

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 ($\text{Fe}(\text{NO}_3)_3$)
 - 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

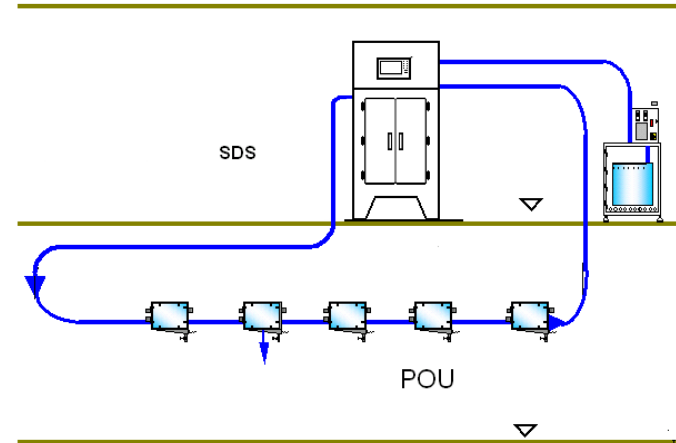
- WHAT to Consider:
 - RECIPE:
 - How many chemicals will be used?
 - Delivery to systems?
 - How critical are upper/lower control limits?
 - Adjustments to recipe?
 - Instrumentation
 - Will the batch require a pass/fail prior to delivery?
 - Affects make up rates and production
 - Will there be a need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

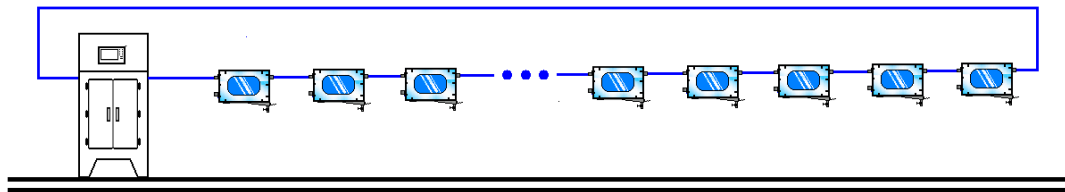
Process Planning

- 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



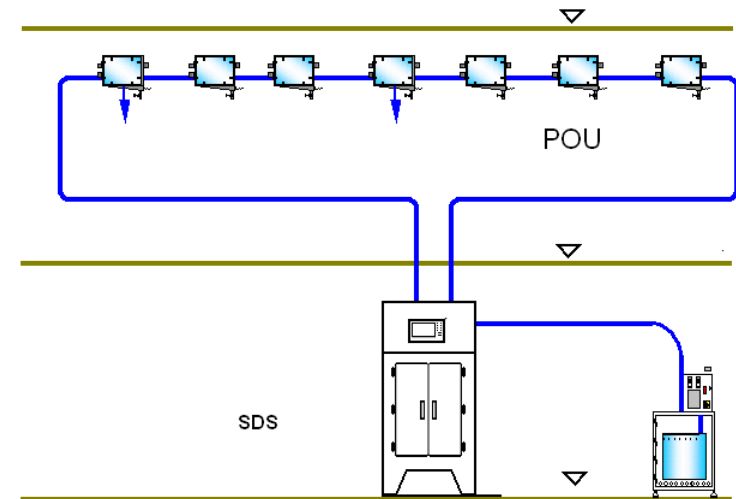
Process Planning

- 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



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 $\frac{1}{4}$ to $\frac{1}{2}$ 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



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