Minimizing Particles During the Post CMP Cleaning Process

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Options For Post CMP Cleaning Fluid Delivery

- Pressurized delivery system and needle valve
- Rotameter with needle valve
- Peristaltic pump
- Liquid flow controller

Key Messages

Peristaltic pump:

- Generates a significant level of particles
- Reduces uptime and yield due to maintenance, inaccuracy and particle contamination

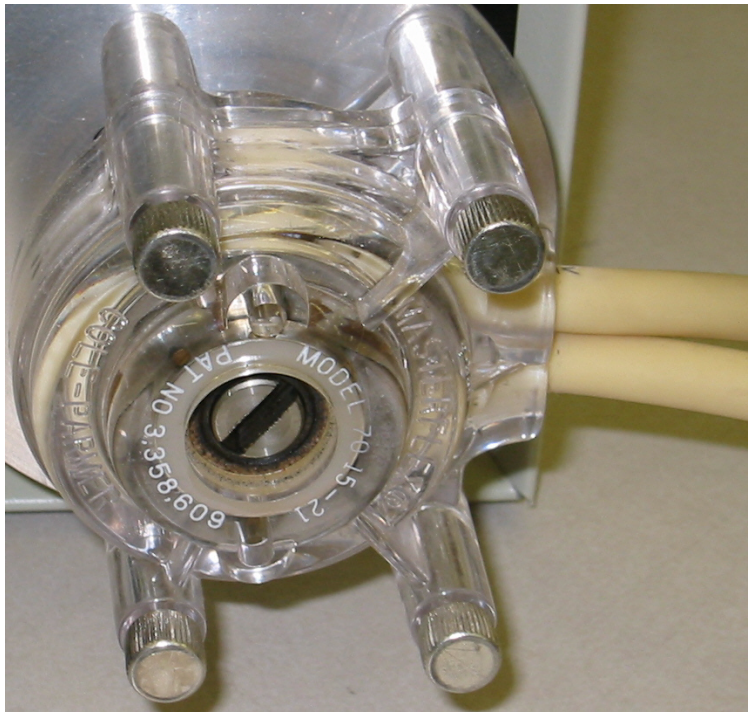
Liquid flow controller:

- Provides significant benefits for post CMP processes
- Minimizes particle addition to the fluid stream

Agenda

- Overview of peristaltic pump technology and performance
- Overview of flow controller technology and performance
- Particle test overview and test results
- Summary and conclusions

Peristaltic Pump Technology



- Repeatedly squeezes flexible tube to dispense fluid
- Typically used for blood transfer and medical operations
- Advantage: no dead legs for material to collect

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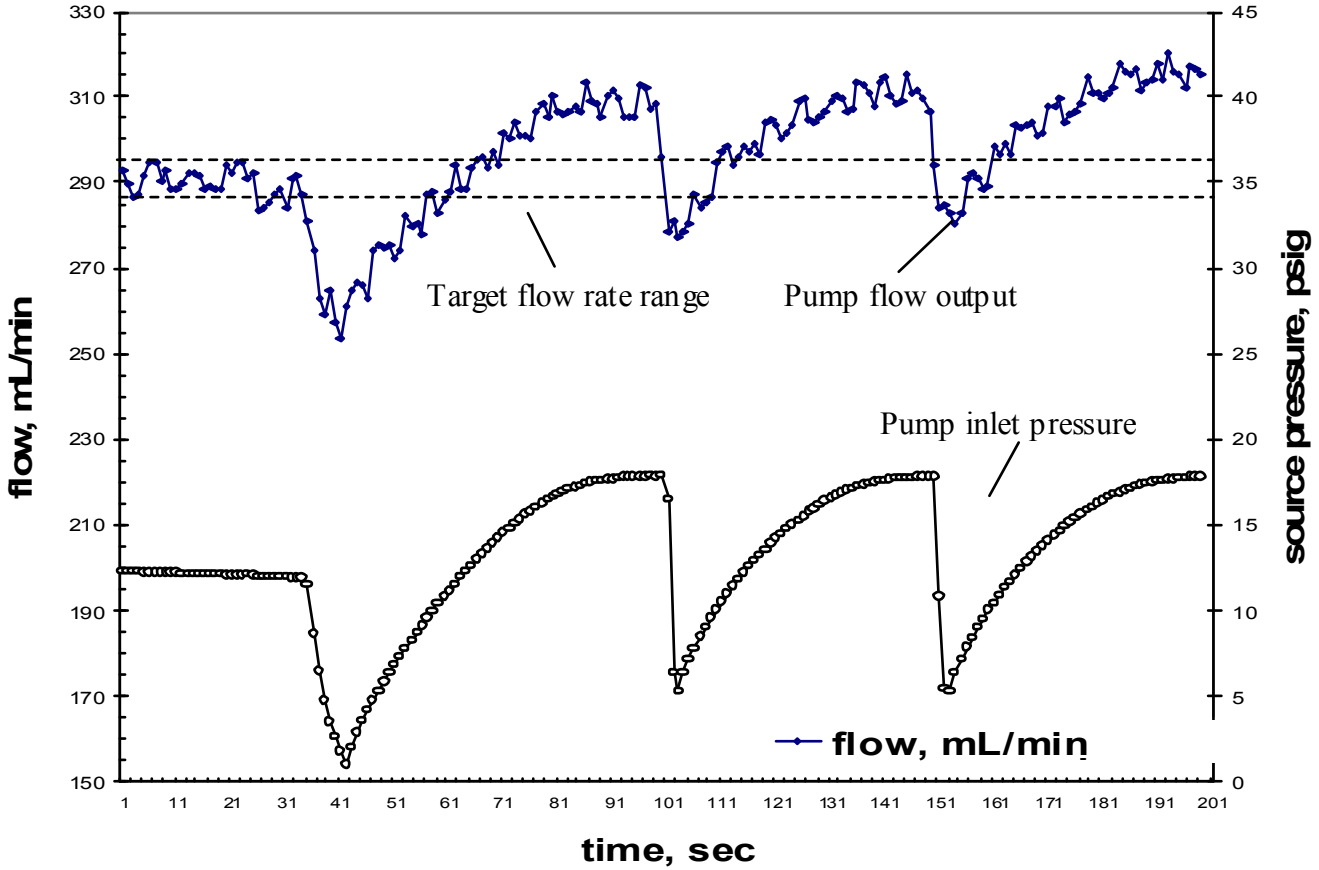
Disadvantages of Peristaltic Pumps

- Fluid flow varies with feed pressure
- Fluid flow with constant pressure varies with time
- No alarms for inaccurate flow conditions
- High maintenance
- Pump tubing generates contaminating particles

