Photometer Calibration Method

Johannes Sood, VITROCELL Systems GmbH, 79183 Waldkirch, Germany

Background

A Photometer is a powerful tool to determine particle concentration in a continuous phase. The VITROCELL® Photometer detects the light scattered by particles or droplets passing through its inner channel. The light is detected by a photodiode which delivers a voltage signal. Sensitivity can be set by a potentiometer. The photometers have to be calibrated to get a correlation between signal and concentration or to compare readings among different photometers.

Therefore a method must be established that produces a stable and reproducible readout. Methods as solid glass rods or liquid aerosols with large droplets were not very promising because the readout was very variable depending on ambient parameters or time. Below is shown a reliable method.

Setup

To produce a dry aerosol and to calibrate the photometers a process was established as shown in figure 1. A VITROCELL® Bioaerosol Generator was operated with a continuous flow of a VITROCELL® calibration suspension (VCS), fed by a peristaltic pump and an airflow of 2 l/min. The generated aerosol was guided through a cold trap (operating temperature 5 °C) to remove the liquid phase. A calibration flow passing through the photometer with a flow rate of 50 mL/min was obtained by a vacuum pump. The particles of the main flow were trapped in a 44 mm microfiber filter pad. After the filtration the humidity was monitored by a Testo 645. To determine the correlation between aerosol concentration different concentrations of VCS and feed rates were tested.

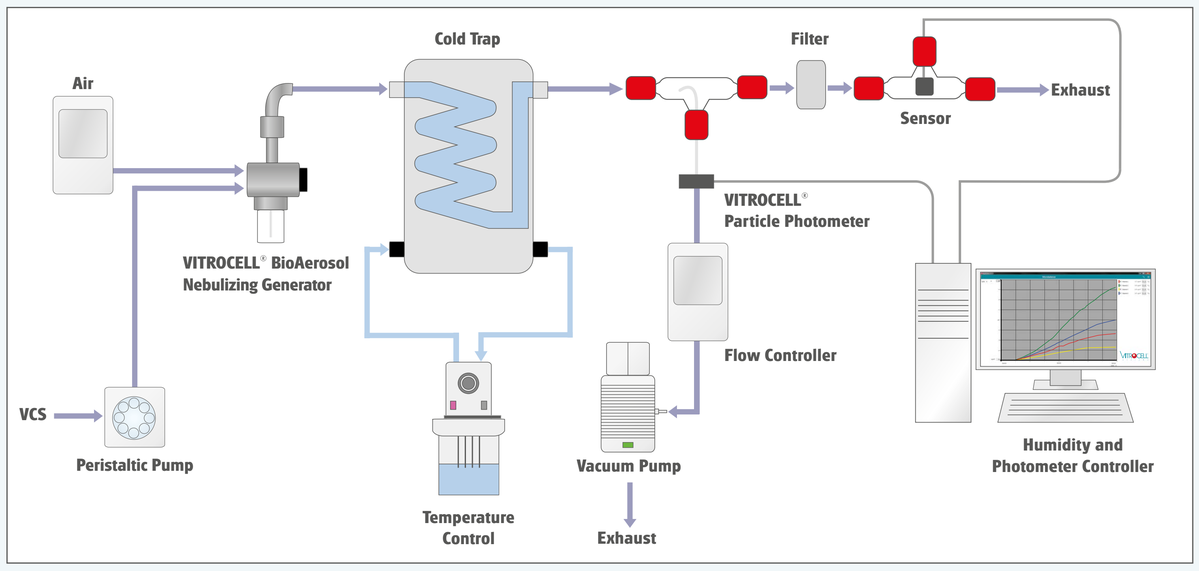

Fig. 1: Process schematic for the generation of a dry aerosol with the VITROCELL® bioaerosol generator and a cold trap. After the cold trap a sample flow is used to calibrate the Photometer.

Generation of a stable and reproducible aerosol

To show that the generated aerosol is stable and reproducible under different experimental conditions different VCS concentrations and VCS feed rates were varied and performed on different days. The voltage signal was recorded for 5 min and the average was determined. Figure 2 shows the average voltage signal as well as the respective standard deviation. Each experiment was performed as least 3 times. The figure shows that the standard deviation in every experiment is not higher than 8 %.

