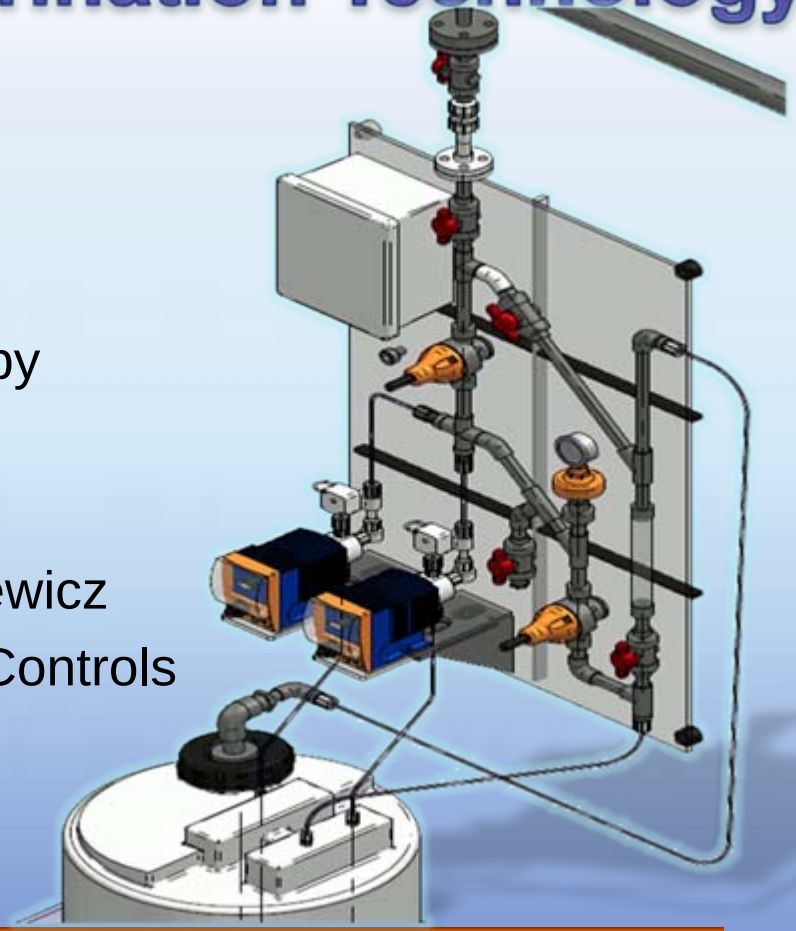
2010 Clean and Safe Drinking Water Workshop

Advances in Hypochlorination Technology



Presented by

Marc Szuszkiewicz
ProMinent Fluid Controls

Water Chlorination

- Elemental Chlorine discovered in 1774
- One of the first use in disinfecting was in the form of Hypochlorite for a water supply in England (1850)
- Sodium Hypochlorite continues to be the most used method for potable water disinfection in Canada
  - Effective
  - Proven
  - Consistent
  - Economical, Easy & Manageable
- Purpose of Water Chlorination
  - Disinfection
  - Color removal
  - Control of iron and manganese
  - Removal of taste and odor
  - Restoration and preservation of pipeline capacity

Chlorine Sources

Chlorine Source	Form	Initial Reaction
Chlorine Gas	Gas	$Cl_2 + H_2O \rightarrow HOCl + H^+ + Cl^-$
Sodium Hypochlorite	Liquid	$NaOCl + H_2O \rightarrow HOCl + Na^+ + OH^-$
Calcium Hypochlorite	Solid	$Ca(OCl)_2 + 2H_2O \rightarrow 2HOCl + Ca^{++} + (OH)^=$

Dosing Hypo → A Challenge?

- Leaks and Corrosion
- Unreliable Pumps
- Off-Gassing
- Unstable Chlorine Residuals
- Time lost
- Blocked Injection Points
- Hard to Maintain
- Short System Life

Sodium Hypochlorite Injection Systems

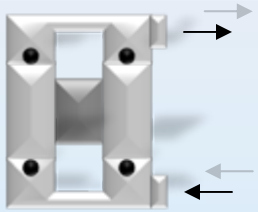
- **Metering Pumps**
  - Chemical Pumps
  - Metering Pumps
  - Hypo Specific Pumps
  - Pump Sizing
- **Dosing from Tank to Pipe**
  - Storage
  - Material Compatibility
  - Peripheral Accessories
  - Systems Control Methods
- **Troubleshooting**
  - Unstable Residuals
  - Pumps Unreliability
  - Corrosion and Leaks
  - Golden Rules

Chemical Pumps ≠ Metering Pumps

Gear Pump

Displacement per revolution not adjustable. Not linear from high to low RPMs due to slip at low speed.

Air Operated Diaphragm Pump

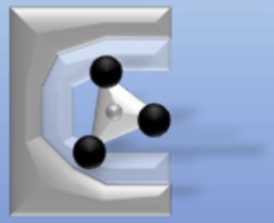


Displacement per stroke not adjustable. Not repeatable due to variable air pressure, flexible diaphragm.

Progressing Cavity Pump

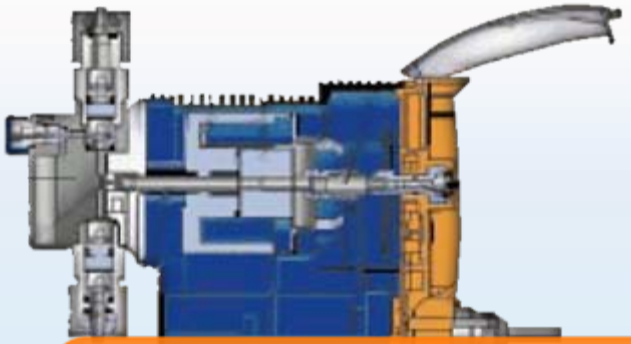
Displacement per revolution not adjustable. Chemical incompatibility common with rotor.

