



Field Evaluation of High Pressure MagLev Pump in CMP Slurry Recirculation

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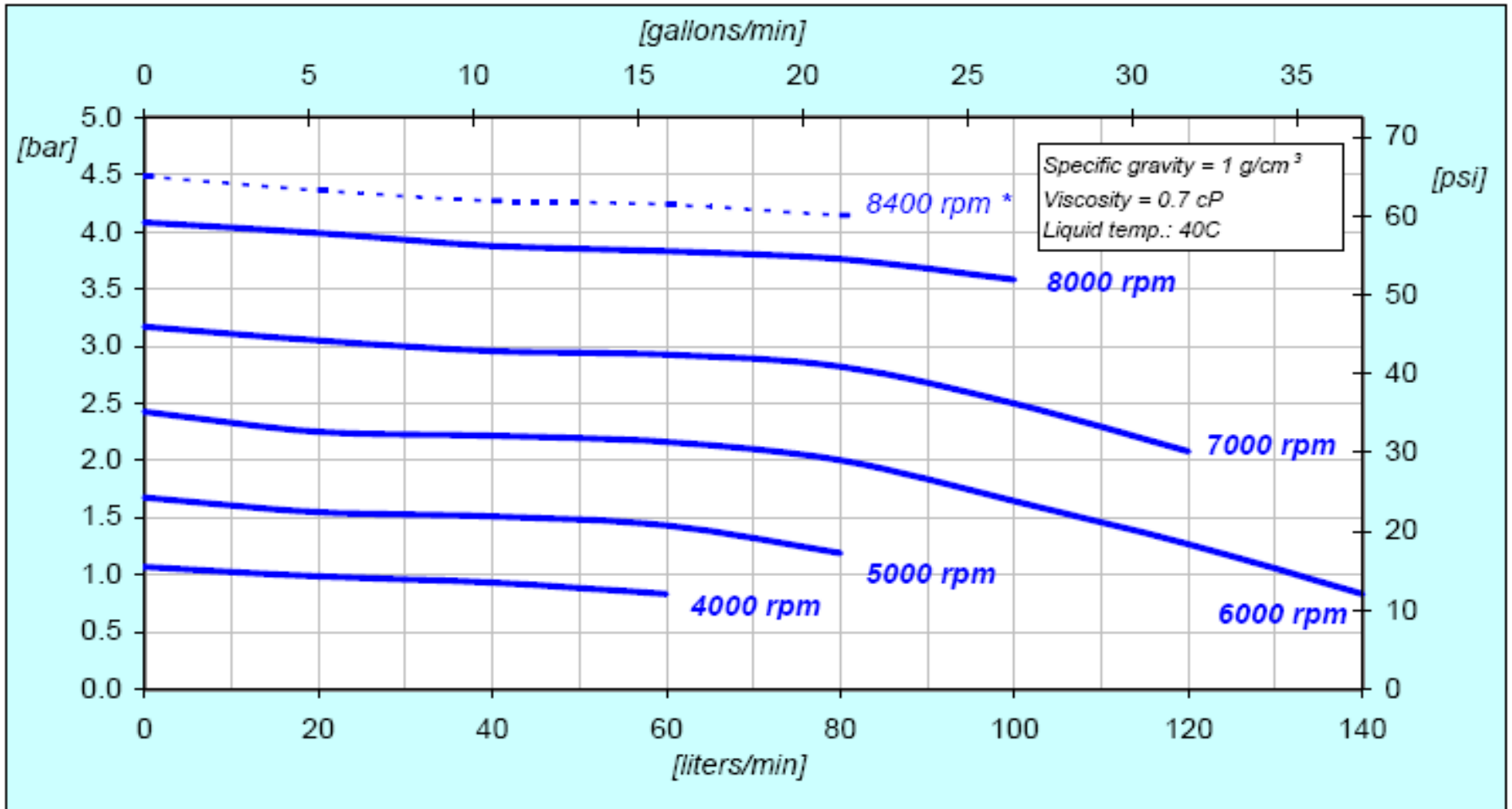
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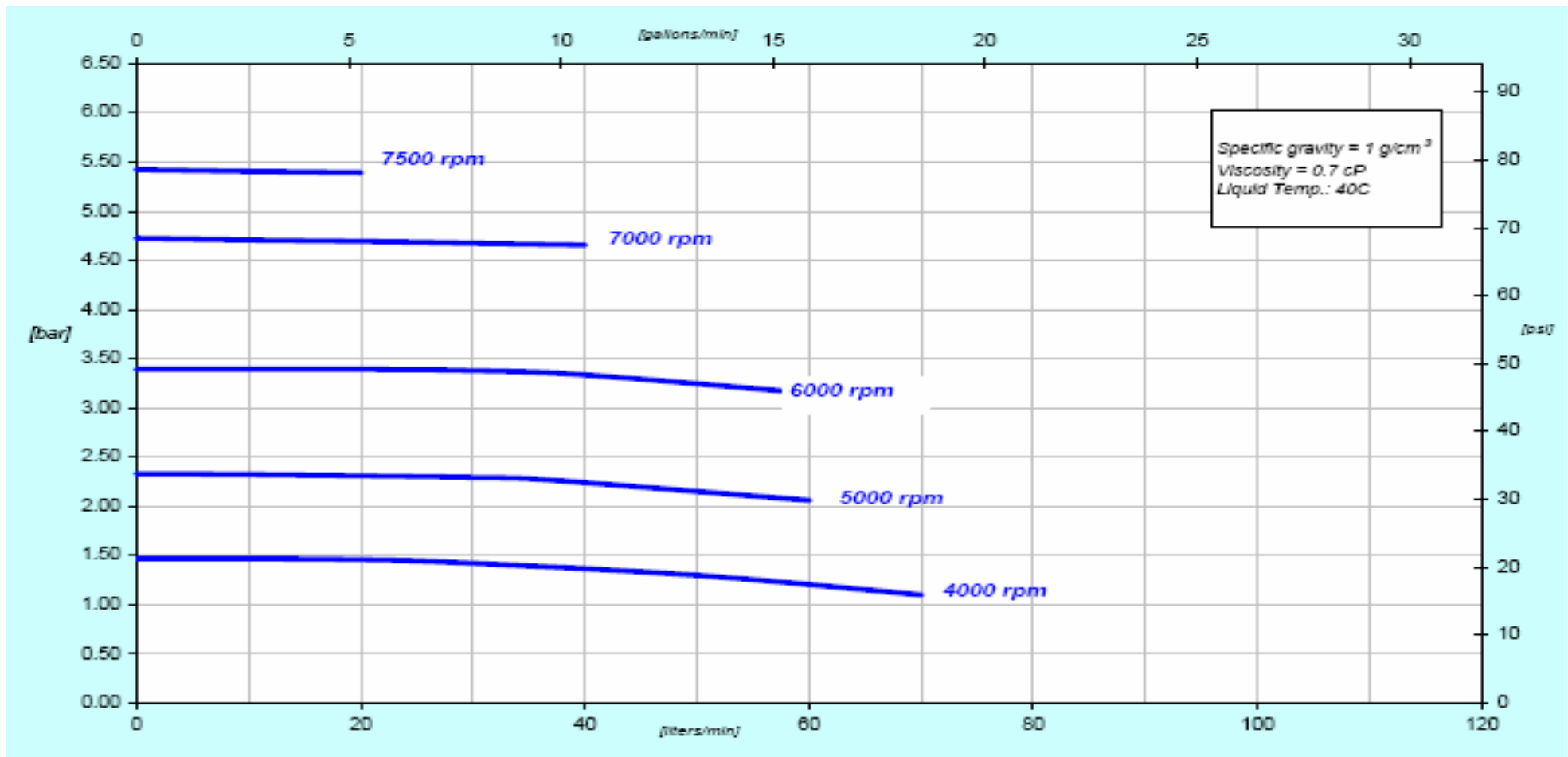
Introduction

