ON-LINE MONITORING NETWORKS FOR DRINKING WATER SECURITY OF KARST WATER

DI Andreas Weingartner, DI Franz Hofstädter[1]

[1]*s::can Messtechnik GmbH, Brigittagasse 22-24, A-1200 Wien, www.s-can.at - aweingartner@s-can.at, fhofstaedter@s-can.at*

Abstract

A novel submersible UV-Vis spectrometer has been used by Vienna Waterworks for the real time monitoring of water quality. Twentytwo of these instruments monitor springs and essential points in the transportation network, the data are transferred to a central early warning system that manages the water sources 24 hours a day. The quick response of the instrument and easy installation allow to monitor even remote sources with rapidly changing quality. To verify the specifications and the inter-instrumental comparability, twelve instruments were installed at the same spring for a period of six months, which proved the equivalence, measuring performance and the long-term stability of the spectrometer probes.

1 Introduction

Springs in geological regions consisting of karstic formations are the main source for drinking water supply for about 60% of the Austrian population. Unfortunately the water quality from these springs shows temporary instabilities for some parameters caused by some natural events such as very heavy rainfalls. Rapid fluctuations of raw water quality, especially in turbidity, but also elevated concentrations of dissolved organic substances and increased bacteria numbers can occur in an almost unpredictable way during storm weather. Furthermore anthropogenic events like accidents in neighbouring areas of the springs might affect the quality of the raw water straightforward.

As it is impossible to predict the impact of such events to the water quality, it is a vital strategy to enhance drinking water security by monitoring the composition of the raw water continuously. The raw water quality is obviously one of the most important factors determining the quality of the drinking water finally used by consumers. In addition, the rapid changes of raw water quality can limit the efficient usage of treatment procedures during drinking water production.

2 Monitoring task

Before 2001, very fundamental springs and important positions in the trunk mains had been monitored online. Complete buildings equipped with power supply, pipe installations and special foundations had to be built for housing the then available instrumentation, partly cabinet analysers, for monitoring the spectral absorption coefficient at 254nm ("UV254"), TOC, turbidity, electrical conductivity and pH. Both the actual costs and the situation of the springs avoided the setting up of a broader monitoring network covering all essential springs. Sample pre-treatment such as a membrane filtration had to be installed prior to some measuring devices, thus the operation of the monitoring stations required regular maintenance increasing the total costs of ownership.

In the year 1999 a novel submersible UV-VIS-spectrometer called "spectro::lyser" was introduced by s::can Messtechnik GmbH. This instrument measures the light absorbance in the spectral range of 200 nm to 750 nm and is able to calculate the SAC254 ("UV254") and the turbidity from the UV-VIS-spectra of the unfiltered sample. Other parameters like organic carbons (e.g. TOC, DOC) and Nitrate are also obtained from the spectral information without any sample preparation. s::can spectrometer probes can be fastened very simply both in flumes or basins where access to free water level is available (cp. Fig.1) and in closed pipes via mounting devices available at s::can. Additional sensors (e.g. for monitoring pH, EC, ORP, NH4, DO) can be integrated to one terminal (the "con::stat") that also provides various interfaces for the automatic data transfer to central PLC systems including GSM/GPRS modem and internet.

Fig.1: s::can spectrometer probe installed in a spring chamber

This new monitoring equipment provided a new opportunity to Waterworks: Now the water quality even of springs without power supply can be monitored by means of online measurement instrumentation. As no pipe installations are to be provided and no pumps, filters, membranes and reagents are used the total costs of ownership are unmatched low.

2.1 Test run

Before starting to establish a monitoring network based on these innovative instruments, a period of long-term validation took place: In order to verify the equivalence of spectral and conventional measurements, the spectrometer probes were operated in parallel to existing TOC cabinet analysers. It was also possible to verify the equivalence of spectral and conventional measurements both for turbidity and SAC ("UV254") for periods of several months. For verification of the parameter specifications and the inter-instrumental comparability, twelve instruments were installed at the same spring for a period of six months. In total readings of more than 18 months were analysed and proofed the equivalence, measuring performance and the long-term stability of the spectrometer probes.

2.2 Early warning system

At present Vienna Waterworks operates s::can monitoring systems in order to monitor turbidity, SAC254, Nitrate, TOC, DOC, temperature and electric conductivity at 22 locations (springs, catchments of various springs and essential points in the transportation network). The results of these monitoring systems are transferred in real time to an early warning system that can be accessed from 4 central stations. This early warning system manages the raw water sources 24 hours a day. Whenever the current readings exceed limits that are specific to each parameter, the water of the spring of concern will not be used for drinking water production but drained off. In this way the proper quality of raw water used for the drinking water supply is controlled continuously and no other water than of perfect quality can enter the transportation network.

3 Results and Conclusions

The time series in Fig.2 shows that the quality of the raw water can vary within very short intervals and online monitoring is indeed necessary to provide water of constant composition to the drinking water production. Monitoring just one parameter would not meet the needs of efficient and safe drinking water supply, as different types of events cause different changes in the composition of the spring water.

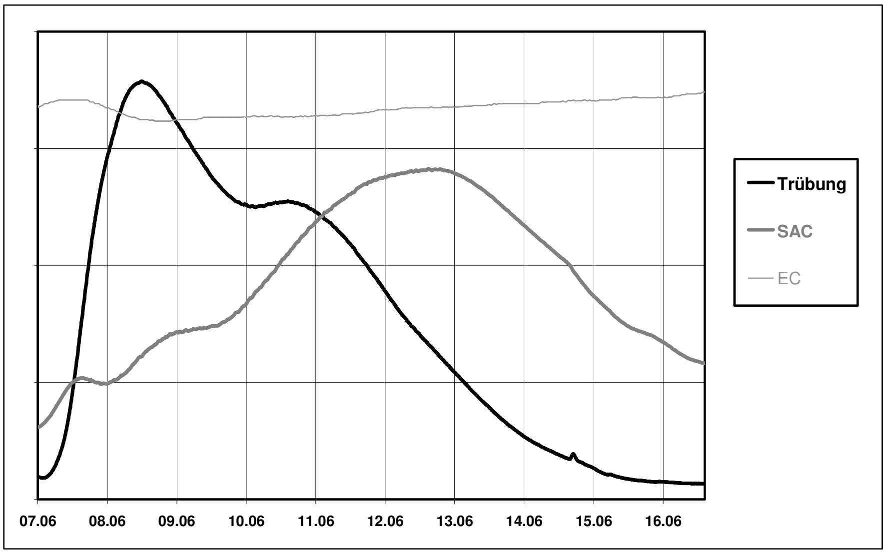

Fig.2: s::can on-line readings in raw water (example)

Since the last 15 years, Vienna Waterworks are controlling and optimizing the overall drinking water quality to a very high level by implementing the management of the raw water sources in real time and since 6 years experience with s::can monitoring systems is available.
In the future, the new and unique methods of "Delta Spectrometry" and "Differential Spectrometry" shall be implemented by s::can and applied in order to detect suspect changes in water quality not detected by conventional parameters (e.g. turbidity, nitrate or DOC). A sudden change in the composition of organic substances can be of high relevance for drinking water security although the total DOC concentration itself might stay rather constant. Each water has its own "fingerprint" of the absorbance spectrum, and each substance absorbing distinct UV-Vis-radiation will cause changes in this fingerprint, and will be recognised by an algorithm developed by s::can to detect small deviations from the natural, unspoiled fingerprint.

References

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