Peristaltic Pump



Displacement per revolution not adjustable. Tube stretch prevents repeatability.

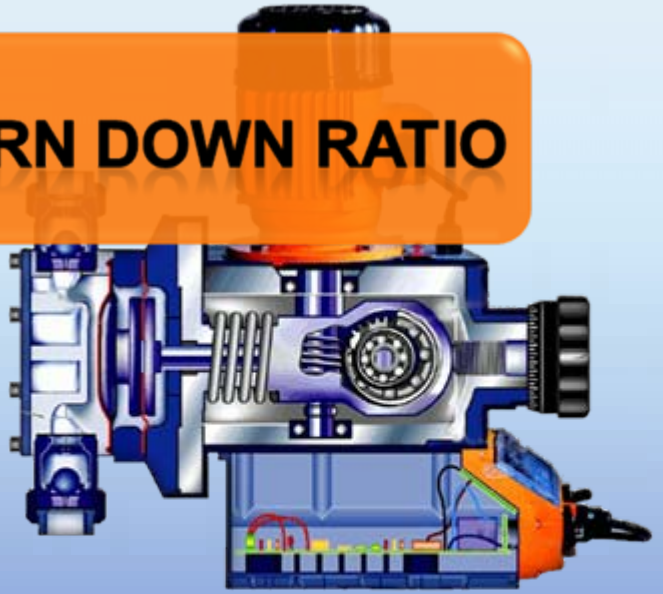
Mechanically Actuated Diaphragm Metering Pumps



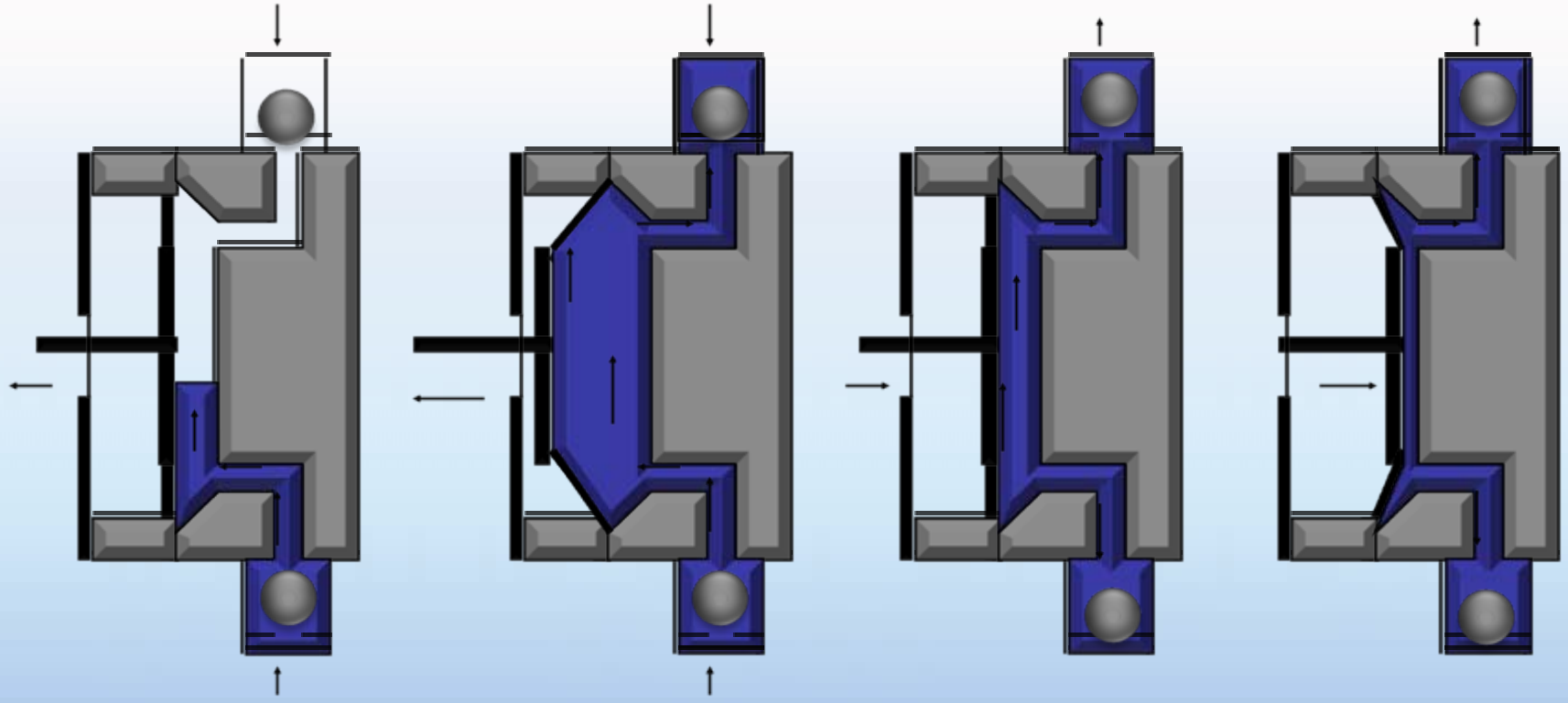
- Stroke Frequency Control
- Variable Stroke Length
- Many Control Types
- Relays, Alarms, Interlocks