- Standard BPS-4 pump can be pushed near or beyond its hydraulic limits in distribution systems with long horizontal runs, greater than usual vertical distances, and in slurry systems where a high velocity is required (.7 m/sec or higher) to maintain suspension.
- A new modified pump-head for the BPS-4 was designed. One of the main features of this design was an increase in available head pressure the pump can produce.
- Levitronix and CTA tested the pump head in Cabot SS-12 with the new pump head showing only a slight impact on large particle concentrations.
- BOC Edwards installed and tested the impeller for two months on site in production at an end-user's facility.

Pump Curves for Standard BPS-4



Pump Curve for HP BPS-4 (preliminary)

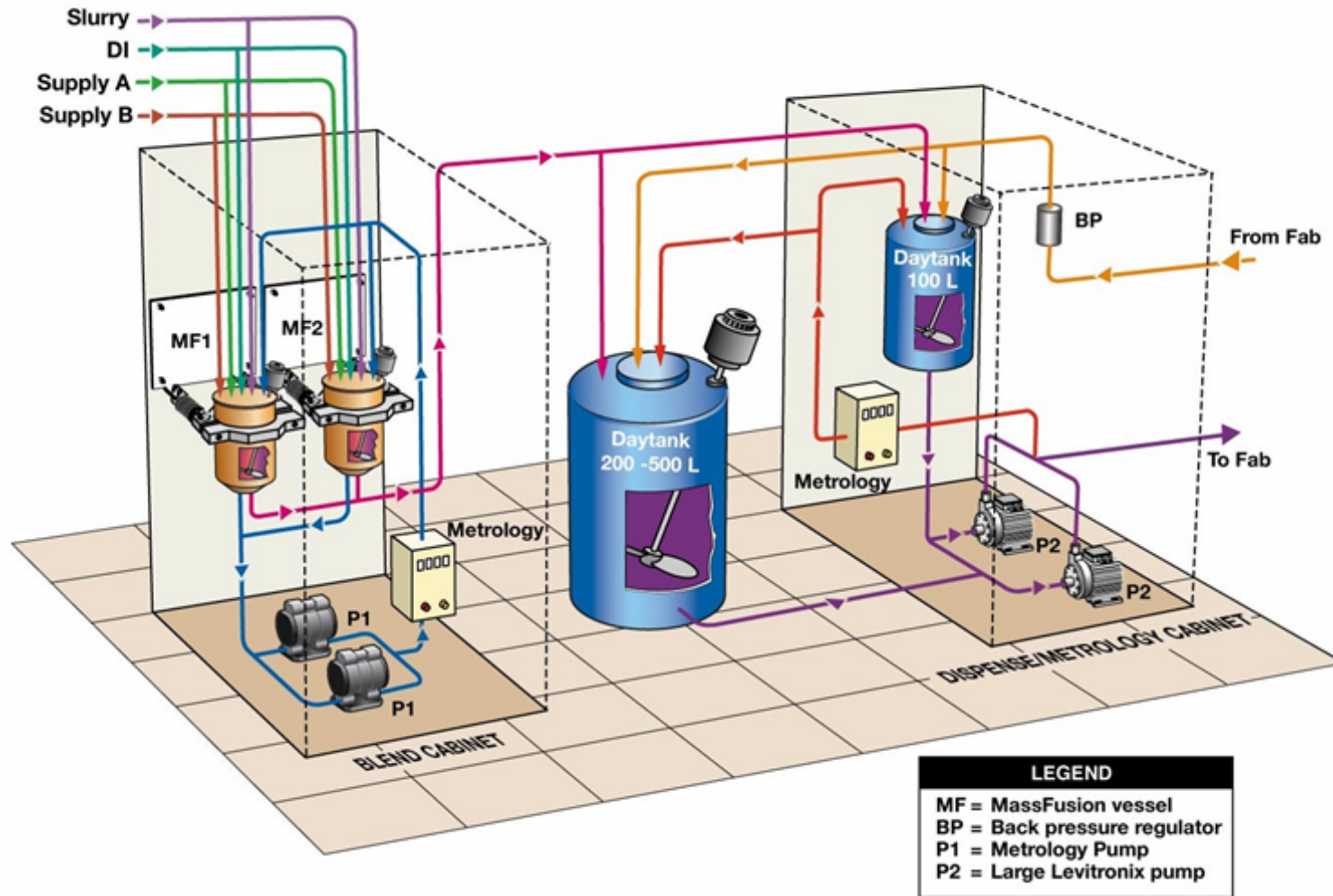




Test Setup/Timeline

- In early November, a single pump was installed at a customer site in a BOC Edwards iSIS 2000 system delivering Cabot iCue 600Y-75 slurry.
 - iSIS 2000 utilizes two Levitronix BPS-4 pumps for redundancy.
 - One of the BPS-4 pumps had the standard head replaced with a new (High Pressure) head and placed on-line to the fab.
 - Redundant pump in the iSIS can be configured to run idle or continuously re-circulate slurry at a user configurable RPM and Flow.
 - Mid-Loop pressure control is achieved by varying the speed of the pump in response to changes in mid-loop pressure.
 - Distribution Loop Recirculation Flow is controlled with a low-shear fixed restriction device.
 - Blended slurry is re-circulated through metrology using a Bellows Pump. (This recirculation may last several hours).
 - Chemical was dispensed to the distribution loop from a 100L internal day tank in the iSIS unit.
- In early Dec., the head on the second BPS-4 pump was replaced with a high pressure head and placed online to the loop.

iSIS 2000 overview diagram.





