BROOKS® INSTRUMENT

Beyond Measure

Effects of Tubing Changes on Calibration of BCU Clamp-on Ultrasonic Flow Meters

BCU Clamp-on Ultrasonic Flow Meters are factory calibrated to customer specific tubing to ensure the most accurate and reliable measurement results. The unique properties of the tubing, such as material of composition, inner diameter, and durometer affect the speed at which the ultrasound travels through the tubing and are accounted for during the calibration process. If BCU flow meters are used with a tubing that differs from the tubing used for calibration, there will be a shift in the calibration causing potential inaccuracies in reported measurement. Tubing changes can be accounted for with adjustments using the embedded web-based interface or through factory recalibration. While BCU flow meters can be accurately calibrated for most industry standard tubing, it is important to understand how tubing changes can affect the calibration and therefore the reported flow measurement.

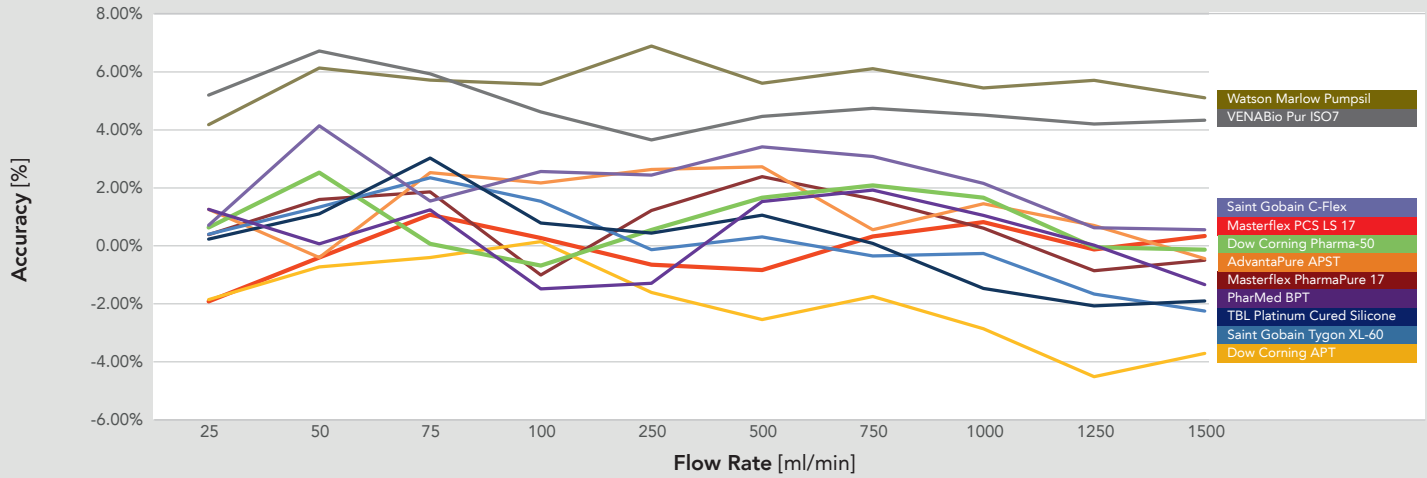
Flow Meter Set-Up for Comparison of Multiple Tubing Types

Sensor	BCU Clamp-on Ultrasonic Flow Meter
Tubing Size	1/4" ID x 3/8" OD
Baseline Calibration	Standard factory calibration for Masterflex® PCS [water, 23°C ±2 K, standard sensor flow range]
Comparison	Made by changing tubing while all other parameters remain constant

Calibration Shift Due to Tubing Change

The Diagram shows the comparison of multiple tubing types used on the BCU flow meter calibrated for Masterflex® PCS.

Conclusion: Changing tubing will cause a calibration shift. Flow meter must be adjusted properly for the specific tubing type being used.



