Facilities Recommendations: Liquid Supply Systems

Some Recommendations from Sub Fab Experiences

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Contents

- Review/Primer
- Process Planning
  - System Design Requirements
  - Waste Streams
- Component Specifics
  - Critical Items to Note
  - Peripherals
- Maintenance Programs

Overview

- Review and recommend some upfront questions
  - Topics to consider for any system investment
  - Areas to focus on when designing in a new capital purchase
    - Recommendations to layout
    - Scale of the system
    - Surrounding connections

Slurry Review

- Three major ingredient types
  - Silica
    - Shear sensitive
      - Particle growth in certain operational circumstances
    - Environment considerations
      - Low pH: Dried aggregates (cement-like)
      - High pH: Soft aggregates
    - Most prone to require filtration
      - Drum
      - Blend
      - Point of Use

Slurry Review

- Three major ingredient types
  - Alumina
    - Sediment potential
      - Long term operation can cause serious line clogging
      - Poor agitation in tank leads to varied removal rates
    - Environment considerations
      - Soft aggregates
    - Modifying chemicals (Fe(NO3)3)
      - Waste treatment and additional safety related handling
  - Ceria
    - Sediment potential (some cases)
      - Long term operation can cause serious line clogging
      - Poor agitation in tank and drum/tote leads to varied removal rates
    - Environment considerations
      - Soft aggregates

Process Planning

- WHEN to Consider:
  - High use production scenarios
    - Multiple tools
    - High throughput of product
  - Custom recipes
    - Tight tolerances of a blend
    - Potlife issues with tertiary chemicals
  - Removal of bottlenecks
    - Drum/tote
    - Labor

Process Planning

- WHAT to Consider:
  - GROWTH:
    - Will this process grow in production scale?
      - Sizing global systems
        - » Piping
        - » Pump Engine
        - » Day Tank
    - Will there be more tools in the near future?
      - Sizing blending make-up rates
        - » Blend tank
        - » Flow meters or scales
    - Are there dedicated support systems?
      - Additional Blend chemicals
      - DI, N2, etc
      - Waste handling facilities

Process Planning

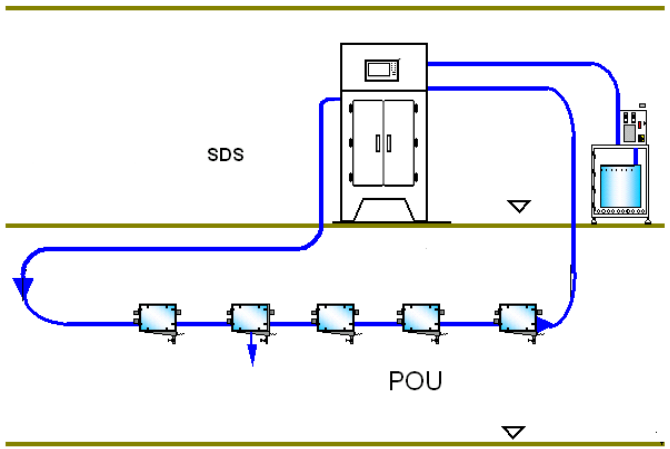
- WHAT to Consider:
  - RECIPE:
    - How many chemicals will be used?
    - Delivery to systems?
    - How critical are upper/lower control limits?
    - Adjustments to recipe?
  - Instrumentation
    - Will the batch require a pass/fail prior to delivery?
      - Affects make up rates and production
    - Will there be a need to control process functions?
      - Critical versus process warnings

Process Planning

- WHERE to Consider:
  - Layout:
    - Where to locate with respect to production
      - Minimize power requirements for pump engine
      - Minimize global loop lengths and rises
        - » Reduce slurry agglomeration
        - » Reduce volume of *unused* product
      - Avoid serpentine loops
        - » Slurries with sedimentation issues
    - Environmental surroundings
      - Minimize temperature fluctuations between system placement with respect to production tools

Process Planning

- Best
  - Tools directly below
    - Less energy required by pump
    - Less long term pressure associated wear
  - Imparts the least amount of stress to the chemical and components
  - Requires pressure regulation at VMB