Test conditions

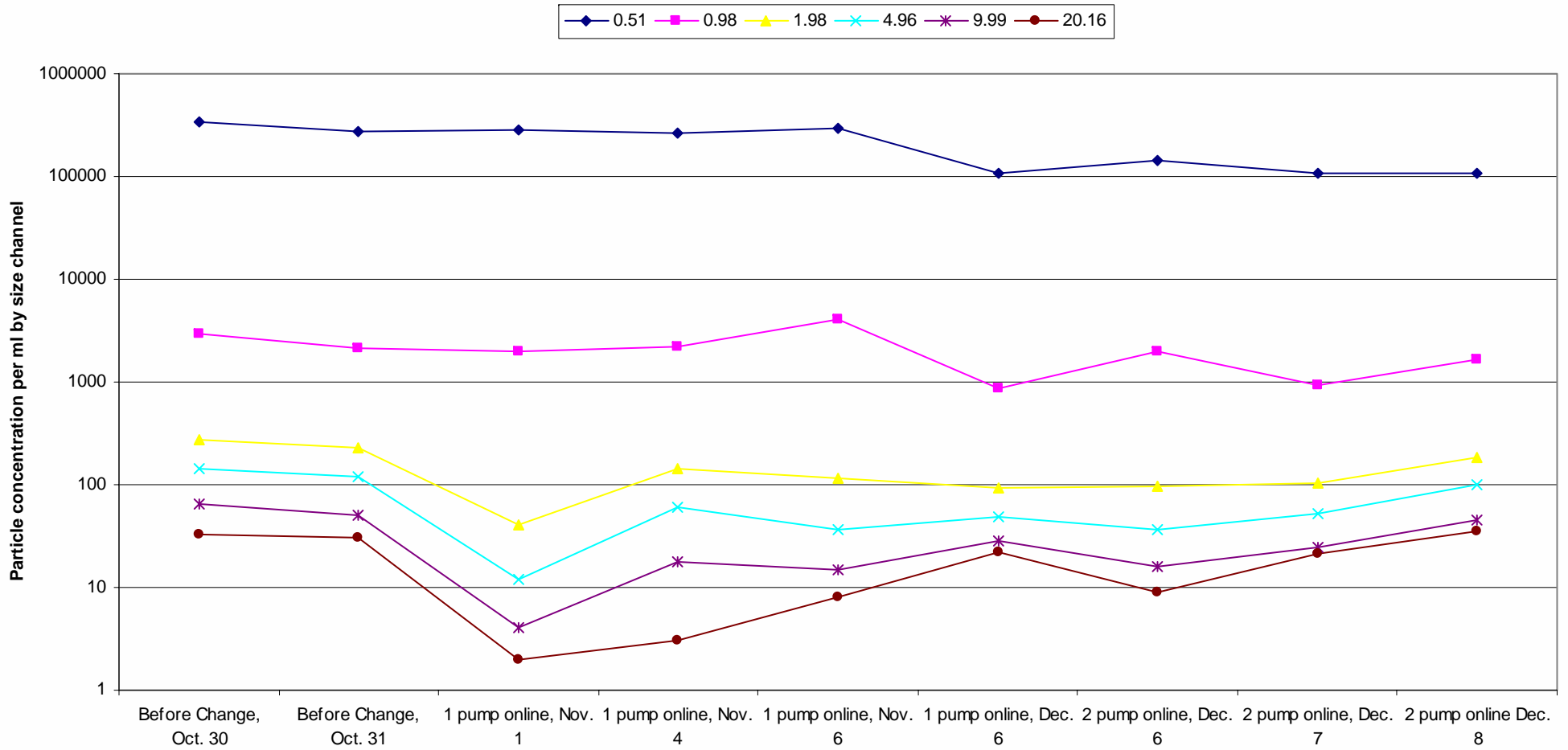
- To simulate worst case conditions
 - Mid-loop pressure was raised 5 psi higher than with the standard BPS-4 head.
 - Low consumption system with low level in daytank.
 - Higher flow than necessary (14 LPM) to create high turnover rates.
 - Redundant pump operating near RPM of online pump and recirculation flow was set at a nominal 15 LPM.
 - Total flow = 30 LPM.
 - Total volume (tank + loop) = 150 L.
 - Slurry turnover rate approximately once every 5 minutes.



