

Dosing with the OEM-C Sensor

Product: OEM-C / OEM-C mini Flow Sensor

Date: 27.11.2020
Version: 1.0

Introduction

The OEM-C is a differential pressure Flow Sensor for dosing applications. It is well suited to dispense small amounts of liquid or measure the continuous flow of fluid containing gas bubbles.

Used Material

- OEM-C Flow Sensor (B2, 10-100 ml/min)
- Simple Peristaltic Pump
- Precision weight scale Mettler Toledo (0.01 mg)

Experiment setup

The peristaltic pump is connected via 2/4 mm silicone tubing to a water reservoir. A filter with 25 µm mesh size is used to prevent contamination of the sensor. The water is pumped through the sensor and onto the weight scale.

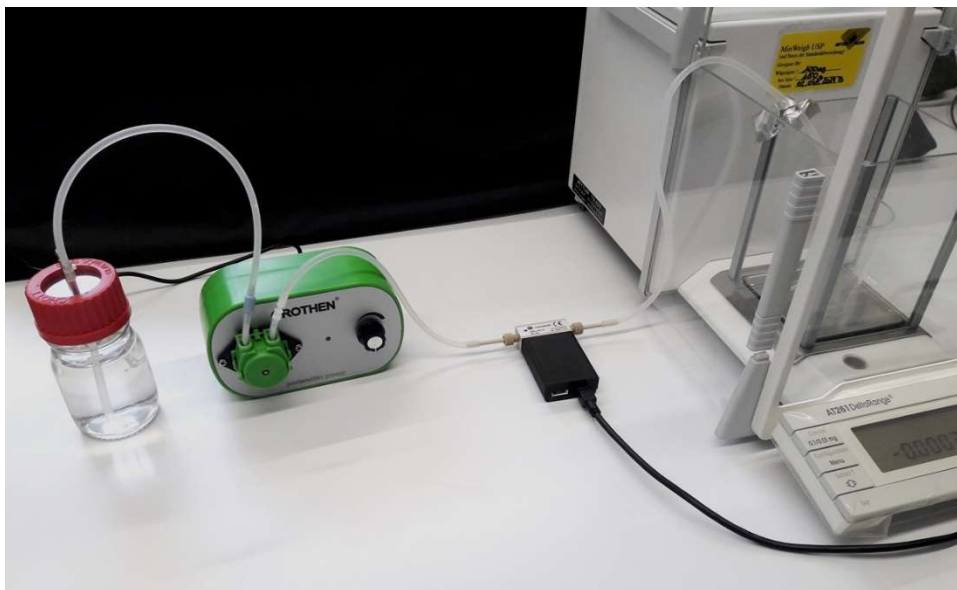


Figure 1: Experiment setup

Connecting the Sensor

The OEM-C Flow Sensor is connected by USB (5V and Data). Also a RS232 connection is possible (for further details consider the user manual of the OEM-C and the quick start guide). With the command **M_Cont 1** a continuous flow signal is sent by the sensor with an Interval of 1 second.

Setting the flow to zero

The OEM-C measures the flow by evaluating a differential pressure signal generated by two pressure sensors. The pressure sensors values can be accessed by the command **M_Press** (Answer: P1 976.49 mbar P2 977.322 mbar).

In order to reach a good measurement accuracy the pressure offset between the two sensors has to be set to zero (**S_SetZero**) before the flow measurement.

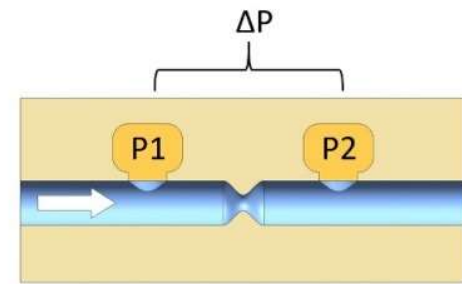


Figure 2: Sensor principle

Make sure that the sensor is in its fixed mounting position, filled with liquid and has no flow at the moment of setting zero. Otherwise these factors may lead to a displaced zero point and therewith to measurement errors.

Threshold settings

The OEM-C has a calibrated flow range of 1-15, 3-30 or 10- 100 ml/min. Below this calibrated range it can still measure the flow. However the measurement error increases exponentially approaching a flow of 0ml/min. Therefore it makes sense in every application to neglect values below a certain flow threshold.

The plot on the right shows the same flow pulse with and without a threshold of 25 $\mu\text{l/s}$.

The operator can read and set the threshold manually (**S_SetThreshold /S_GetThreshold**).