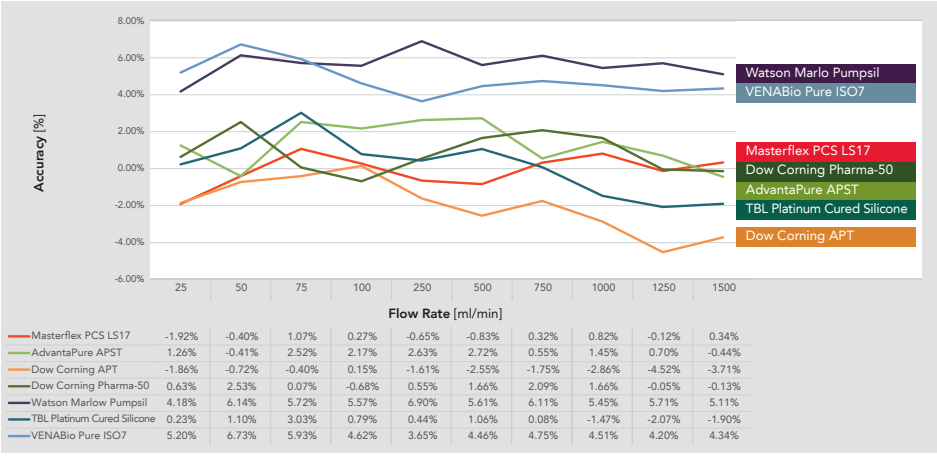
	25	50	75	100	250	500	750	1000	1250	1500
Masterflex PCS LS17	-1.92%	-0.40%	1.07%	0.27%	-0.65%	-0.83%	0.32%	0.82%	-0.12%	0.34%
Masterflex PharmaPure 17	0.39%	1.60%	1.86%	-1.00%	1.22%	2.39%	1.61%	0.61%	-0.86%	-0.50%
AdvantaPure APST	1.26%	-0.41%	2.52%	2.17%	2.63%	2.72%	0.55%	1.45%	0.70%	-0.44%
Dow Corning APT	-1.86%	-0.72%	-0.40%	0.15%	-1.61%	-2.55%	-1.75%	-2.86%	-4.52%	-3.71%
Dow Corning Pharma-50	0.63%	2.53%	0.07%	-0.68%	0.55%	1.66%	2.09%	1.66%	-0.05%	-0.13%
Saint Gobain Tygon XL-60	0.40%	1.34%	2.35%	1.54%	-0.13%	0.31%	-0.35%	-0.26%	-1.66%	-2.25%
Saint Gobain C-Flex 374	0.71%	4.14%	1.54%	2.57%	2.44%	3.41%	3.08%	2.16%	0.63%	0.56%
Watson Marlow Pumpsil	4.18%	6.14%	5.72%	5.57%	6.90%	5.61%	6.11%	5.45%	5.71%	5.11%
TBL Platinum Cured Silicone	0.23%	1.10%	3.03%	0.79%	0.44%	1.06%	0.08%	-1.47%	-2.07%	-1.90%
PharMed BPT	1.26%	0.07%	1.24%	-1.48%	-1.29%	1.53%	1.93%	1.05%	0.02%	-1.34%
VENABio Pure ISO7	5.20%	6.73%	5.93%	4.62%	3.65%	4.46%	4.75%	4.51%	4.20%	4.34%

Tube Comparison Test 2: Same Material, Different Manufacturer

Manufacturers have specific proprietary formulations for tubing materials which may alter the ultrasonic transmission. Two platinum cured silicone tubes from different manufacturers may perform differently in an ultrasonic sensor.

Using Masterflex® PCS as a baseline, the diagram at the right shows the shift when changing from one PCS to another from a different manufacturer.

Conclusion: Not all silicone is the same. The flow meter must be adjusted if changing from one manufacturer's silicone tubing to another.



	25	50	75	100	250	500	750	1000	1250	1500
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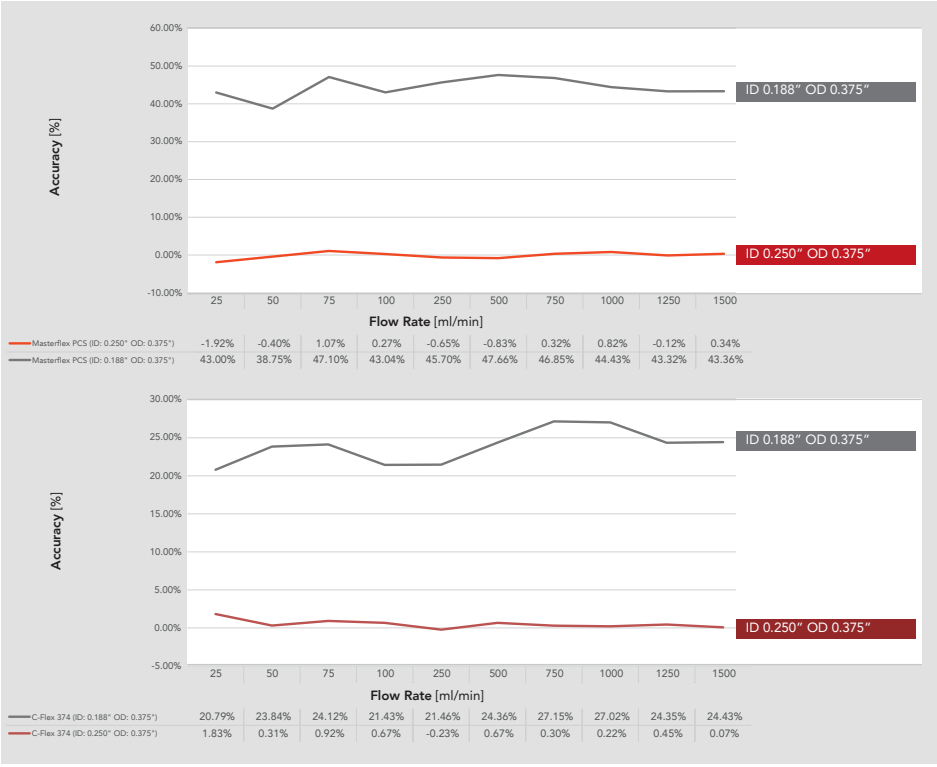
AdvantaPure APST	1.26%	-0.41%	2.52%	2.17%	2.63%	2.72%	0.55%	1.45%	0.70%	-0.44%
Dow Corning APT	-1.86%	-0.72%	-0.40%	0.15%	-1.61%	-2.55%	-1.75%	-2.86%	-4.52%	-3.71%
Dow Corning Pharma-50	0.63%	2.53%	0.07%	-0.68%	0.55%	1.66%	2.09%	1.66%	-0.05%	-0.13%
Watson Marlow Pumpsil	4.18%	6.14%	5.72%	5.57%	6.90%	5.61%	6.11%	5.45%	5.71%	5.11%
TBL Platinum Cured Silicone	0.23%	1.10%	3.03%	0.79%	0.44%	1.06%	0.08%	-1.47%	-2.07%	-1.90%
VENABio Pure ISO7	5.20%	6.73%	5.93%	4.62%	3.65%	4.46%	4.75%	4.51%	4.20%	4.34%