METERING PUMP = HIGH TURN DOWN RATIO

- 2% repeatability
- Low cost
- Seal less design
- Liquid End Compatible with Fluid



Metering Pump Liquid End



Suction Stroke Begins: discharge valve closes, suction valve opens, chamber fills

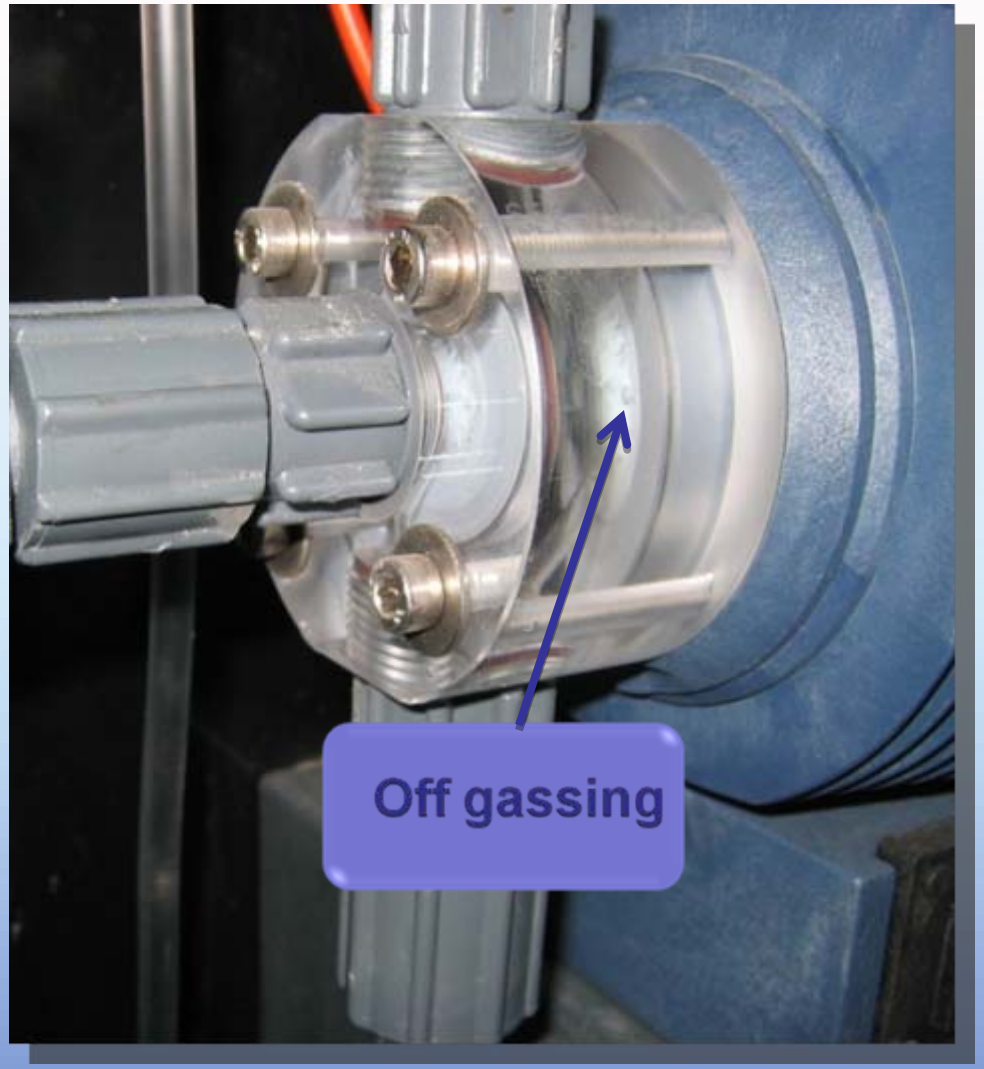
Suction Stroke Complete: fluid chamber is full

Discharge Stroke Begins: discharge valve opens, suction valve closes

Discharge Stroke Complete: fluid in chamber is displaced

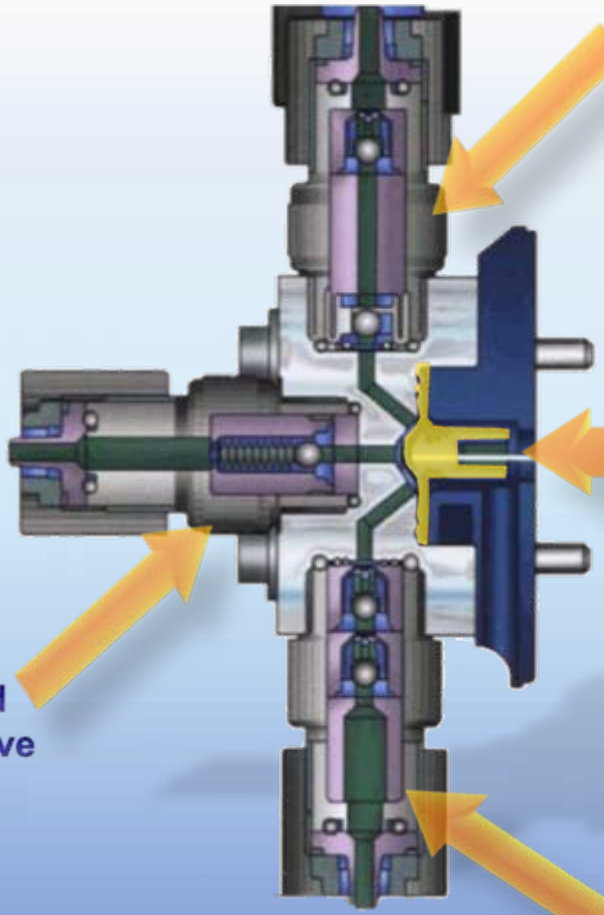
Off-Gassing in Liquid Ends

- Sodium Hypochlorite off gasses when off duty.
- Gas bubbles build up in the piping and liquid end
- Pump starts pumping but nothing moves
- Pump is Air Locked
- A problem for intermittent / low flow rates