Fluid Flow Varies with Feed Pressure



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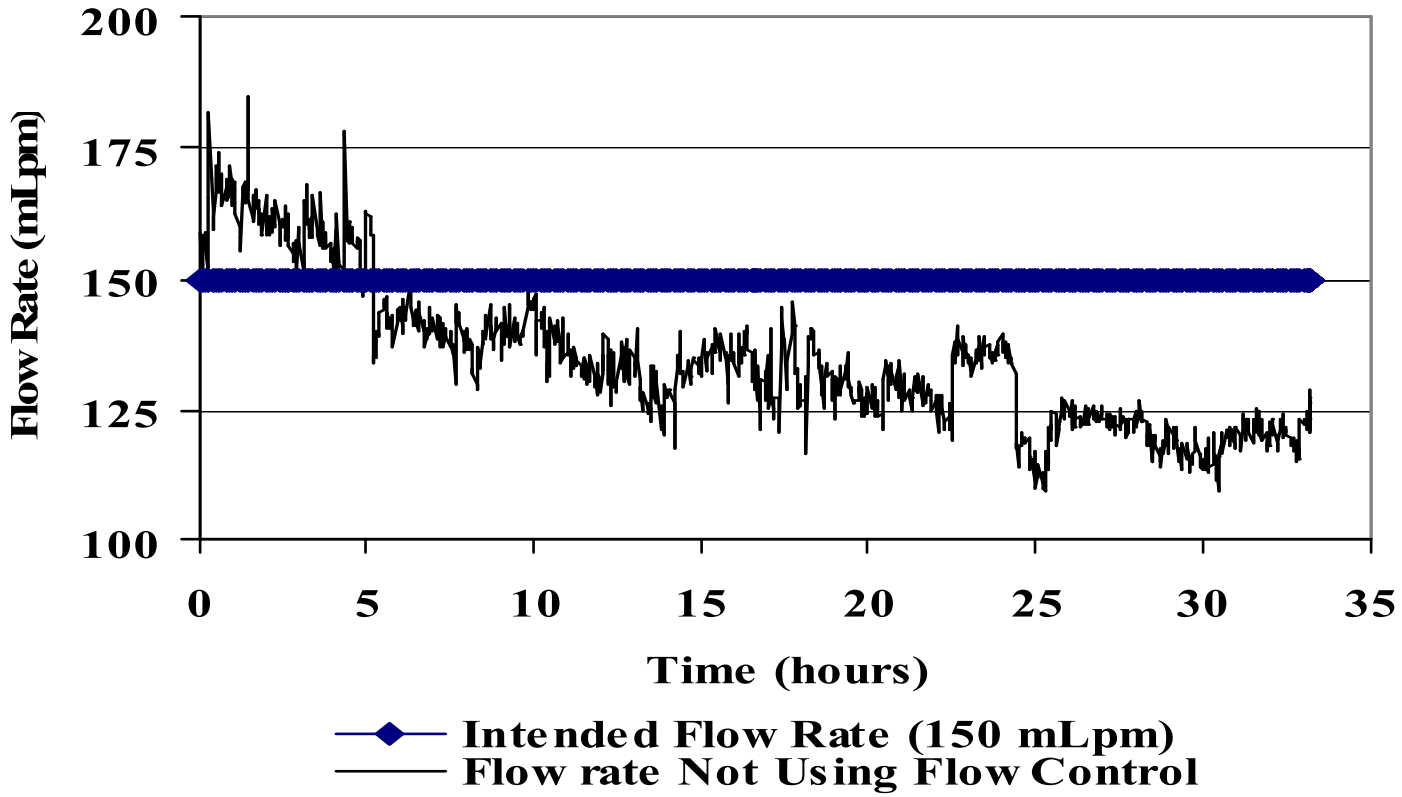
Fluid Flow with Constant Pressure



Fluid Flow Varies with Time Due to Tubing and Pump Wear

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No Alarms for Inaccurate Flow Conditions

Two conditions that require alarms:

1. Inaccurate flow

   Over or under polishing / post CMP cleaning

   Increases scrap and lowers yields

2. No flow

   Dry polishing / applying no post CMP cleaning fluids

   Potential catastrophic product loss

High Maintenance

- Pump replacement Approx 1x / year
- Pump calibration Approx 1x / month
- Pump tubing change Approx 1x / 3 month
- Process downtime and labor costs due to maintenance

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- **Overview of flow controller technology and performance**
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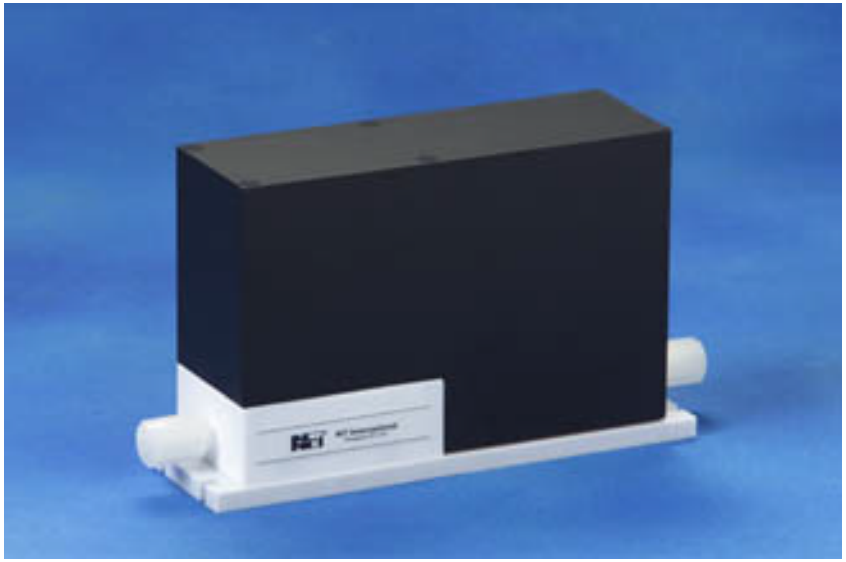
Upgrading Tools with a Flow Controller

- Provides *consistent* liquid flow rate
- *Increases yield* by providing proper chemical flow
- Reduces possibility of *catastrophic failure*
- Eliminates *particle contamination* from pump tubing
- Eliminates *downtime and labor costs* due to pump maintenance and replacement

Liquid Flow Controller



- Applications
  - CMP Slurry Dispense
  - Post CMP Cleaning
  - Chemical Blending
  - Wet Etch
  - Wet Cleaning