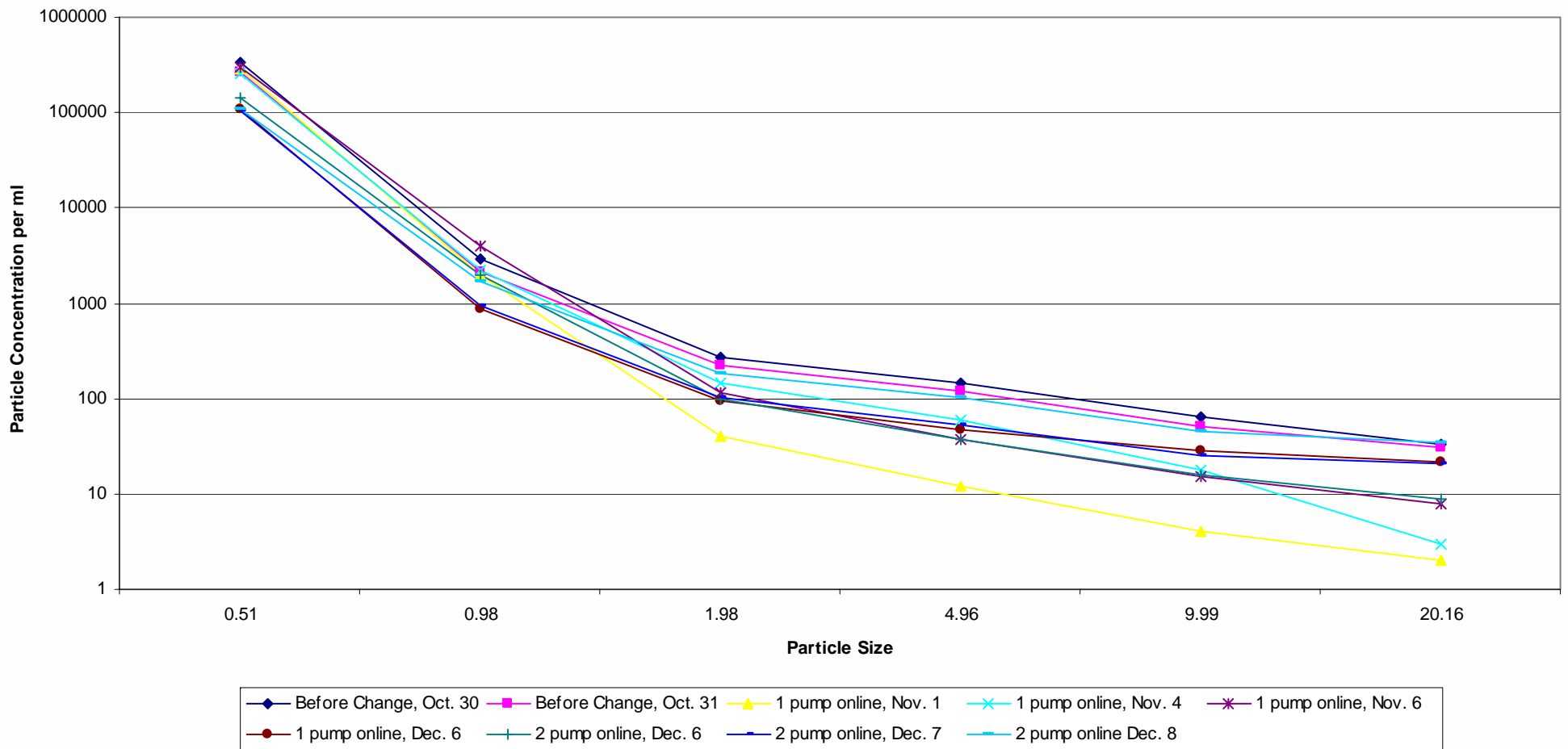
Particle Size Distribution Testing

- Samples were taken prior to and immediately after each pump head replacement.
- Samples were analyzed for Large Particles by a third party lab using an Accusizer 780.
 - Two samples were analyzed within 48 hours of the first pump head replacement as a baseline.
 - Four samples were taken between the two pump head changes at the 1-day, 4-day, 6-day and after 37 days.
 - Three samples were taken after the second pump head change at 24, 48 and 72 hours.