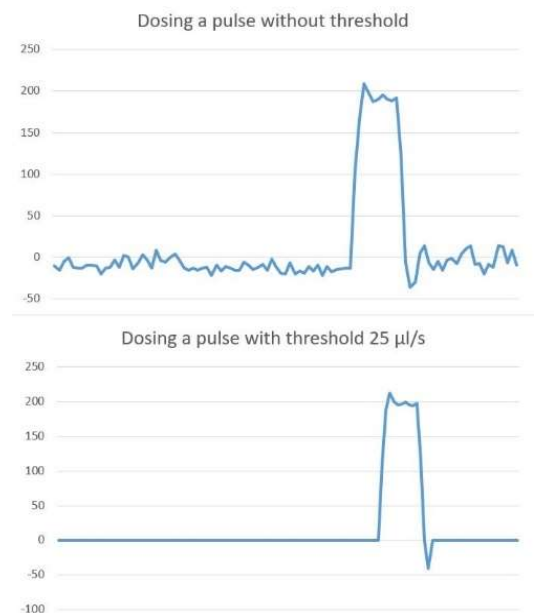


Figure 3: Pulse and Threshold

To choose the optimal threshold for an application, the noise of the sensor can be analyzed by setting the threshold to zero and the readout interval to 10 ms (**S_SetThreshold 0, S_Interval 10**). These settings lead to the raw acquisition data of the sensor (Figure 4). The Threshold should be set at least 5 times higher than the standard noise.

In this application the Threshold was set to 5 ml/min (**S_SetThreshold 83** ($\mu\text{l/s}$))

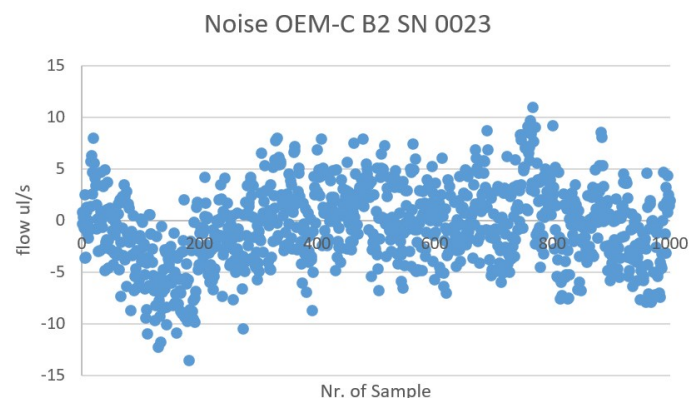


Figure 4: 1000 samples at 100 Hz – no flow

Flow and fluid calibration

The OEM-C uses a physical model to calculate the flow from a differential pressure. Within the flow equation, the values of viscosity and density can be changed using the commands **S_GetFluidCal** and **S_SetFluidCal**. (For example: **S_SetFluidCal 998 1** sets the density to 998 kg/m³ and the viscosity to 1 mPas). Like this, the sensor can be adjusted to higher viscous or denser media. An disregarded density change can influence the flow measurement by 40 % and a viscosity change by up to 5 %.

In case of a remaining linear offset, a multiplier (X) can be set by the command **S_SetFlowCorr X** to correct the flow rate.

Our sensor has the preset fluid density of 997.77 and viscosity of 0.955. **S_GetFluidCal**, which are the Parameters of water at 22° C.

The sensor temperature can be accessed by the command **M_Temp** and it is 21.84° C. So we keep the preset fluid parameters.

First dosing Volume and Calibration

We prime the system to fill all tubes with water.

Then we set the weight scale to zero.

Finally, we start the sensor and pump about 6 ml on to the weight scale. The Sensor is set to an interval of 10 s to only produce a few data points (averaged over 10 seconds).

Command:

S_GetThreshold

S_SetZero

S_Interval 10000 (10 seconds)

Answer:

Threshold 83.00 ul/s

Zero 0.180 mbar

Interval = 10000 ms

	Run 1	Run 2	Run 3
M_Cont 1	Flow 0.000 ul/s	0.000	235.925
	Flow 439.02 ul/s	242.014	428.920
	Flow 194.184 ul/s	366.307	425.300
	Flow 0.000 ul/s	0.000	412.941
Total measured Flow:	6.33205 ml	6.08321 ml	15.0309 ml
Weight scale value:	6.29955 g	6.12833 g	15.10086 g
Difference (density corrected)	0.29 %	-0.96 %	-0.68 %

The measurements don't seem to have a systematic error. Also the accuracy is not dependent on the dosing amount. Therefore the correction factor is left at 1.0 (**S_GetFlowCorr, Ans: FlowCorr 1.0000**)

Different readout rates:

The OEM-C has a unique internal sampling rate of 100 Hz at any moment. By setting the interval to 10 ms (**S_Interval 10**) the maximum readout rate is achieved.

By setting longer readout intervals of 1000 or 10000 ms, an average is calculated while the sensor is still sampling at 100 Hz.

This fact leads to different sensor signals, depending on the readout rate, while the volume integral stays the same.