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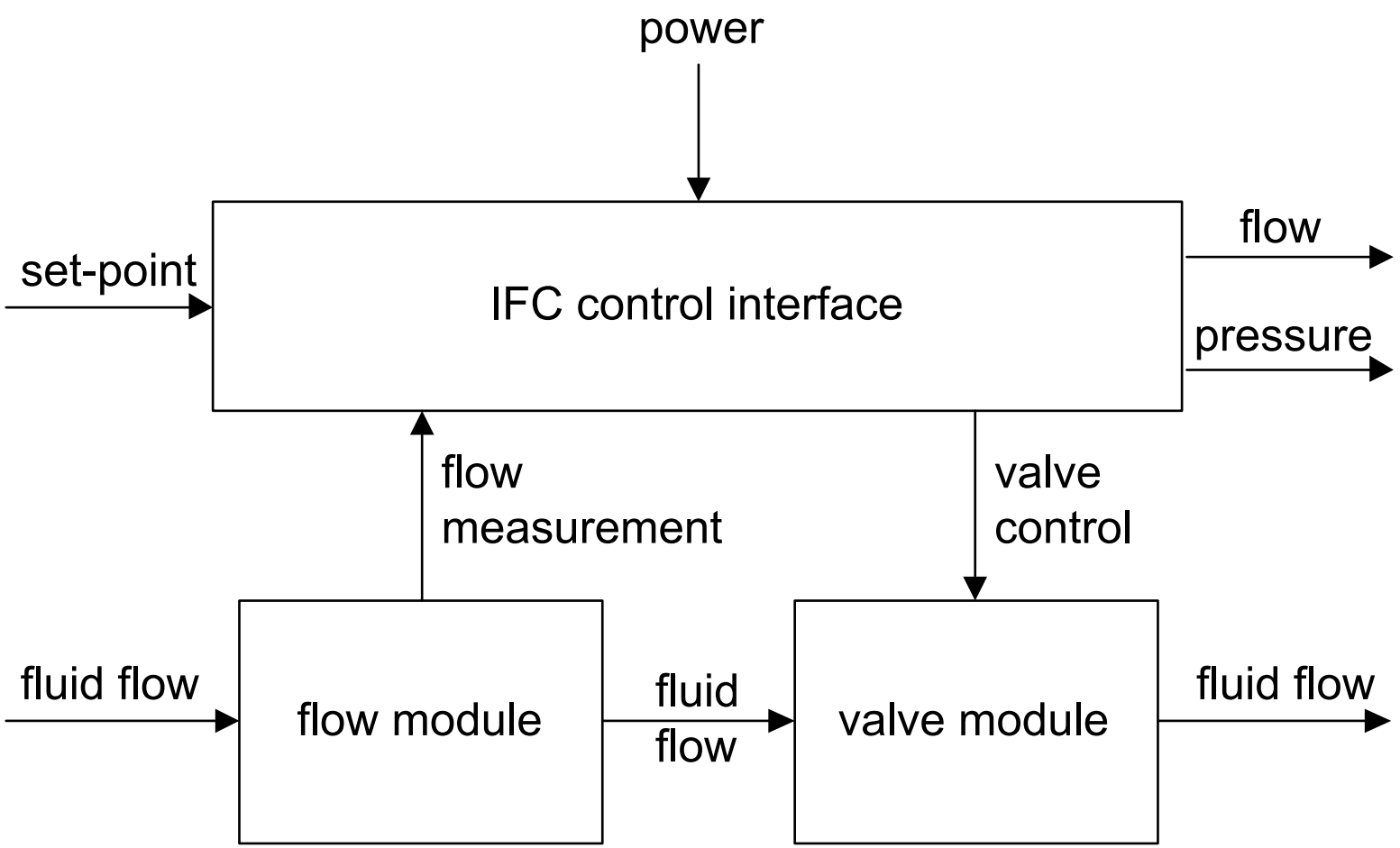
Liquid Flow Controller

Design Requirements for a particle-free flow controller:

- Flow measurement technology that contains no moving parts
- Control valve technology that minimizes movement of wetted parts
- Dead volume minimized

Liquid Flow Controller Design



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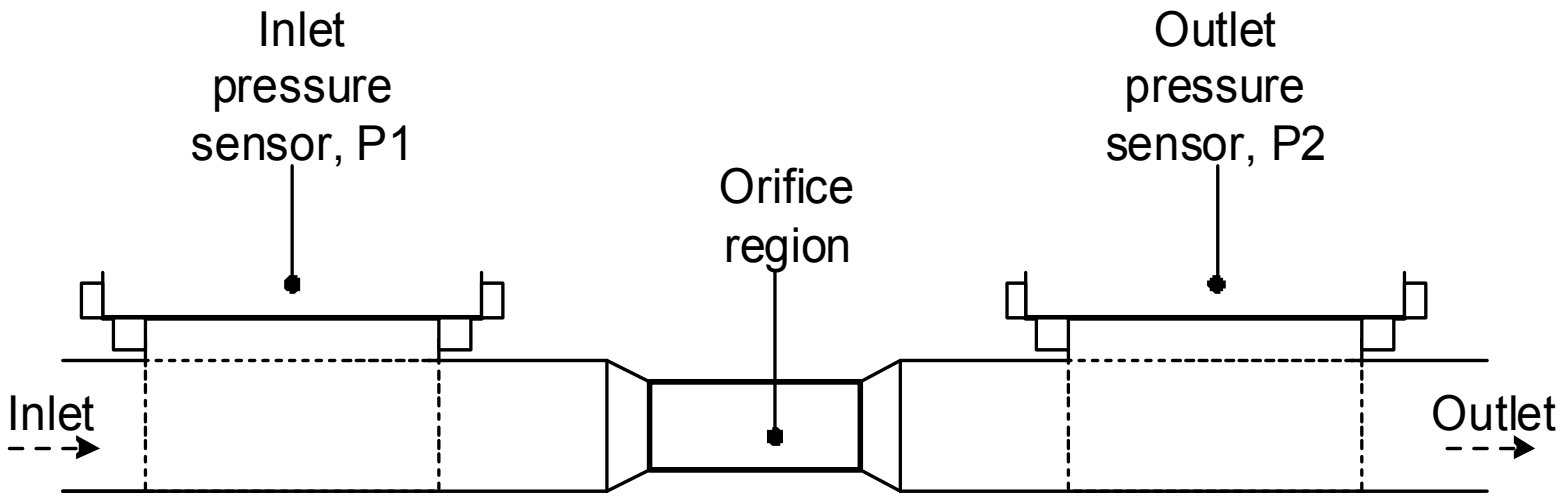
Differential Pressure Flow Measurement Technology



$$\text{Flow} \propto k \sqrt{(P1\text{-}P2)}$$

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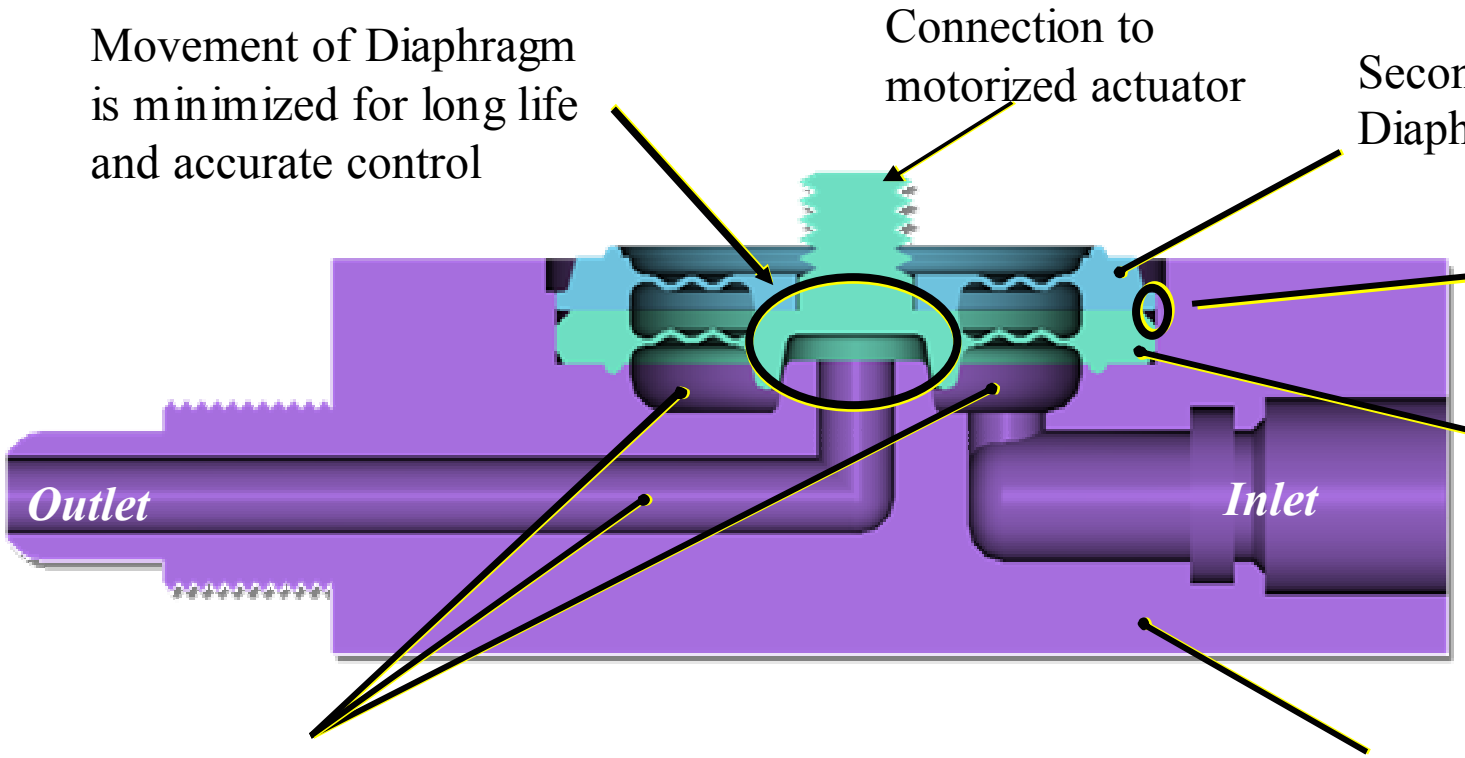
Control Valve Technology