Solution for Off Gassing (I)

GammaL



Degassing Valve

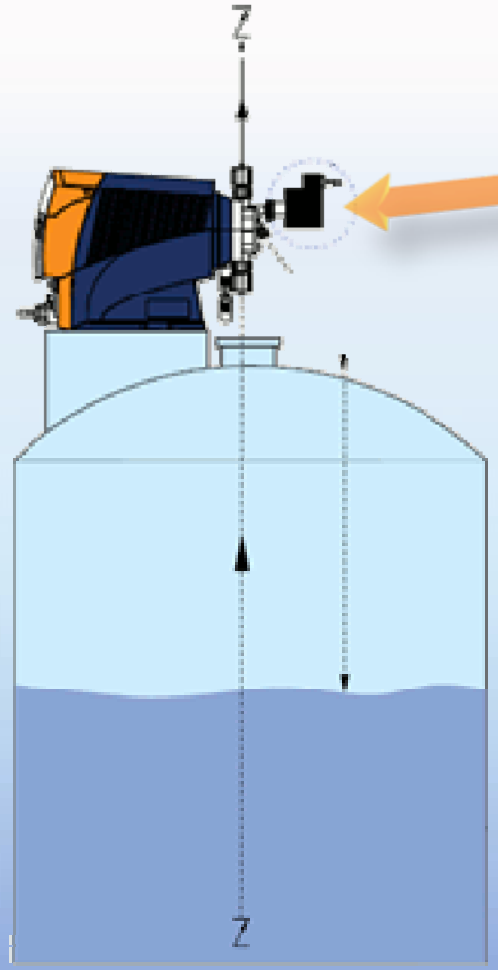
Diaphragm translation

Spring Loaded discharge Valve

Suction Valve

Solution for Off Gassing (II)

Delta OptoDrive®



Solenoid Valve

Detected With Optodrive

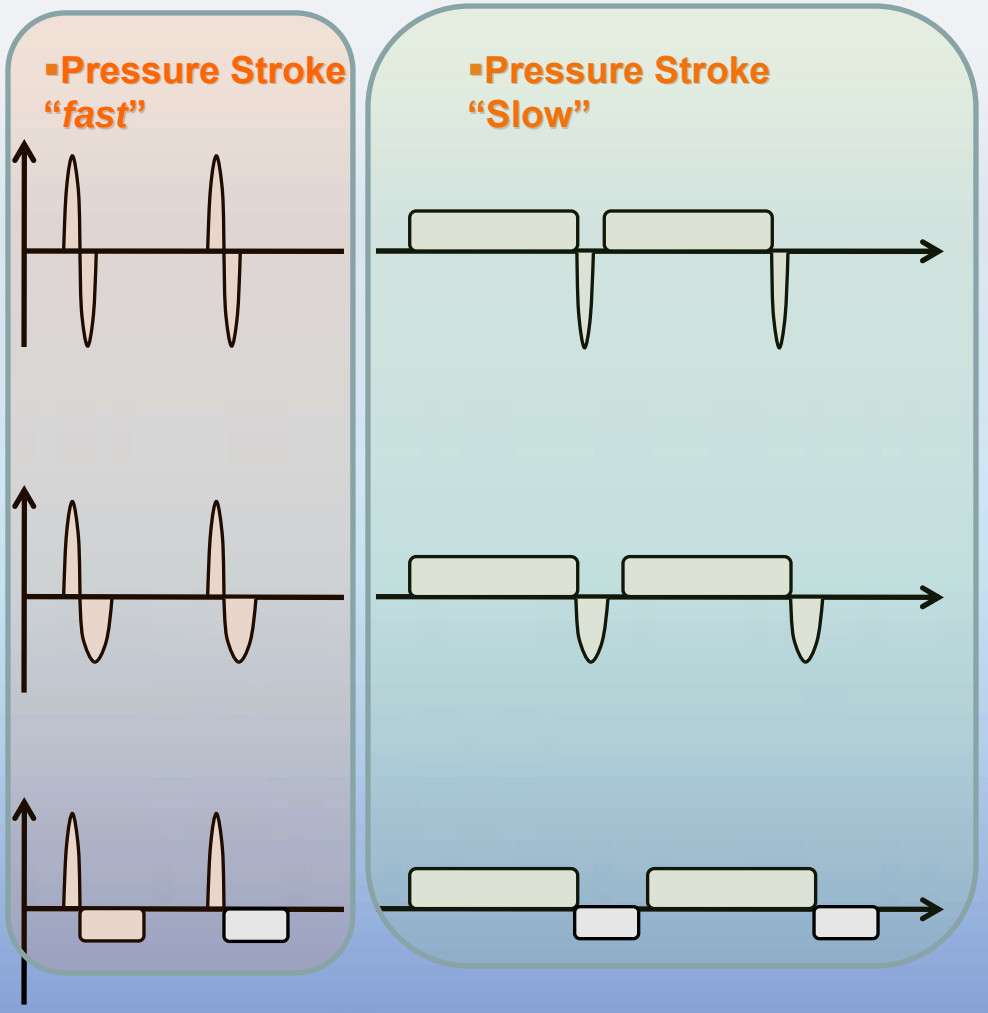
- Airlock
- Over pressure
- Burst discharge line
- Low pressure

