s::can Online UV/Vis Spectrometry for Event Detection Systems at Bratislava Waterworks

Bratislava Water Company (BVS) is responsible for the operation of water and waste water systems of Bratislava, the capital of the Slovak Republic. The supply of safe and wholesome drinking water to its customers is one of the core responsibilities of BVS. BVS produces drinking water for and distributes it to the Bratislava agglomeration, which has a total population of well over 600.000 people. The drinking water is produced in seven central water treatment facilities from 176 raw water sources with an overall capacity of over 6300 l/s. The only treatment performed is chlorination to prevent microbiological (re)growth during distribution. Despite this high quality, BVS decided an online water quality monitoring system is essential to ensure that this high quality is never compromised.

BVS therefore established an early warning network that actually monitors all essential ground water sources used for its drinking water supply. This s::can early warning system monitors the raw water quality in real time, 24 hours a day. In the case that the actual ground water quality should be outside of the very strict quality limits specified, the water from the source of concern will not be used for drinking water production. Only after a detailed laboratory analysis has confirmed the proper quality of this water source, the production of drinking water from this source will be reinstated. In this way the water used for the drinking water supply will be controlled continuously and only raw water of approved quality will be able to enter the treatment facilities.

Methods and Results

Driven by the requirement to establish an online quality monitoring and event detection system, BVS performed a multi stage evaluation of available technologies. This consisted of the following steps:

(1) definition of requirements

(2) evaluation of suitable instrumentation based on manufacturer specified performance

(3) field test of short-listed monitoring technologies

(4) event detection capability evaluation with real water samples

As a result of these tests, the fully submersible UV s::can spectro::lyser™ (Figure 1) was selected as the preferred instrument for BVS. The spectro::lyser™ can be used to measure multiple parameters simultaneously (e.g. turbidity, TOC, nitrate) from the spectral information (Figure 2). The spectro::lyser™ was additionally equipped with 4 spectral alarm parameters that exploit the 1st derivative of the absorption spectrum to detect resulting from untypical, possibly harmful, water quality events. These parameters are trained on online measurement data from the monitoring sites and then respond to deviations from the water quality observed during the training. The conventional standard parameters (nitrate, TOC, SAC254, temperature, electrical conductivity) are foreseen to detect probable harmful natural events affecting the raw water quality, e.g. surface water inflow in water sources that could make it microbiologically unsafe. The spectral alarm parameters were considered to be a solution for the detection of dangerous contaminations of anthropogenic origin: Especially water soluble components of oil (mainly aromatic substances), pesticides and chemical warfare agents were identified to be potential contaminants of reasonable risk.

During phase 4 of the evaluation of technologies, several samples of realistic water compositions were produced to represent the potential contamination events that could realistically occur. Samples of Bratislava's ground water spiked with TOC standard, benzene and carbendazim were presented to the two monitoring systems. This test series was executed on site to assess the sensitivity of the automatic spectral event detection features of the instruments under evaluation. Furthermore, a theoretical sensitivity analysis for a number of extremely toxic substances (e.g. saxitoxin), which could not be used under the available field conditions, was also performed.

The evaluation with the specific substances showed that the s::can spectrometer probes are able to detect potassium phthalate at all concentrations presented as well as carbendazim at all concentrations tested, i.e. as low as 20 µg/L. The trained spectral alarm parameters of the s::can spectro::lyser™ reproducibly triggers alarms fully automatically as a result of water composition changes,.

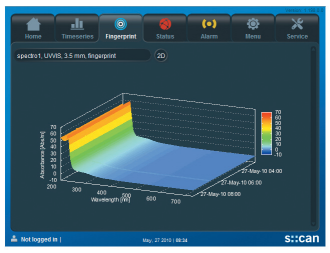

Figure 2: s::can fingerprints with moni::tool

The trained spectral alarm system on the spectro::lyser™ showed an unambiguous alarm in the ground water at the following concentration levels: 1 mg/L TOC standard, 50 µg/L carbendazim, 150 µg/L benzene. Using the signal strength to determine the lowest concentrations that would trigger an alarm yield the following results: 0.1 mg/L TOC, 25 µg/L carbendazim, 100 µg/L benzene and 50 µg/L Saxitoxin.

The spectro::lyser™ showes excellent sensitivity which is clearly exemplified by its ability to detect benzene. Because of its performance, its proven excellence in comparable applications and the availability of the easily trained and operated spectral alarm system, BVS selected the spectro::lyser™ for use in its event detection system.

Conclusions

The results clearly show that online spectroscopy is a powerful tool for monitoring of drinking water quality and security. Online spectrometer probes are instruments that, in a small and easy to use package, combine a cost efficient monitoring capability both for standard water quality parameters as well as a powerful event detection system for unknown contaminants. Contaminants presented could be detected down to low µg/L concentrations and the spectral alarm system of the spectro::lyser™ additionally generated unambiguous water quality alarms at these low concentrations.

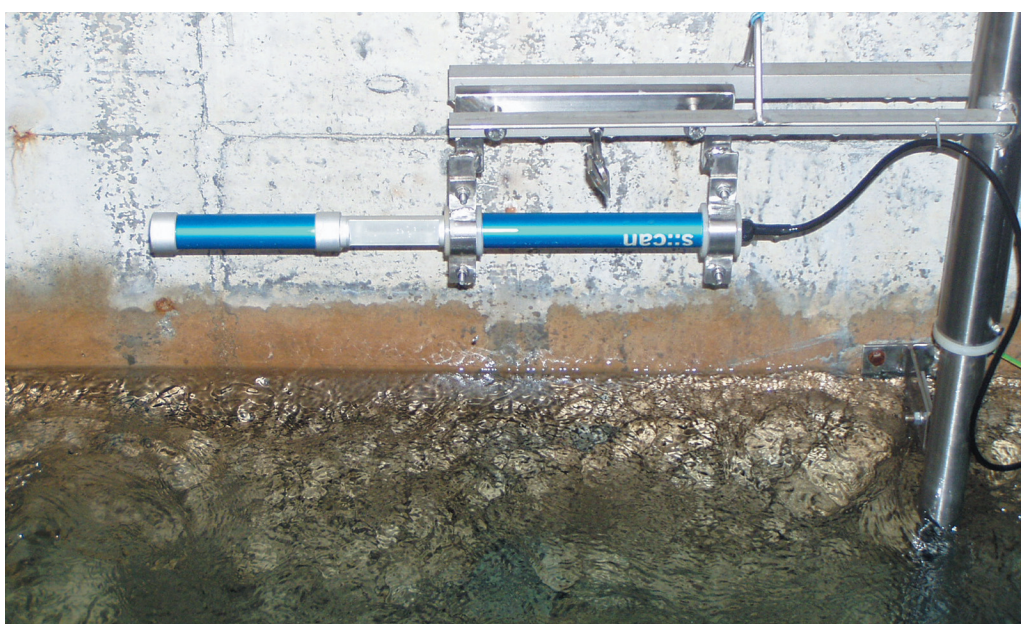

Figure 1: Example of a submersed installation of the spectro::lyser™

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