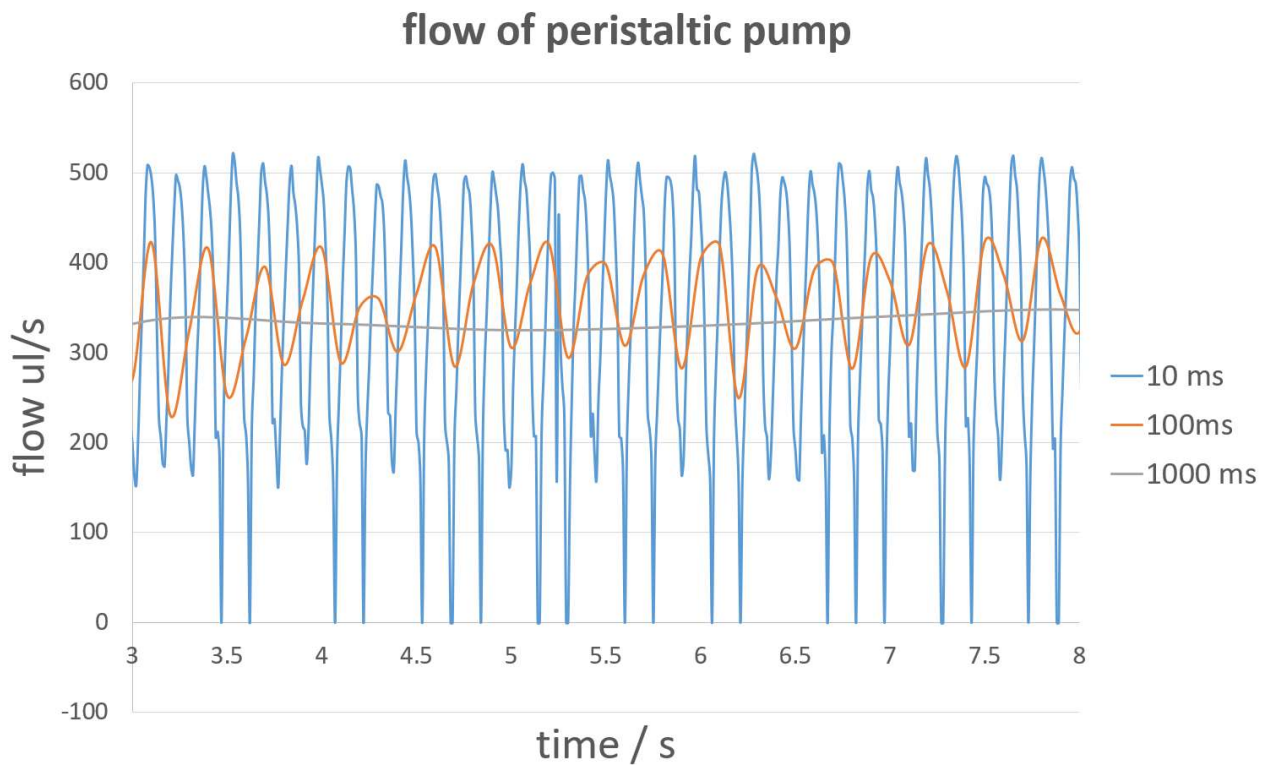


Figure 5: Volume flow at readout intervals of 10, 100 and 1000 ms

Pumping liquid with air bubbles

To show the OEM-Cs capability to measure liquid containing air bubbles, 10 ml of water were pumped by the peristaltic pump. Then random air bubbles were introduced to disturb the sensor. The readout interval was 1 second.

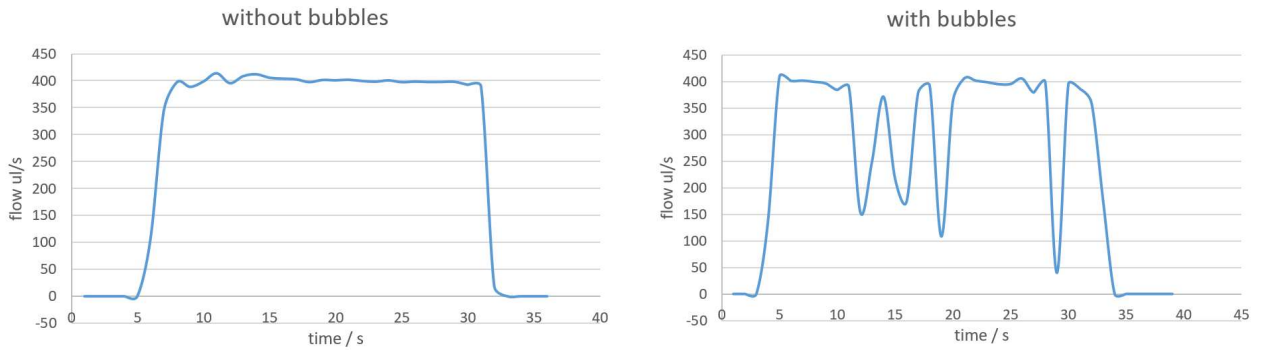


Figure 6: Dispensing with introduced air bubbles

The pumped water was measured on the weight scale and compared to the sensor data:

	Run 1	Run 2
Without bubbles:		
Weight scale	10.271 g	10.162 g
Sensor	10.280 ml	10.217 ml
Error (density corrected)	-0.13 %	+0.32 %
With air bubbles:		
Weight scale	9.8047 g	10.223 g
Sensor	9.8767 ml	10.320 ml
Error (density corrected)	+0.51 %	+0.72 %

The two runs containing air bubbles show a slightly higher sensor signal. However, the deviation is below 1 %.