Suction/discharge strokes

OptoDrive®

- Pressure Stroke "*fast*"
- Pressure Stroke "Slow"

- Suction stroke normal
- Suction stroke HV
- Suction stroke HV3

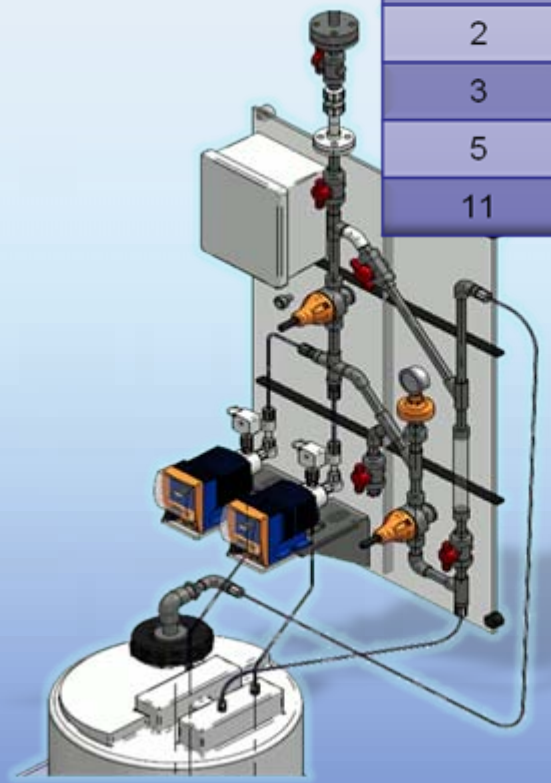


Chlorine dose

- Pump flow rate in l/h for 1 ppm dose

GPM USgal	12%	6%	4%	2%
25	0.04	0.08	0.12	0.24
50	0.08	0.16	0.24	0.49
75	0.12	0.24	0.36	0.73
100	0.16	0.32	0.49	0.97
200	0.32	0.65	0.97	1.94
400	0.65	1.30	1.94	3.89
800	1.30	2.59	3.89	7.78
1000	1.62	3.24	4.86	9.72

Part		Solution Concentration
Water	Hypo	%
0	1	12
1	1	6
2	1	4
3	1	3
5	1	2
11	1	1



Chlorine Dose

$1\,\text{lb} = 0.454\,\text{kg}$

$1\,\text{m}^3 = 1000l$

$1USGal = 3.7854l$

$\text{SG} = \text{Specific Gravity} = \frac{\rho_{\text{NaOCl}}}{\rho_{\text{Water}}}$

$\rho = \text{Density} = \frac{kg}{m^3}$

$\rho_{water} = 1000\frac{kg}{m^3}$

$\text{SG}_{\text{NaOCl12\%}} = 1.168$

$\rho_{\text{NaOCl12\%}} = 1168\frac{kg}{m^3}$

$$\text{Flow Rate} = \text{Q} = 1000\frac{USGal}{\text{min}}$$

$$\text{Desired Dose} = 1\,\text{ppm} = 1\frac{mg}{l}$$

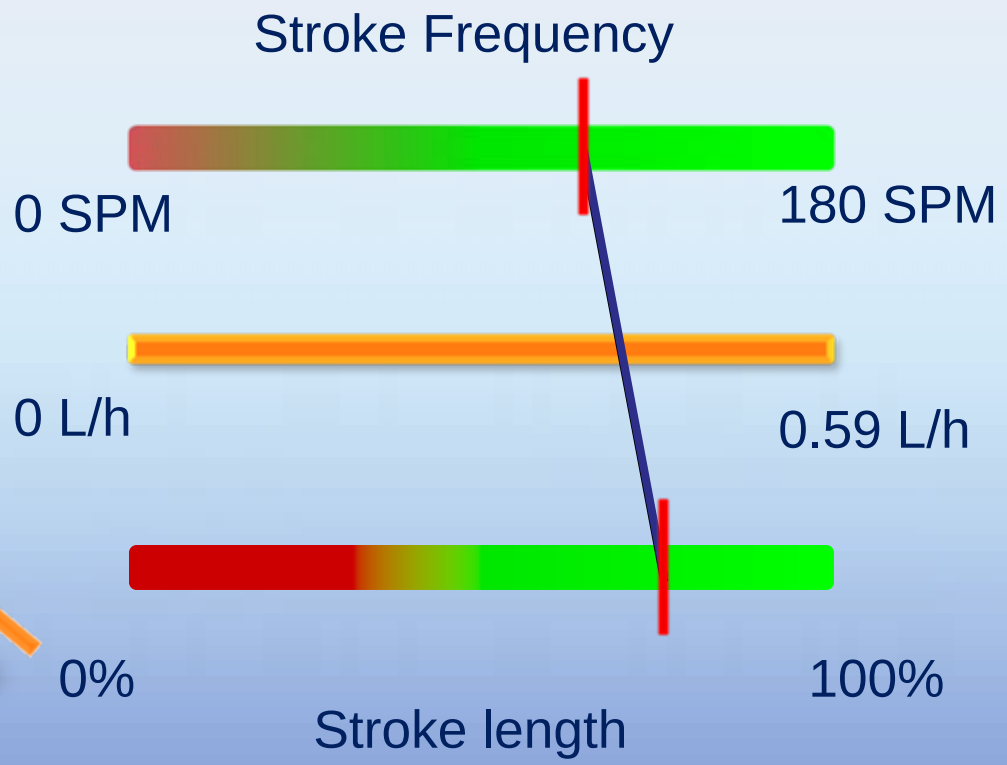
$$\text{Sodium Hypochlorite Solution Concentration} = 12\%$$