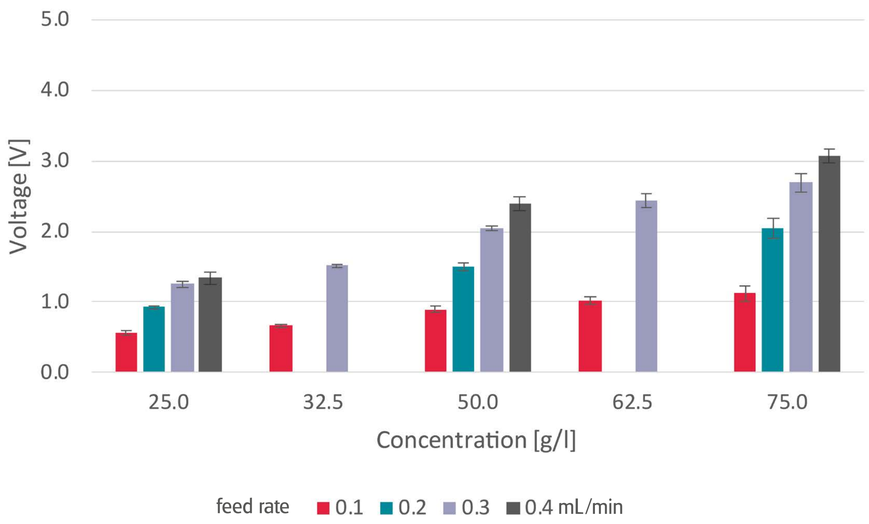

Fig. 2: Voltage signal is shown for different VCS concentrations and feed rates. Each bar represents at least 3 experiments on different days with the corresponding standard deviations.

Consistency of Photometer Calibration

A master photometer (MP) was measured using a VCS concentration of 50 g/l resulting in a voltage signal of 2.06 V. The other so called slave photometers (SP1, SP2 and SP3) were calibrated to the value of the MP. Different concentrations were tested with the calibrated photometers to show that calibration is not affected by concentration levels (figure 3). Standard deviation is 0.8 % for the calibration value at 50 g/l and 4.4 % for 75 g/l.

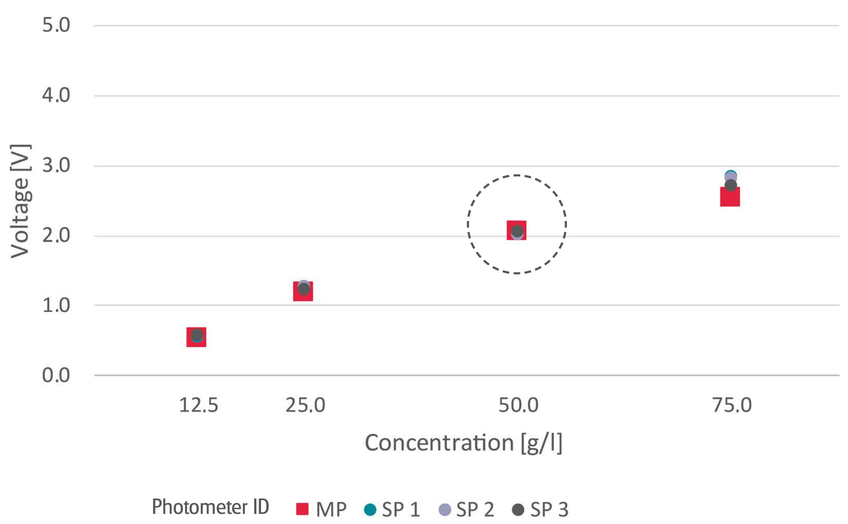

Fig. 3: Voltage signal for the MP and 3 SP in dependency on VCS concentration. The Photometers were calibrated to an equal signal at 50 g/l.

Conclusion and Outlook

The results above show that the established calibration method for aerosol photometers is a promising tool. The generated aerosol is stable even if VCS concentration or feed rate are changed. Because the method is reproducible different photometers can be adjusted to the same sensitivity, which is important to compare different concentration levels in a process.

Next steps will be to examine the limits of the method concerning feed rate and max. concentration of VCS. Then the limits should be compared with the full working range of the photometers.
Furthermore a control mechanism should be established to guaranty a consistent calibration system.