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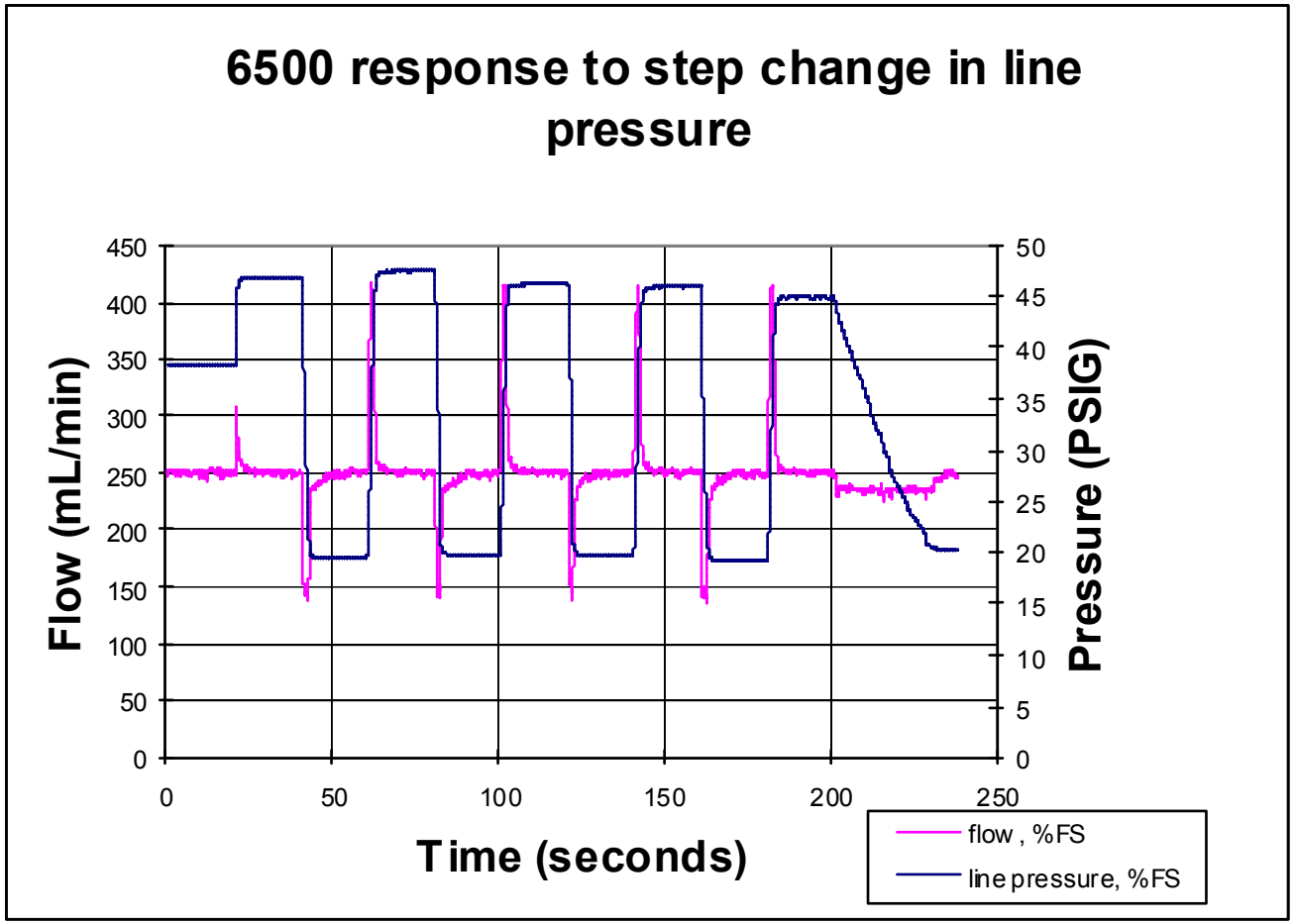
Liquid Flow Controller

- 1% of full-scale flow accuracy
- Response time to new set point or pressure change is 3 seconds
- Easy to integrate, small footprint
- Cost effective, clear return on investment (ROI)
- Provides 0-60 PSIG (0-4.1 Bar) pressure measurement