PSD by size channel over time



PSD Curves





Test results

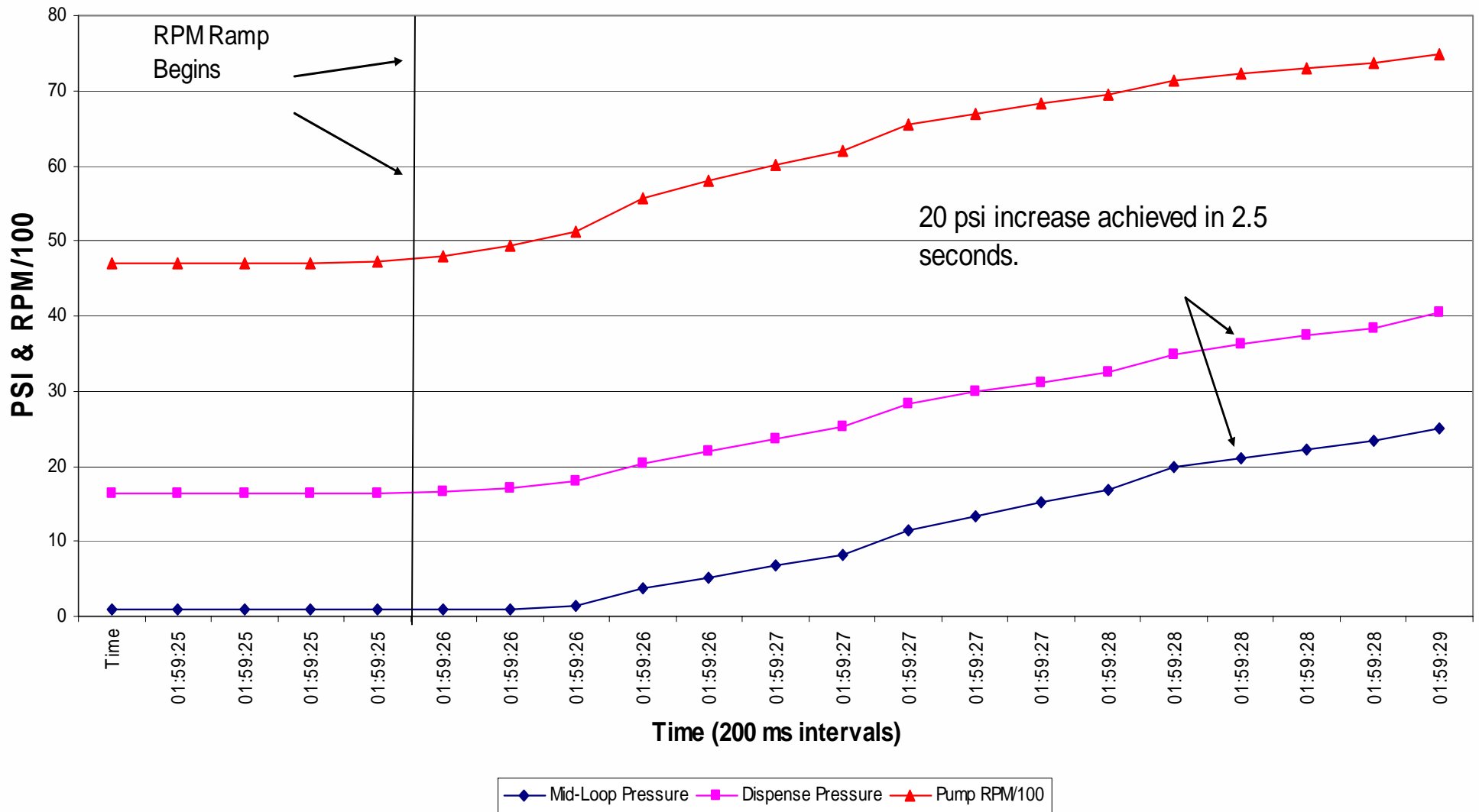
- No adverse impact from the new pump head was indicated.
 - Large Particle Concentrations remained stable based on sampling.
 - End user reported no adverse impact on yield or defect rates.



