



Technical Note

Low Flow Measurement with SONOFLOW® CO.55 V3.0

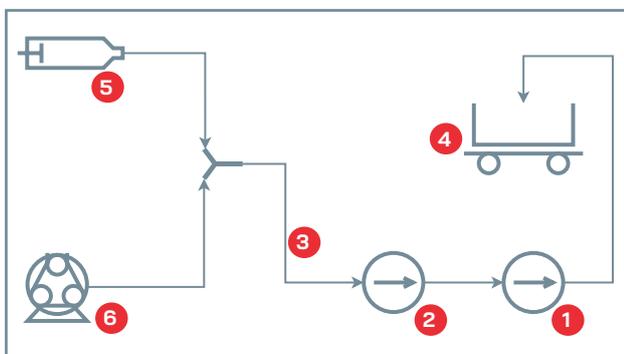
With the growing popularity of micro-bioreactors, perfusion, as well as cell & gene therapy applications in the life sciences industry, the need to measure low flow rates non-invasively is ever increasing. With updated electronics and improved computational algorithms, SONOFLOW CO.55 V3.0 clamp-on flow meters push the boundaries of low flow measurement in flexible tubing, without the need to come in contact with the media being measured. This technical note outlines the improvements that can be achieved with the new SONOFLOW CO.55 V3.0 sensors.



List of Materials

No.	Description	Specification
1	Flow sensor A	SONOFLOW® CO.55/060 V2.0 SN10709
2	Flow sensor B	SONOFLOW® CO.55/0250 V3.0 SN10031
3	Measurement tubing	Masterflex® Platinum Cured Silicone 96410-16
4	Scale	Sartorius Entris® 2202-1S
5	Syringe pump (≤100mL/min)	Chemyx Fusion 100T
6	Peristaltic pump (>100mL/min)	Masterflex® L/S® Thermo Scientific Masterflex® P/S Easy-LoadII Pump Head (Model 955-0000)
7	Thermometer	Fluke 52II
8	Medium	Tap water, de-gassed, 23 °C, Density 0.9975 g/cm ³

Scheme of the Setup



* outer diameter of the tubing

Materials and Methods

To demonstrate the low flow capabilities of the new SONOFLOW CO.55 V3.0 flow meter series, comparative measurements have been performed between a SONOFLOW CO.55 V2.0 and a SONOFLOW CO.55 V3.0.

For the testing, water (@ 23 °C/73 °F) was pumped through a ¼" Masterflex Tubing* using a Masterflex peristaltic pump or a Chemyx syringe pump, which are both connected via a Y-connector to the measuring tubing. Each pump can be pinched off using standard hose clamps. Both flow meters are clamped to a new, straight line of tubing with a distance of 20 cm before, between, and after the sensors. For accurate reference measurement, the scale does not have any contact with the setup material and is tared before each test run.

Target flows from 2.5 mL/min to 1000 mL/min are tested. The collected volume of a one minute run is weighed. By dividing the measured weight by the density of water (@ 23 °C), the reference flow value is determined.

Important SONOFLOW CO.55 Sensor Settings

For both sensors, the averaging type has been set to "Floating Averaging", while the averaging value was set to 64 (resulting in step response $T_{95} \sim 0.06$ sec).

The setup and the sensor settings are used to repeat a calibration run covering 18 flow values between 2.5 mL/min and 1000 mL/min for five times. The flow meters are not re-clamped or moved in between the five calibration runs.

Results

The plot below summarizes the test results by focusing on the flow range between 2.5...100 mL/min. At flow rates higher than 50 mL/min, both tested clamp-on flow meters show almost the same deviation from the target flow with an accuracy of 1 % and better.

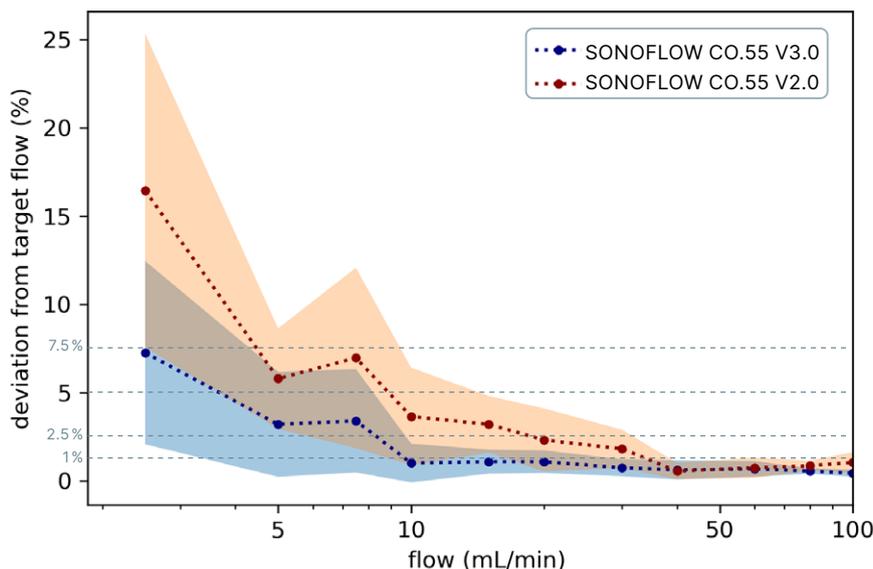
The total testing in the low flow ranges covers 11 target flow rates with 5 runs per target rate. The X-axis indicates the flow rates as a logarithmic function. The red-dotted curve shows the mean values of the measurements with the SONOFLOW CO.55 V2.0 flow meter; the blue-dotted curve depicts the mean values for the measurement with SONOFLOW CO.55 V3.0. The colored areas next to the dotted curves displays the standard deviation for the tested flow rate.

The plot impressively shows the improvements of the SONOFLOW CO.55 V3.0 flow meter compared to SONOFLOW CO.55 V2.0 in the very low flow

ranges. Particularly in the range lower than 40 mL/min, the new ultrasonic sensor demonstrates its strength.

SONOFLOW CO.55 V3.0 has been designed for low flow applications in biopharmaceutical process development. Considering the testing with 2.5 mL/min, the new flow meter is significantly more accurate than the previous sensor version by a factor of 2. The mean deviation from the target flow is only 7% for the SONOFLOW CO.55 V3.0; the previous version diverges with about 16%, which still is at this low flow rate an outstanding result.

The standard deviation for SONOFLOW CO.55 V3.0 underlines the high accuracy in the very low flow rates. At flow rates above 10 mL/min, the standard deviation is only $\pm 2\%$ for the new sensor; SONOFLOW CO.55 V2.0 achieves this excellent low standard deviation at a flow rate of 30 mL/min.



"Our latest non-contact clamp-on flow meter SONOFLOW CO.55 V3.0 combines accuracy and usability for low flow applications."

Nico Polley
Product Manager

Plot: Testing of SONOFLOW CO.55 V3.0 and SONOFLOW CO.55 V2.0 in low flow measurement

Conclusion

For the flow rates between 5 mL/min and 20 mL/min, SONOFLOW CO.55 V3.0 also shows a higher accuracy compared to SONOFLOW CO.55 V2.0 with a factor of 1.5. Although SONOFLOW CO.55 V2.0 is considered one of the most accurate non-contact clamp-on flow meters, the new sensor development

also shows considerable improvements for these flow rates. The measurement results demonstrate that the development work for the SONOFLOW CO.55 V3.0 flow meter was successful and the aim of achieving significant improvements in the low flow ranges was impressively achieved.

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