Integrated Flow Controller



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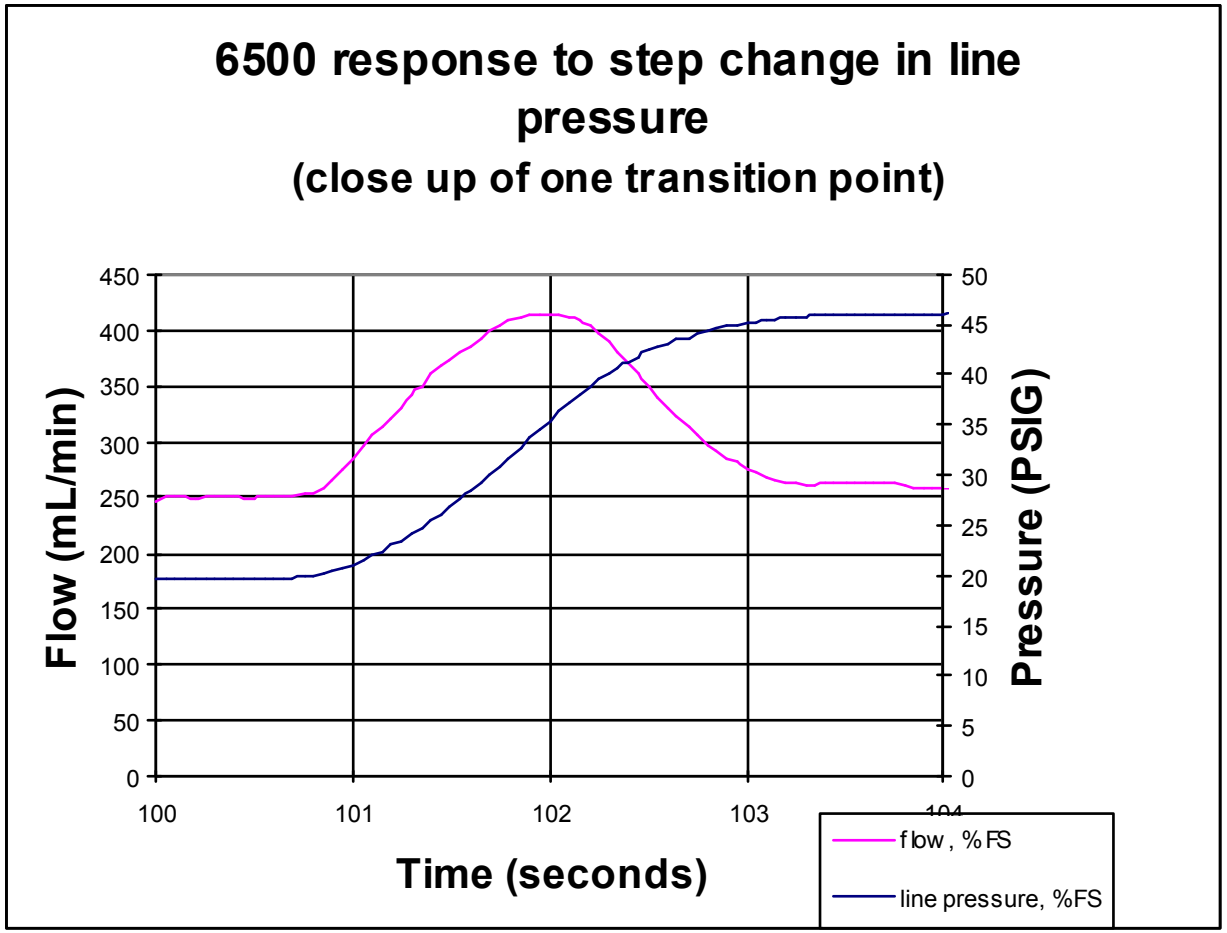
Integrated Flow Controller



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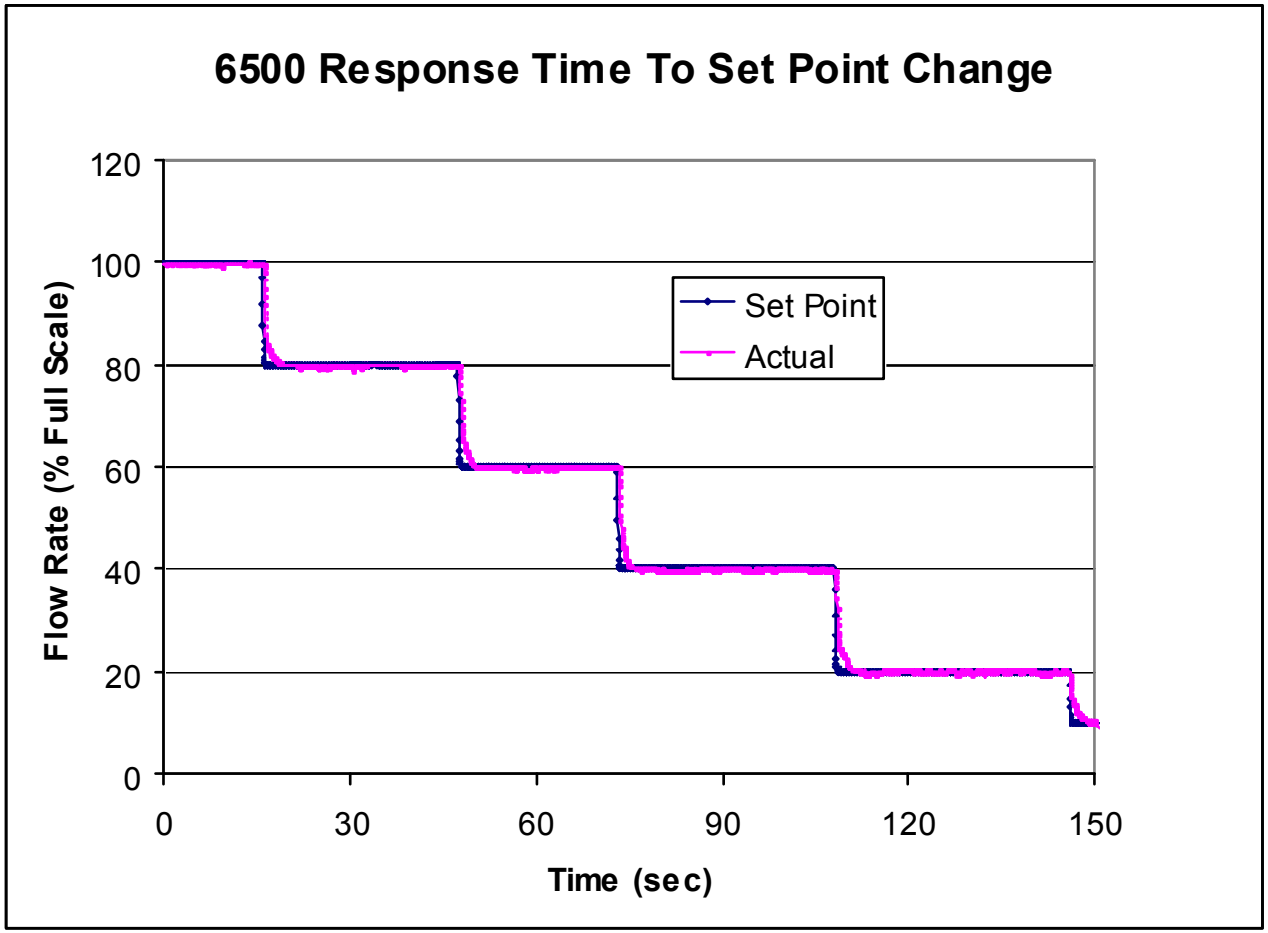

