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Validation of an innovative passive collector for pollutant analysis in groundwater

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Abstract. A passive pipe sampler device for contaminant analysis in groundwater was developed which create a permanent sampling flow from groundwater and in addition to temperature, conductivity and pressure, now also has room for specific sorbents. The large surface of the adsorber offers more binding surface for the analyte and the constant movement of the sorbent with fresh groundwater also provides homogeneous binding. The spectroscopic analyses at the monitoring site of the pipe passive sampler for groundwater monitoring points enables a measurement-based validation of the sorbent circulation as an alternative to a visual assessment. The optimum pump speed for the sorbens Lewatit® M500 and SR7 was evaluated. The 42mm slim measuring device allows the use in DN50 monitoring well and thus allows the setup of a closer measuring network.

1. Introduction

Our groundwater is one of the most valuable resources, whose quality is continuously decreasing over the last years due to pollutions. Nitrate is increasingly ending in the groundwater due to excessive fertilization, which has been proven by the latest Nitrate Report 2020 [1]. An early warning system that detects contaminant concentrations in groundwater continuously and is connected to an alarm system could be a method to validate water quality. Pollutants that are exposed / fluctuate / enter groundwater only in lowest concentrations during a certain period of time are difficult to detect. The mobile pipe passive sampler can be used in all (un)moving water resources and allows sampling with subsequent laboratory measurement. The advantage of this system is, besides the measurement of lowest pollutant concentration, the small device diameter. Groundwater measuring points with a filter pipe of DN50 are already sufficient.

2. Method

The system will measure temperature, pressure and conductivity of the water. The pump draws actively a part of the groundwater and flows permanently through a 10 ml glass vial (see fig. 1) with filter insert (0 - 72 ml/min). A globular ion-exchange resin can be used as an adsorber in the sample vessel for the analyte. The reversible accumulation of the analyte will be done over several days / weeks, so that the measured values can be recorded in the laboratory afterwards. Reproducible results are only possible with constant parameters. The adsorber must be surrounded by fresh groundwater from all sides, but must not settle.

To validate the pumping speed, a measuring station was developed in addition to a subjective visual evaluation. There were 3 LEDs in the station to illuminate three different positions of the vial. For each measurement, a spectrometer probe was connected opposite each LED. The holder for the LEDs and the spectrometer probe was 3D printed with ABS (see fig. 2). This validation will not take place during groundwater measurement, but when a new adsorber is to be used, it is necessary to determine the flow characteristics of the adsorber.

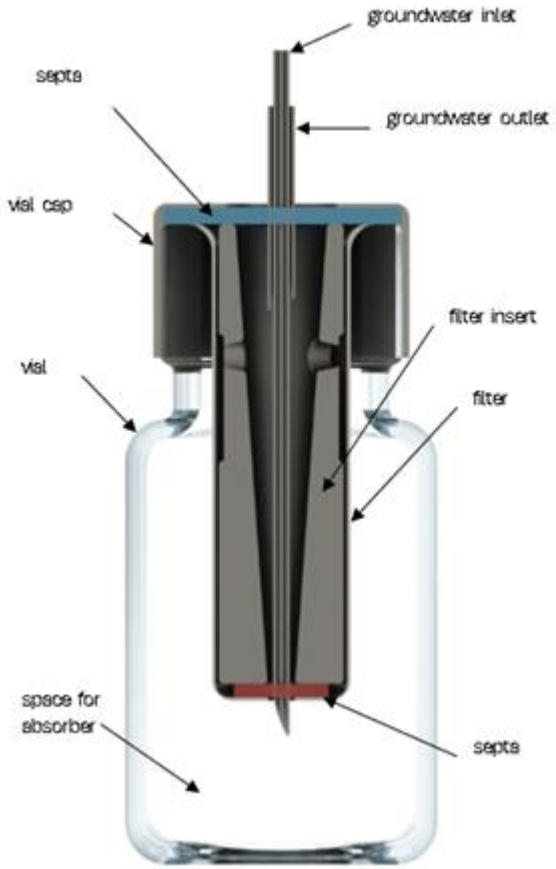

Fig.1: Setup of the used vial for the adsorber material

3. Results and discussion

The behavior of both adsorber was fluidically similar - small quantities entered the neck of the bottle at low pumping speeds - with increasing adsorber quantities, turbulences generated by the adsorber itself (grid / swarm turbulence [2]) became predominant, so that with more material, higher speeds as well as surface area could be provided for the analyte. While SR7 can only be used from 0.4 g and 22.5 ml/min up to 1 g at 65 ml/min, M500 showed good flowability at 30 ml/min regardless of quantity.

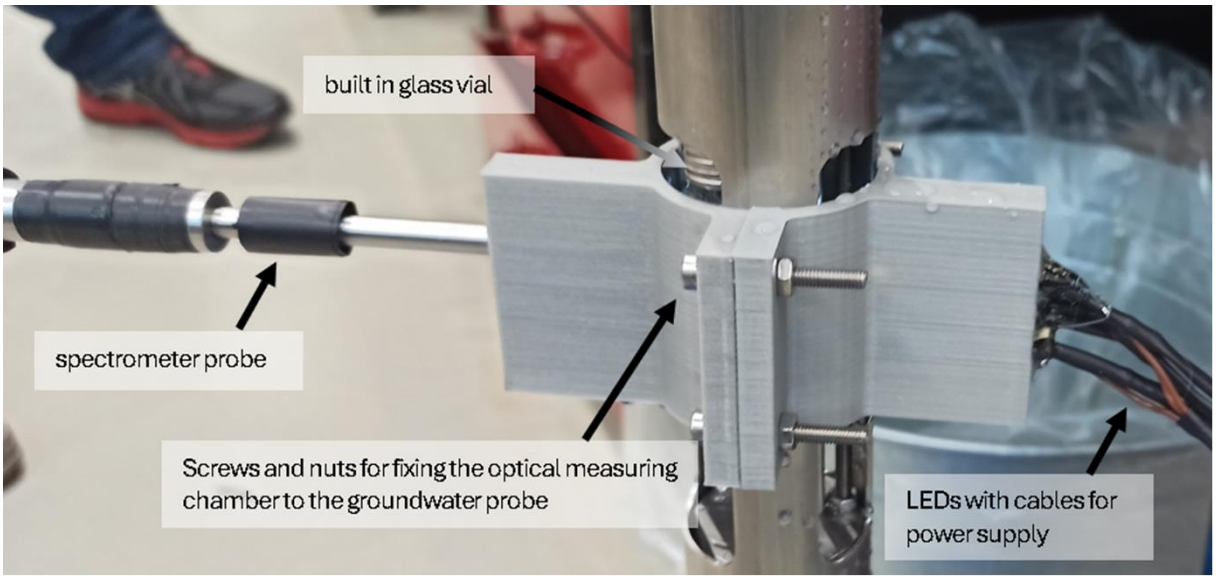

Fig.2: Optical measuring chamber for detection of absorption in operation

4. Summary

A slim groundwater measuring device was produced, allowing to use it in more measuring stations for water analysis. The tighter measurement network for monitoring the water quality might be improved with this developed measurement device. The developed measuring method enables to optimize the flow rate together with the flow characteristics of the adsorber material. Further work should be done with this groundwater measuring device to make practical measurements. In addition, this device will be equipped with an online measurement chamber for nitrates, and this data can be requested online, giving the user immediate access without waiting for laboratory analysis.

Data availability

If you are interested in the used measurement data, please send a request to the author (jan.millauer@th-wildau.de). CAD data are not available in this case.

Competing interests

The authors declare that they have no conflict of interest.

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