$$\text{Mass}_{\text{hypo}} = 1000\frac{USGal}{\text{min}} \times \frac{3.7854l}{1USGal} \times 1\frac{mg}{l} \times \frac{100\%}{12\%} = 31545\frac{mg}{\text{min}} \times \frac{1kg}{1000000mg} = 0.0316\frac{kg}{\text{min}}$$

$$\text{Volume}_{\text{hypo}} = \frac{0.0316\frac{kg}{\text{min}}}{1168\frac{kg}{m^3}} = 000027\frac{m^3}{\text{min}} \times \frac{1000l}{1m^3} = 0.027\frac{l}{\text{min}} \times \frac{60\,\text{min}}{hr} = 1.62\frac{l}{hr}$$

Optimum Sizing

Model	Psig	L/h	Strokes/min
GALa 1601	232	0.59	180



Available Metering Pump Manufacturers

Grundfos
DME

Alldos
True Dose
209/222

W&T
Chem AD E60XL

Watson Marlow
520 Series

Pulsafeeder
Chem AD E60XL

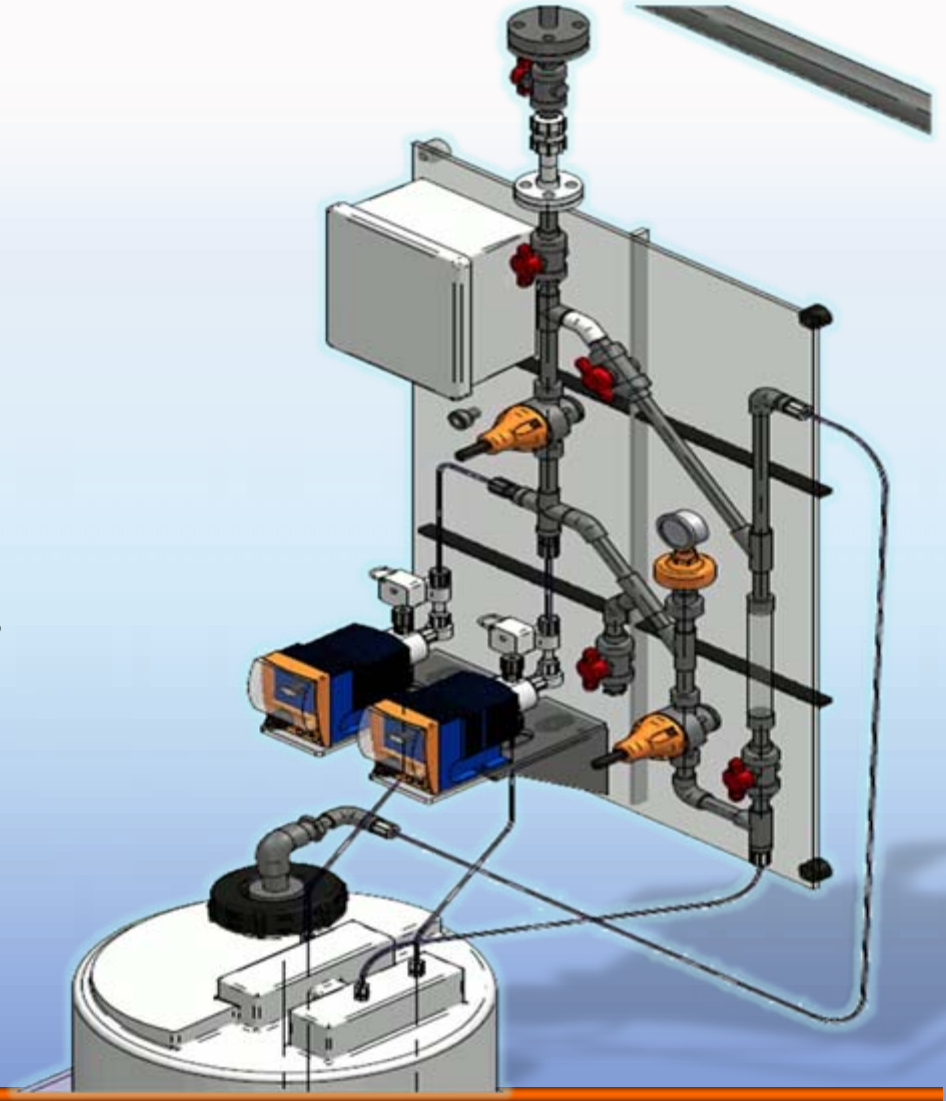
LMI
Chem AD E60XL

Iwaki Walchem
EK Series

Neptune
PZi4-8

Dosing from tank to pipe

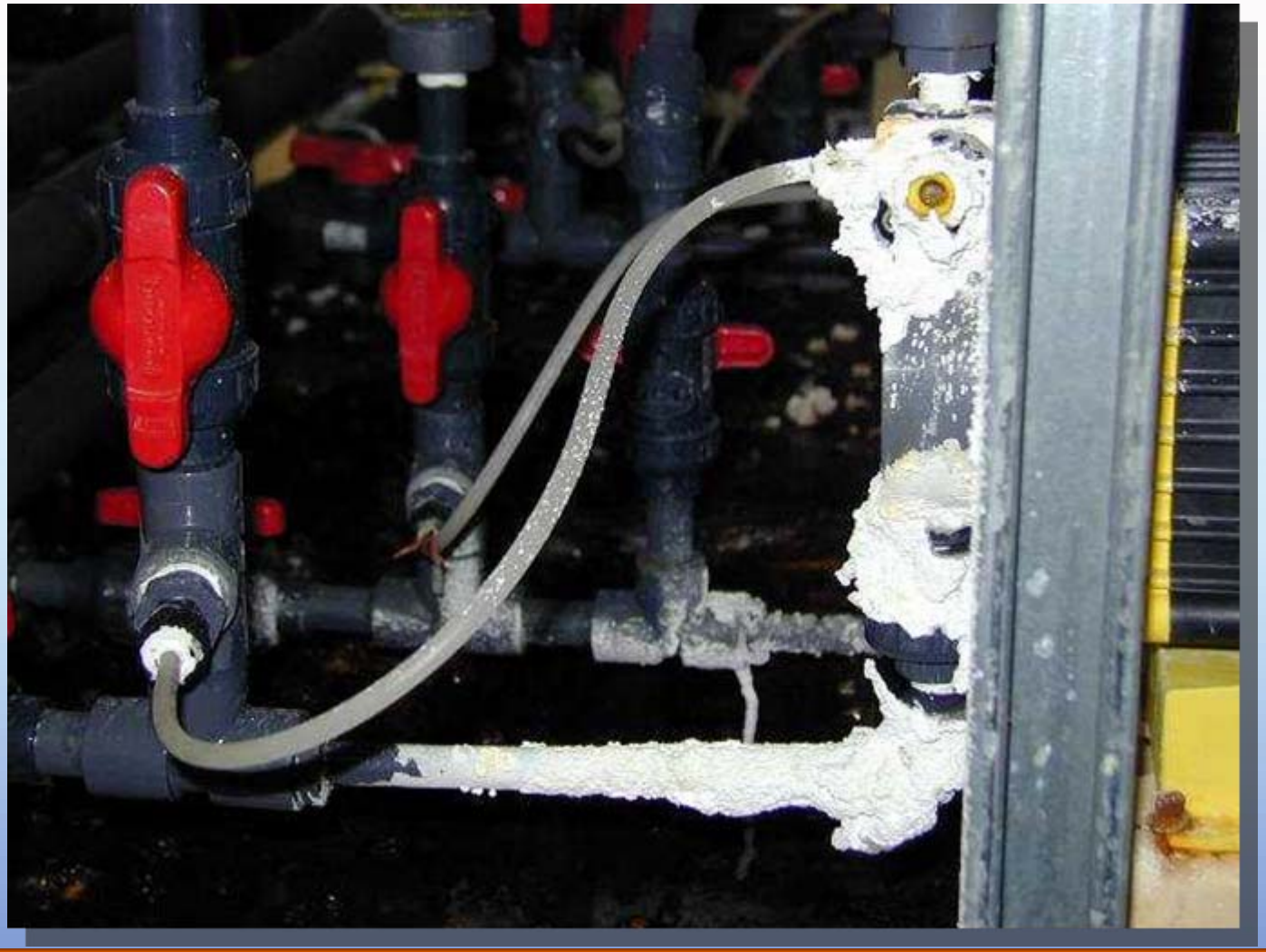
- **Dosing from Tank to Pipe**
  - Storage
  - Material Compatibility
  - Peripheral Accessories
  - Systems Control



Product Storage

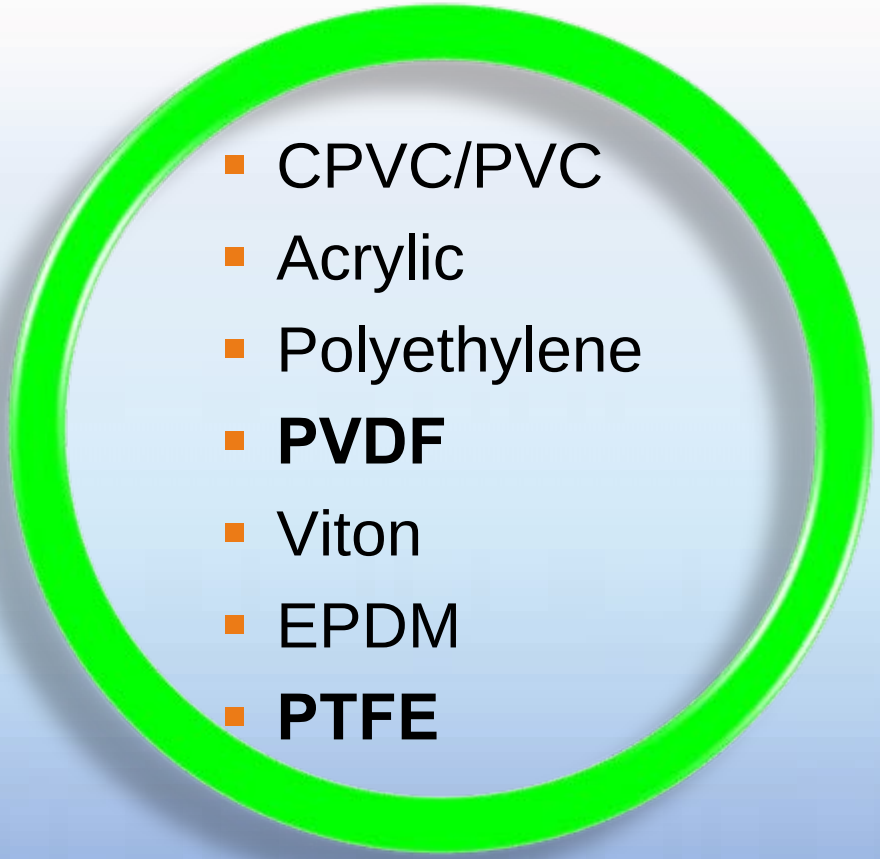
- Tank size should be 4-8 week supply
- Made of Polyethylene, UV protected
- Containment basin 110% volume of tank
- Should be in a well ventilated area with a vent pipe if possible
- Location as close as possible to the metering pump
- Kept in a cool place.
- Controls – Alarms & Inventory, Levels, Leaks

Corrosion and Leaks???