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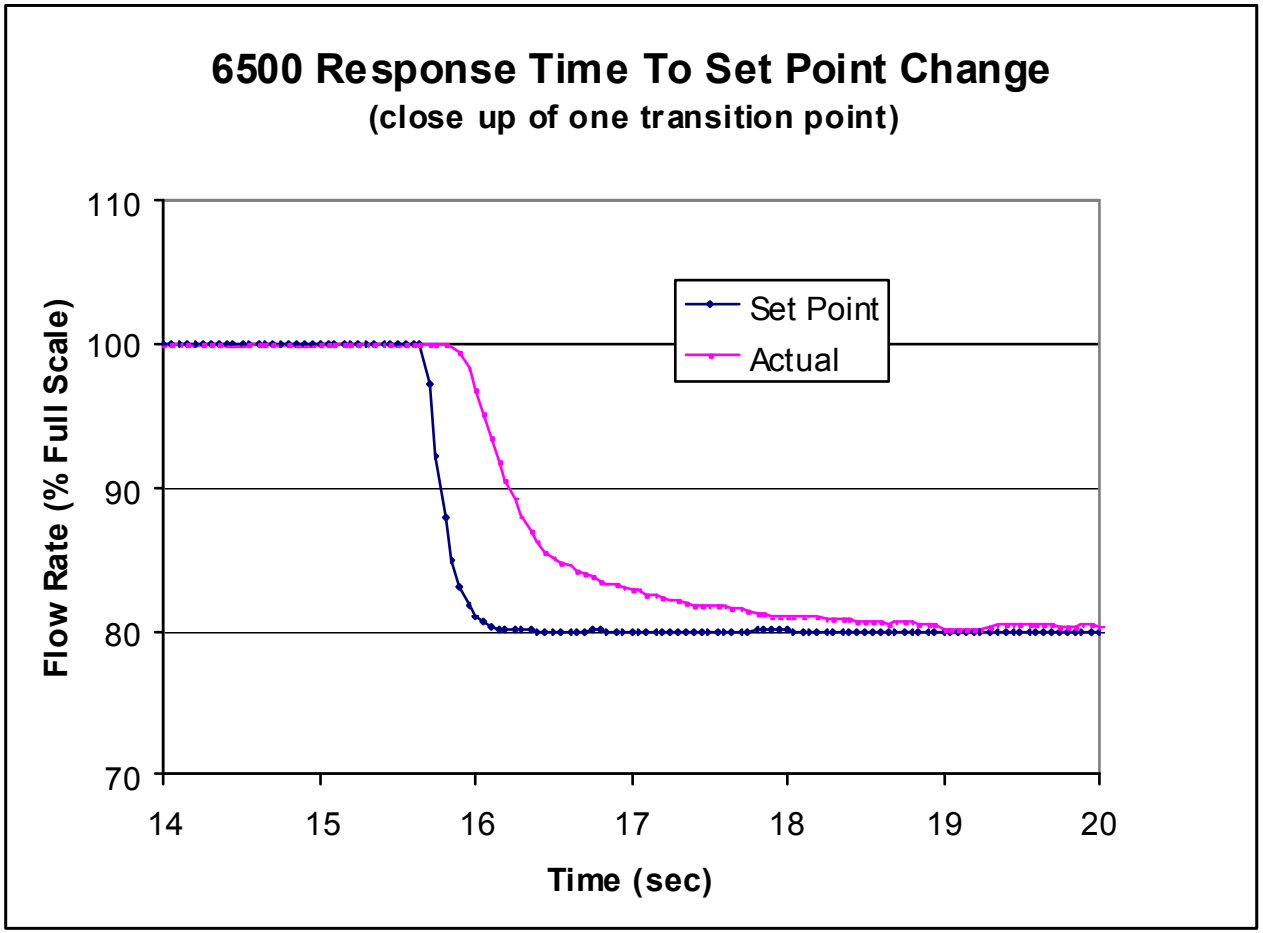

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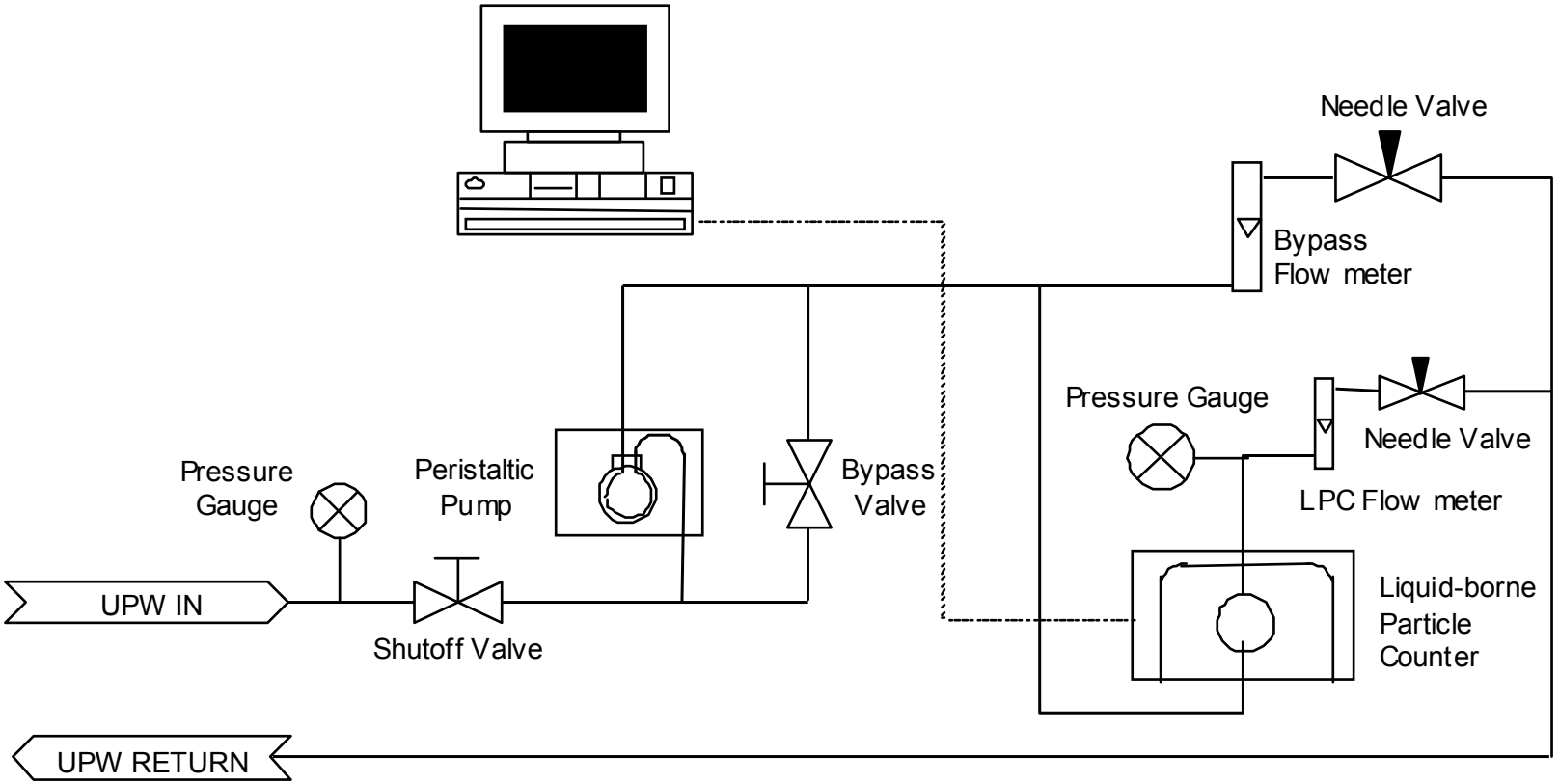
Particle Test Overview

- Performed at Technology Characterization Laboratory, Entegris, Inc
- Ultrapure DI water
- PMS Liquistat Particle Counter
- Masterflex Pump Head (Model A-07015-20)
- Norprene High Performance Precision Pump Tubing (Model A-06402-15 L/S15)
- Two Liquid Flow Controllers (Model 6500)

