Magnetic Levitation Applications: Clean, Simple and Reliable

Keith Kerwin
Matt Cannon
Robert Hall
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Chemical and Slurry Supply

• The intent of UHP supply schemes... and for that matter Slurry supply schemes too

  – No added contamination (metals, PCs)
  – Filtration, with no particle shedding
  – No failures, no leaks, no personnel exposure
  – Reliability, it just runs
  – Simplicity, easy to understand and operate
  – Low initial cost, not cheap – cost effective
  – Low maintenance & spares cost (simple, reliable, low cost)
In the Days of My Youth

• The early days
  – Pour up chemicals from Bottles
    • Exposure
    • Variability, contamination
    • Waste bottles
    • Resources (manual)
    • No PC reduction

  – Pump & Filter
    • Pump failure – reliability & contamination
      (shuttles/proximity sensors, solenoids, diaphragms or bellows, seals, guides, shafts)
    • Filter pressure pulsation...
      Add a pulse dampener and it works better but...
    • System pressure swing
The Big and the Bold

• Large Pressure Vessel & Filter
  – Pressure to Pressure (pump independent)
    • Large high pressure tank(s)
    • No pumps
    • Mobile pressure vessel (drum)
      • High initial cost
      • Cost for chemical transfill
  – Pump to Pressure (minimal pump dependency)
    • Large high pressure tank(s)
    • Pumps
      • Drum transfer pump backpressure
      • Pump failures
  – With any PV there is a chance for N2 entrainment
    • Not an issue for most chemistries but not ALL chemistries
    • Increases with larger vessels (surface area)
    • Higher pressure
    • Greater residence time
All Things to All Customers

- Small Pressure Vessel & Filter
  - Pump to Pressure Piston
  - Vacuum to Pressure Piston
    - Small pressure vessels
    - High cycle valves
    - Timing circuits and sensor dependent
    - Maintenance modes for flushing/filter change
    - Shutdown modes for everything under the sun
    - Pump interdependence (pump/piston)
    - Limited throughput and application, components (vacuum/pressure)
    - Just way too complex (40+ sensors & solenoids)
## The Status Quo

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My Resistance to Change

• Why would I want to use a Levitronix pump?
  – Oh, it’s just another magnetic drive pump
    • Seals, drive failures, contamination, cost
  – Oh, it’s a “Slurry” pump
  – Oh, it has no suction lift
  – Oh, it cost way too much
  – Oh, we’re happy (not) with the status quo
  – Oh, it’s complicated (pump controller)
  – Oh, it’s single source supply

• Oh, no! Oh, no!

• Oh YES said CMP Technology Development
  – “Build one just like the last one” – were my marching orders
Experimental Slurry Systems

- BPS-4 pump
- Simple single line with minimal bypass loops
- Open framework (no HPM)
- Low voltage Controls are separated from high voltage pump drives
- Can run in manual mode or with LUI
Experimental Slurry Systems

- CMP Technology Development
  - “Build one just like the last one” – were my marching orders
    - Operation by Pressure Control PID Loop
    - Transfer = drum & diaphragm pump
    - Process = Daytank, Mag/Lev Pump, filter, flow/pressure meter
    - Return = Heat Exchanger and backpressure adjustment

- Application – Slurries, low use for trial/test use
  - Bulk Cu
  - Barrier Cu
  - Oxide
  - W
  - Analog Technology Slurries
  - Filter Studies
  - Problems
    - Oops, 25% Oxide Clogs
    - Barrier (cottage cheese chunks)
    - Heat build up – not significant
    - Floating Ground (~200mv) speed mismatch frustration
      (drive and controller not tied to same ground)
Bulk H2SO4 System

- BPS 4000 Pumps
- Nippon Pilar fittings
  - 1 ½” in / 1” out
  - 1 ½” PFA pipelines
- Air cooled
- 20 meter interface cables
- Pump associated with a tank (Pump A to Tank A)
  - If offline, recirculating only
  - If online, recirculate & supply
Bulk H2SO4 System

• Supply multiple factories with UHP H2SO4
  – 1250 gallons per day
  – 1 ½” Teflon Tube Pipeline
  – Longest pipeline is 1800 feet (550 meters)
  – 50 foot (15 meter) elevation change
  – Fill local non-pressurized day tanks in factories

• Levitronix application engineering
  – Provided pressure drop node analysis
  – Pump and pipeline sizing alternatives

• Continuous pump flow
  – Dual pumps, dual offload/supply tanks
  – Continuous tank recirculation
  – Deadhead pipeline supply (demand valve)
  – Pressure PID Loop control

• Start up concerns
  – Contamination/leachables
  – Run dry, Priming
## My Conversion

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UHP Chemical Dispense Systems

• Basis of Design
  – Experimental Slurry Systems
  – Simple design
    • 6 solenoids (4 valves, 2 diaphragm pumps)
    • Manual sampling, filter venting
    • No automatic maintenance functions (flush, filter change, etc)
  – HPM Containment/Enclosure (packaging, ease of maintenance)
  – Redundancy (dual mag/lev pumps – because we just have to + dual filters)
  – Integrated Drum Transfer
  – Local filter recirculation/polish (dead headed distribution)

• Controls & Programming
  – Open architecture, off the shelf industrial equipment
  – Simple display
  – Pressure and flow metering
    • Pressure transmitter upstream of filters and downstream for PID loop control
    • Flow transmitter to set recirculation & gauge flow
    • Flow transmitter – Adrian & the cable guys, just hit reset

• Local recirculation
  – Eliminate dead head and minimize heat buildup
  – Filter polishing
  – Rock solid pressure control to dead headed demand distribution

• Quick spec/analysis
  – New CDUs in-spec quickly (metals < 100ppt and PCs <2 total in all bins)
UHP Chemical Dispense Systems

- BPS 4 Pumps & BPS 4000
- Flare fittings
  - 1” in / 1” out
  - 1 PFA pipelines
- No added air cooling
- Standard interface cables
- Weekly Manual pump rotation
- Automatic pump E-Call
- BPS 4000 for H2SO4
UHP Chemical Dispense Systems

- Simple flow path
- Simple redundancy
- Minimal instrumentation
- Minimal automation
UHP CDU Systems

• High Voltage Compartment
• Power terminals
• PLC and Pump interface terminals
• Connectors and status lights on top of controllers
• Convenience power
UHP CDU Systems

- Low voltage controls, CPU, IO & Flowmeter
- Dual power module, communication module
- Pump & Valve Solenoids, Air/N2 regulation
UHP CDU Systems
Booster Pump System

- Inconsistent Pressure at Spray Processor
  - Farthest point in distribution
    - 650 feet (200 m) pipeline
    - 35 feet (10 m) elevation

- Simple in-line Solution
  - BPS 200 pump, in-line booster with Levitronix pressure controller

- Made complex
  - Bypass, filtration
  - Pressure gauge & transmitter

- And more complex
  - Not enough “features” – need PLC
    - External signals
    - Delay/timing sequence
  - Complete pressure drop/starvation
  - No suction capability
  - Added (not shown) Head Tanks
And to the Future?

Questions?