised and therefore the volumes of treated water can be maximised. By mounting the instrument at the flexible part of the decanter the amount of withdrawn water can be increased.

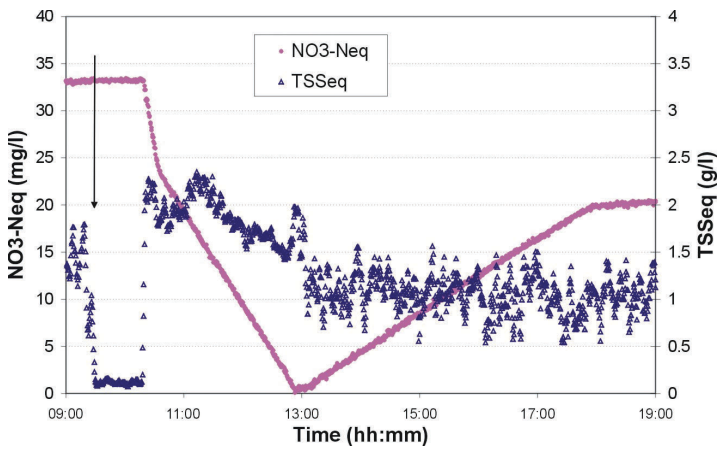


Figure 2: Measurement of NO_3 and TSS simultaneously in an SBR reactor

5 characteristic points can be observed:

1. The TSS concentration drops rapidly after switching off the aeration. Once the low TSS concentration is reached settling is finished and withdrawal can start. During settling and withdrawal the NO_3-N concentration stays constant.
2. A rapid drop of the NO_3-N concentration occurs after filling and mixing starts. Readily biodegradable organic matter in the influent water is utilised as carbon source for denitrification. The TSS concentration increases due to mixing.
3. After filling of the SBR (the maximum water level is reached) mixing without aeration is continued for further denitrification. A change of the slope of the NO_3-N curve can be observed because during this period less readily biodegradable organic matter is available for denitrification.
4. The depletion of nitrate nitrogen shows the end of the possible denitrification and the aeration can be turned on.
5. During the aeration phase nitrification occurs and the nitrate nitrogen concentration is increasing. The change of the slope indicates that the free available ammonia nitrogen is consumed. The aeration can be turned off at this point. The slower increase afterwards is caused by nitrification of ammonia released due to ammonification and decay processes. The periodic fluctuation of TSS concentration indicates quickly changing local hydraulic conditions.

Monitoring of NO_2, NO_3, $COD_{soluble}$ and TSS in the effluent of a WWTP

Swiss and Viennese researchers succeeded at the monitoring of NO_2, NO_3, $COD_{soluble}$ and TSS in the effluent of a WWTP – all by one instrument (Rieger et al., 2004*)

A UV spectro::lyser with 10 mm open pathlength was located in the secondary clarifier effluent of a Swiss WWTP. 256 wavelengths are measured simultaneously between 210 and 400 nm with a resolution of < 1 nm. This high resolution / narrow range instrument is needed to distinguish between NO_3 and NO_2 at the disadvantage of restricted but still acceptable TSS accuracy. Spectral ranges of some measured substances are pictured in figure 3.

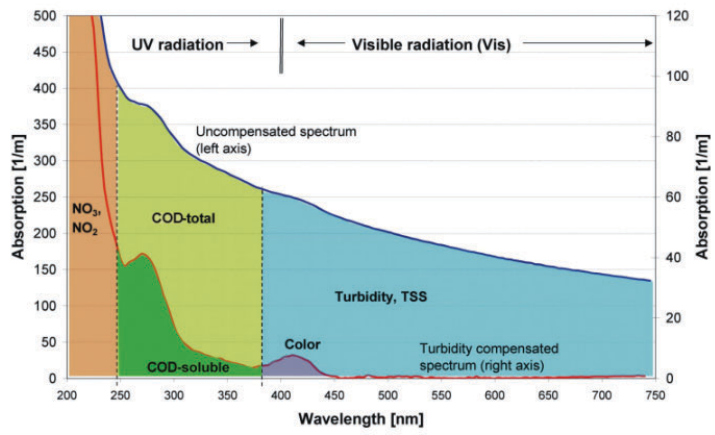


Figure 3: Measured substances and their spectral ranges

The calibration of the spectrometer is based on a chemometric PCA/PLS model correlating the concentrations of the required determinants to UV spectra. An improved algorithm uses different optimal numbers of principal components for each parameter. However, this is only one of the methods that are provided by s::can Messtechnik, Vienna.

Comparison to conventional photometry: In the table below it is evident that no distinction between the substances would be possible using only one wavelength / classical UV monitor. Using spectrometry and the multivariate calibration algorithms based on PLS regression, calibration results were excellent (NO_2, NO_3, $COD_{soluble}$) or acceptable (TSS).

The measurement of this most relevant combination of parameters by just one small and relatively low cost instrument is considered a substantial and relevant innovation by the water industry and will change the water monitoring attitudes on the long run.

Recently, several competitors have been trying hard to get imitations of s::can's spectrometric concepts running. However, s::can's world wide customers can safely rely on s::can's 5-years experience in real world applications and on the inventor's unrivalled leading edge technology.

	Nitrite	Nitrate	Soluble COD	TSS
Single-wavelength calibration	0.089	0.182	0.213	0.442
Multivariate calibration algorithm	**0.993**	**0.978**	**0.905**	**0.848**

s::can´s new plug-and-measure instrument line

As a solution for the smaller budget, s::can has now taken the proven concept of the spectro::lyser, added a completely new terminal – the G::control - and turned it into a complete plug-and-measure, turn-key system, named nitro::lyser, carbo::lyser, and multi::lyser. The complete systems come factory calibrated and often do not even need any calibration for life-time. If calibration should be needed, it is done automatically while the instrument is staying submersed in the water. Within just 2 minutes from unpacking, the first concentration readings are displayed. After easy installation, up to 4 parameter concentrations from 1 or 2 probes are transmitted via 4-20 mA or RS485 to the SCADA system, at measuring intervals of down to 15 sec. Because of the spectrometric principle, the measurements are much more accurate and robust compared to today's wide spread conventional UV monitors. G::systems are now offered by s::can´s sales partners world wide.

(*) .... please ask for our complete literature list !