Particle Test: Peristaltic Pump



Schematic of the Test Set-up for Peristaltic Pump Particle Generation

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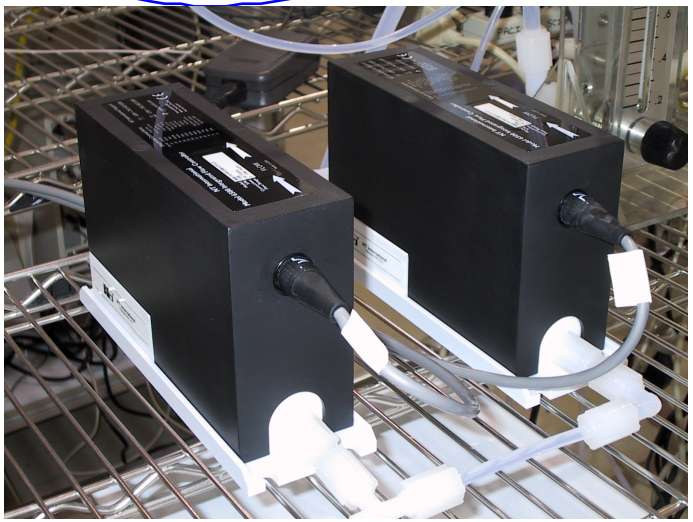
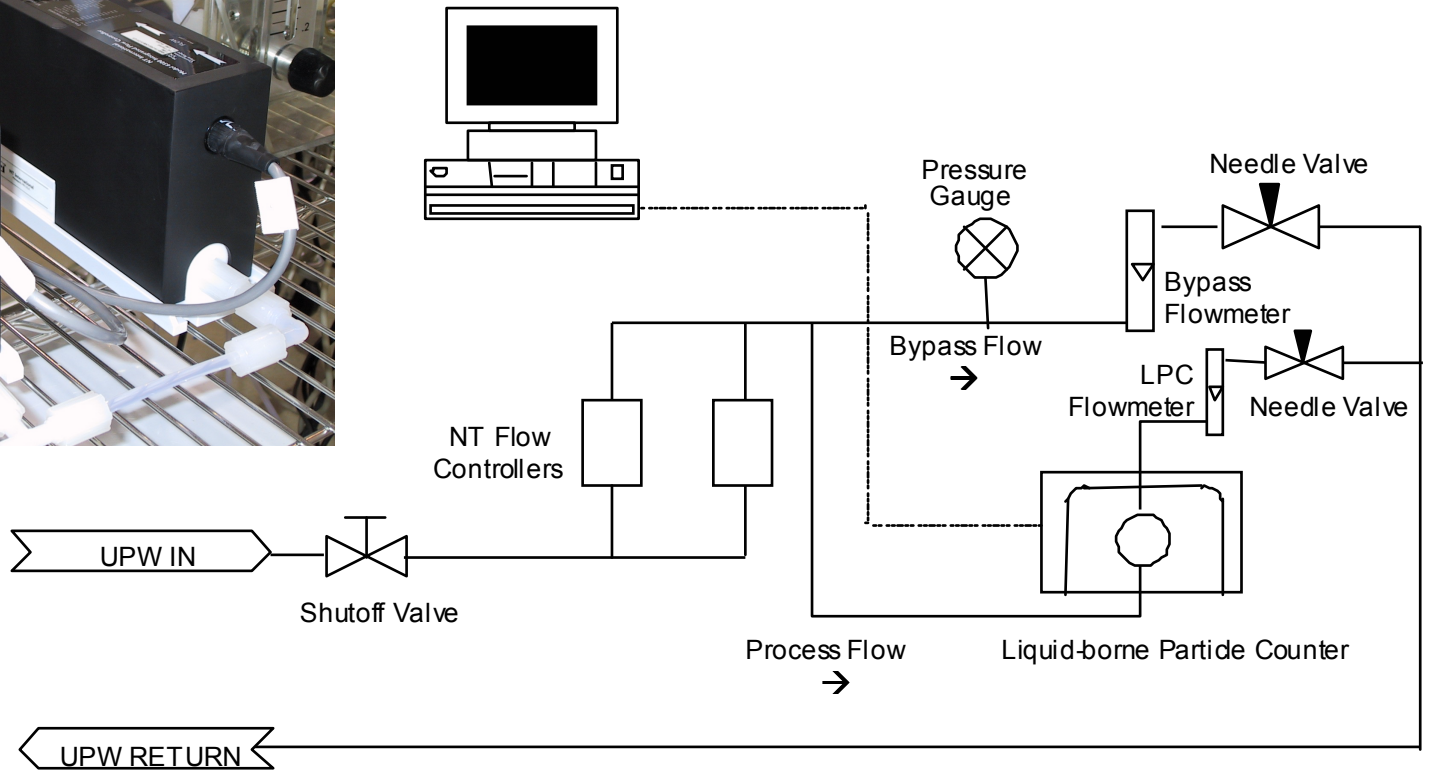
Particle Test: Flow Controllers





Schematic of the Test Set-up for Flow Controller Particle Generation

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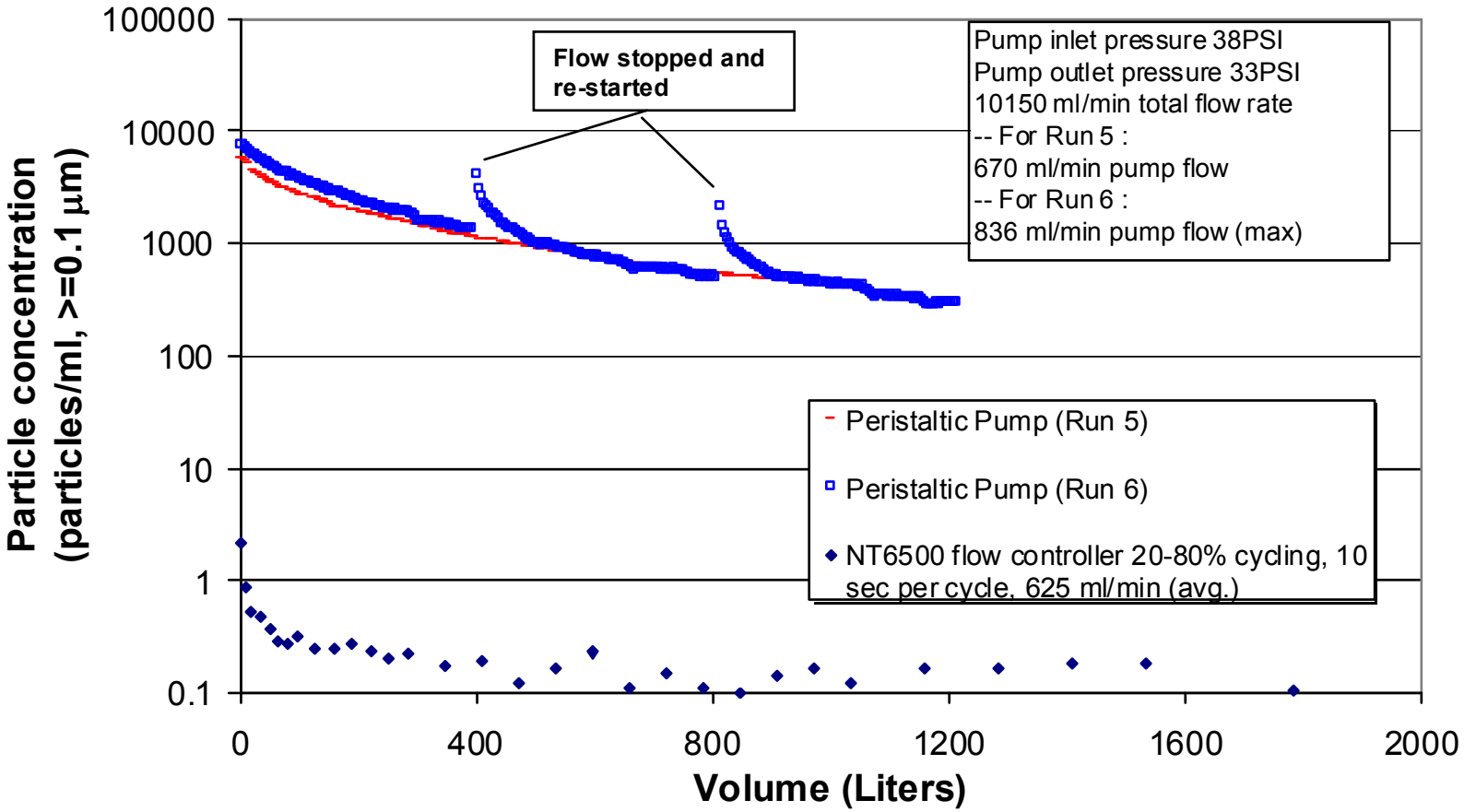
Test Results:
Peristaltic Pump and Flow Controller Particle