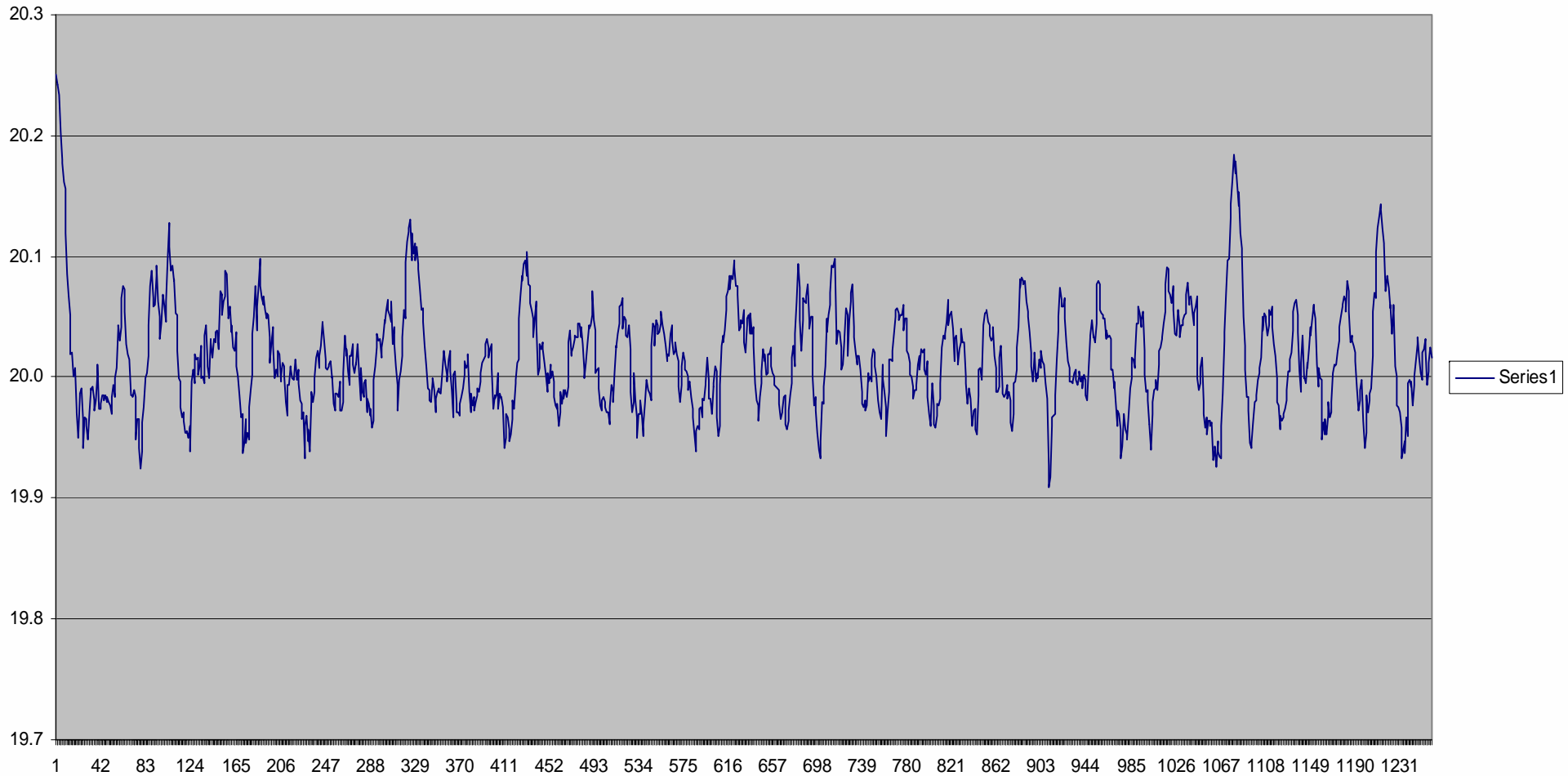
System integration details

- Pump motor runs significantly hotter. (Active cooling recommended).
 - Pump reached warning level temperatures with no air cooling applied. (Stayed below shutdown level).
- Heat generation is similar to the BPS-4 at similar hydraulic (pressure-flow).
 - In this case, each pump would contribute between 2 and 2.5C temperature increase to the system overall at full pressure and flow (Temperature rise is system/installation specific).
- Heat from “Hot Standby” Redundancy vs. pressure disturbances during a failure.