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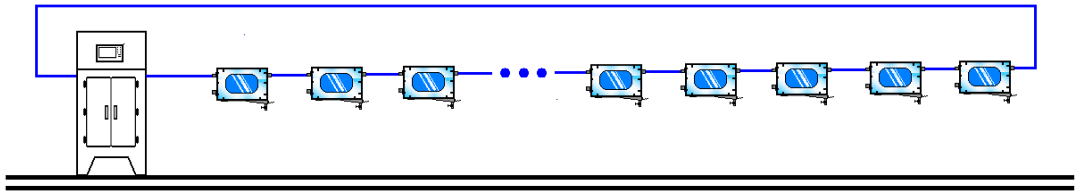
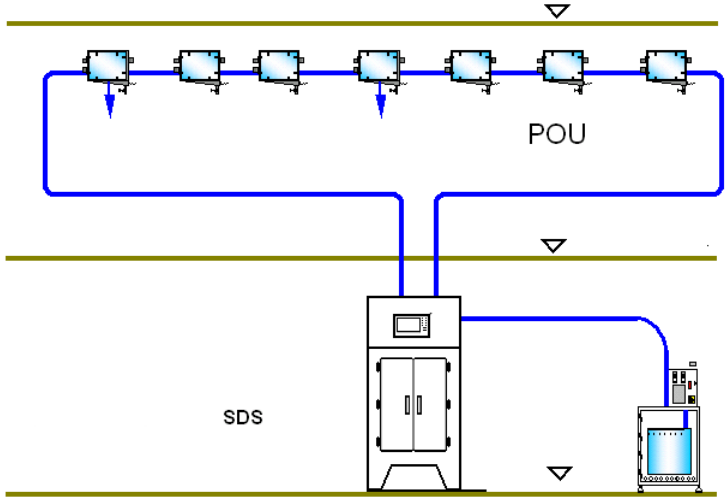
Process Planning

- Better
  - Tools and system on same level
    - Good for long loops
  - Uses more power than previous application, but does not stress pump



Process Planning

- Good (but could get worse)
  - Systems below tools
    - Standard ideology for…ever
  - Changes that impart more stress to pump engine
    - Addition of filtration
    - Additional tools
      - Longer loops
      - More VMB additions
      - Changes to input pressures
    - May require increase in pump engine size
  - Requires the most power to dispense chemical to processes



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Waste Streams

- Usually not well planned
  - Typically viewed in same manner as normal waste water streams
    - Slurry is sensitive to dry air conditions
    - Eddies tend to be nucleation points for buildup to occur
- Typical to have cabinet and process drains tied to the same waste stream
  - Keep cabinet drains to 1” minimum opening
  - Consider hydraulic head of Process
    - Avoid back flow
  - Have your engineer certify calculations
    - Keep slopes at ¼ to ½ inches per foot *ALWAYS!*

Waste Streams

- Small upfront investment can avoid the costly interruptions down the road
  - Keep it WET
    - High flow, timed auto-flush with industrial water
    - OR, Dedicated stream, 100 ml or more, at each waste stream starting point

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Component Specifics

- Dispense Engines
  - Positive Displacement Pumps
    - Bellow/Diaphragm
    - Efficient method for transfer of liquids
    - Simple to replace allowing for a low cost redundancy in any system
    - Lifetime based on application
      - 3 months to 18 months
    - Contributes to shear induced particle growth
      - Pump style and geometry dependent
    - Will add slight increases in the temperature of slurry
      - Thermodynamic fact

Component Specifics

- Dispense Engines
  - Centrifugal Pump
    - Efficient method for transfer of liquids
    - Simple to replace allowing for a low cost redundancy in any system
    - Additional automation controls to enhance system operation
    - Best lifetime of all engines
    - Pressure/flow dependent
      - As head increases, flow decreases requiring more power
    - Do not contribute to shear induced particle growth
      - Shear flow
    - Will add slight increases in the temperature of slurry
      - Mechanic/Thermodynamic fact

Component Specifics

- Dispense Engines
  - Pressure Vessel
    - Inefficient method for transfer of liquids
    - Consists of a myriad of sensors, valves, and logic to operate
      - Trouble shooting issues
    - Leads to evaporation of liquid medium in slurry base
      - Air-liquid interface
      - Sensor drifts
    - Contributes to shear induced particle growth
      - Low to No RH in gas
    - Difficulty in handling slurries with sedimentation issues

Peripherals

- Automation Platforms
  - Multitude of offerings each delivering a level of complexity and cost
    - Many different styles of communication protocols
  - Depend on how much automation the user requires
    - Instrumentation
      - Control processes
      - Communicates to other systems
      - Detailed decision making
    - Can be tied into a SCADA system for global monitoring
      - Paging technicians to alarm specific issues
      - Track and trend data for quality and integrity

Maintenance Programs

- More important than thought
  - Wear and tear of slurries
    - Valves
    - Instruments
- System-wide flush
  - Highly recommended for any slurry type
  - Annual program
  - Couple with complete system validation
    - Finely inspect major components

Summary

- Capital Investment
  - Typically reviewed as an afterthought
- Important Investment
  - Delivering the chemicals to the tool
    - Blending
    - Handling
  - Quality of delivered chemical is affected by quality of the system design
- Avoid time-bombs to production
  - Focus on a long term needs and growth
  - Select a system design that delivers flexibility
- Enforce maintenance programs