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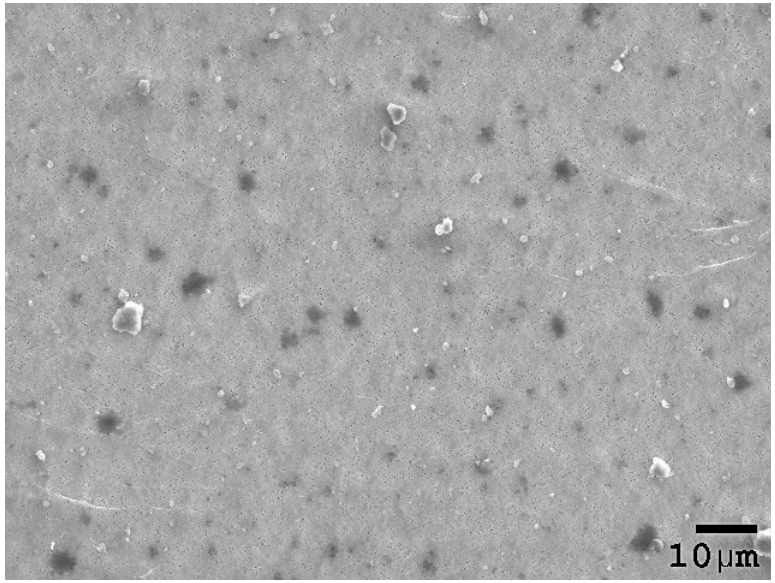
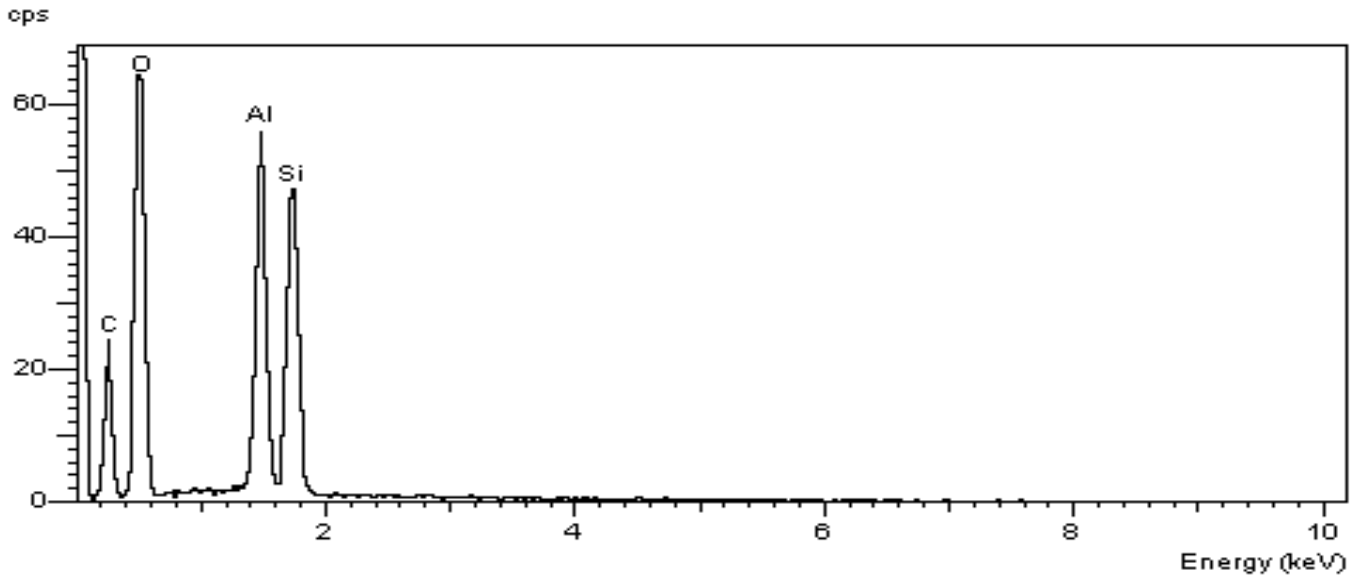
Tubing Particles from Flush Test



SEM photograph of particles released from the peristaltic pump, collected on a 47mm Polycarbonate membrane, approximately 170 Liters of water from start of test.

Tubing Particles from Flush Test



EDS spectrum of a typical particle
Note: High Si and Al content

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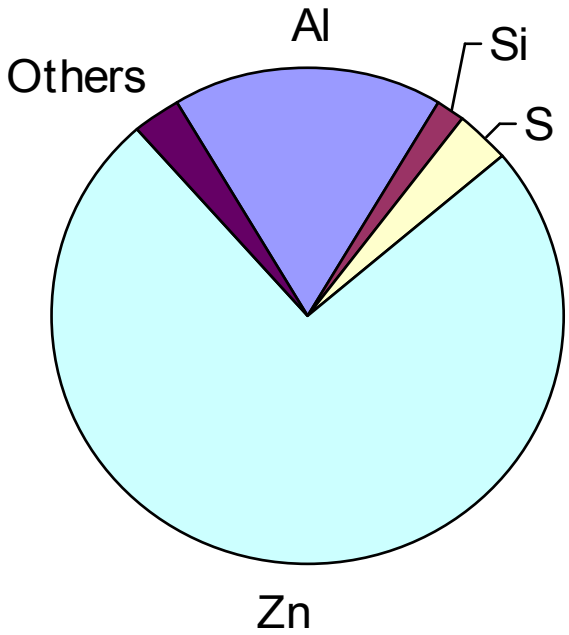
Bulk Trace Metals Test of Norprene Pump Tubing, ICP-MS



Note: High Al and Si content, which supports the hypothesis that the particles are from the tubing.

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Summary and Conclusions

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