Tube Comparison Test 3: Different Inner Diameter (ID)

Inner diameter of the tubing affects the cross sectional area inside the tube, which is a contributing factor in the flow measurement calculation.

Diagrams at the right show how tubing from the same manufacturer with the same composition will differ in measurement calculation when the ID of the tubing is not the same.

Conclusion: The flow meter must be adjusted when changing to a tubing with the same OD but different ID.



	25	50	75	100	250	500	750	1000	1250	1500
Masterflex PCS (ID: 0.250" OD: 0.375")	-1.92%	-0.40%	1.07%	0.27%	-0.65%	-0.83%	0.32%	0.82%	-0.12%	0.34%
Masterflex PCS (ID: 0.188" OD: 0.375")	43.00%	38.75%	47.10%	43.04%	45.70%	47.66%	46.85%	44.43%	43.32%	43.36%

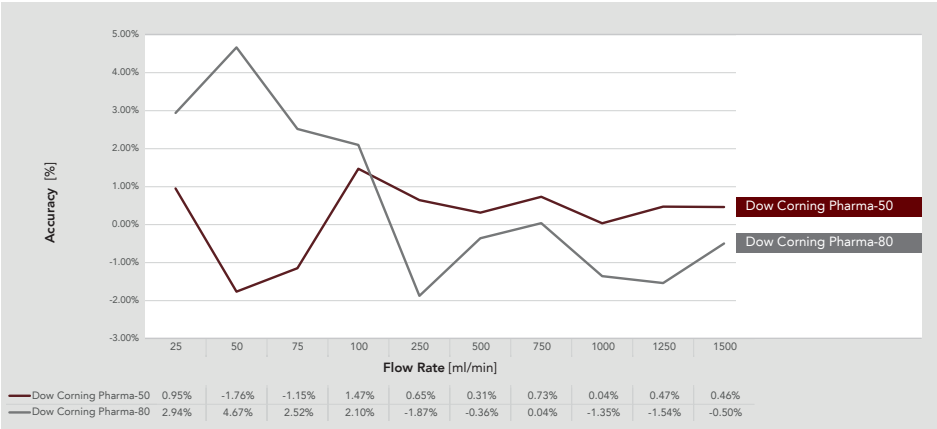
	25	50	75	100	250	500	750	1000	1250	1500
C-Flex 374 (ID: 0.188" OD: 0.375")	20.79%	23.84%	24.12%	21.43%	21.46%	24.36%	27.15%	27.02%	24.35%	24.43%
C-Flex 374 (ID: 0.250" OD: 0.375")	1.83%	0.31%	0.92%	0.67%	-0.23%	0.67%	0.30%	0.22%	0.45%	0.07%

Tube Comparison Test 4: Different Durometer

Durometer of the tubing will also affect the calibration because the ultrasound will travel at different speeds depending on durometer. In addition, tubes with differing durometers fit differently in the flow meter, affecting the inner diameter measurement and area.

The diagram at the right shows a flow meter calibrated on Dow Corning Pharma 50 compared to Pharma 80.

Conclusion: It is important to adjust the BCU flow meter when changing the tubing durometer



	25	50	75	100	250	500	750	1000	1250	1500
Dow Corning Pharma-50	0.95%	-1.76%	-1.15%	1.47%	0.65%	0.31%	0.73%	0.04%	0.47%	0.46%
Dow Corning Pharma-80	2.94%	4.67%	2.52%	2.10%	-1.87%	-0.36%	0.04%	-1.35%	-1.54%	-0.50%

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