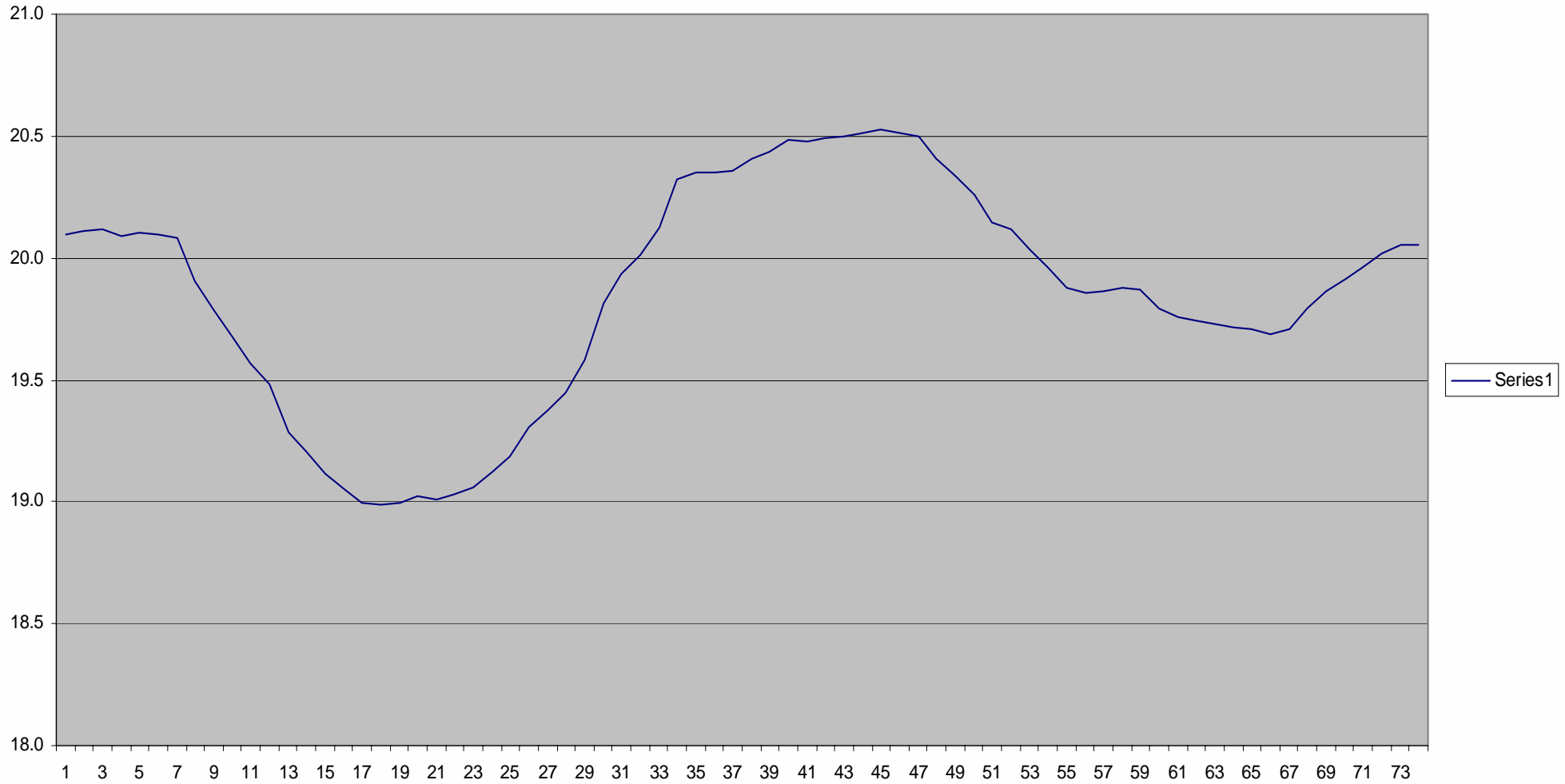
Standard BPS-4 Pump Ramp (Speed Mode)



Midloop Pressure Stability with HP head (200 ms)



6 LPM Flow Demand Transient with HP head





Conclusions

- BPS-4 (HP) provides higher pressure and flow capacity
- Impact on slurry Particle Size Distribution over time while not as good as the standard BPS-4 is still small.
- Pressure stability is similar to the original BPS-4.