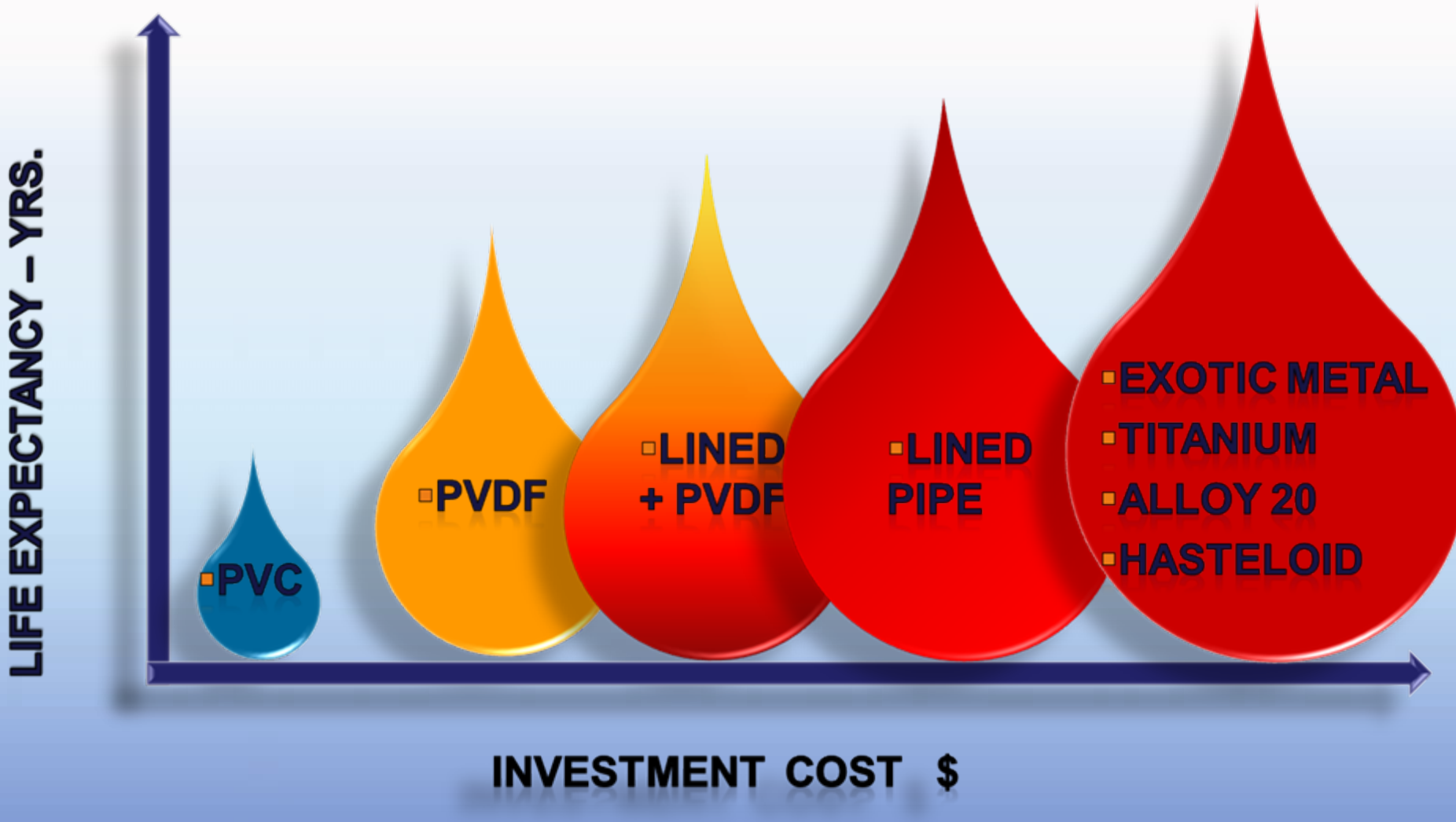
Maintainability: Material Compatibility with Hypo

- Stainless Steel
- Brass
- Cast iron



- CPVC/PVC
- Acrylic
- Polyethylene
- **PVDF**
- Viton
- EPDM
- **PTFE**

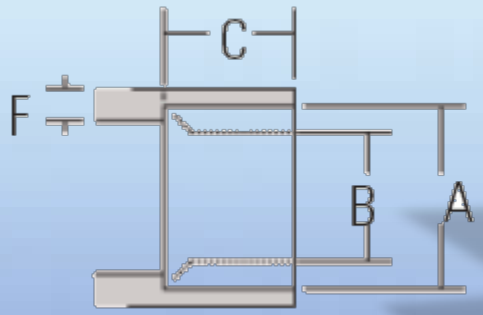
Material Selection



Quality Materials = Consistent Results

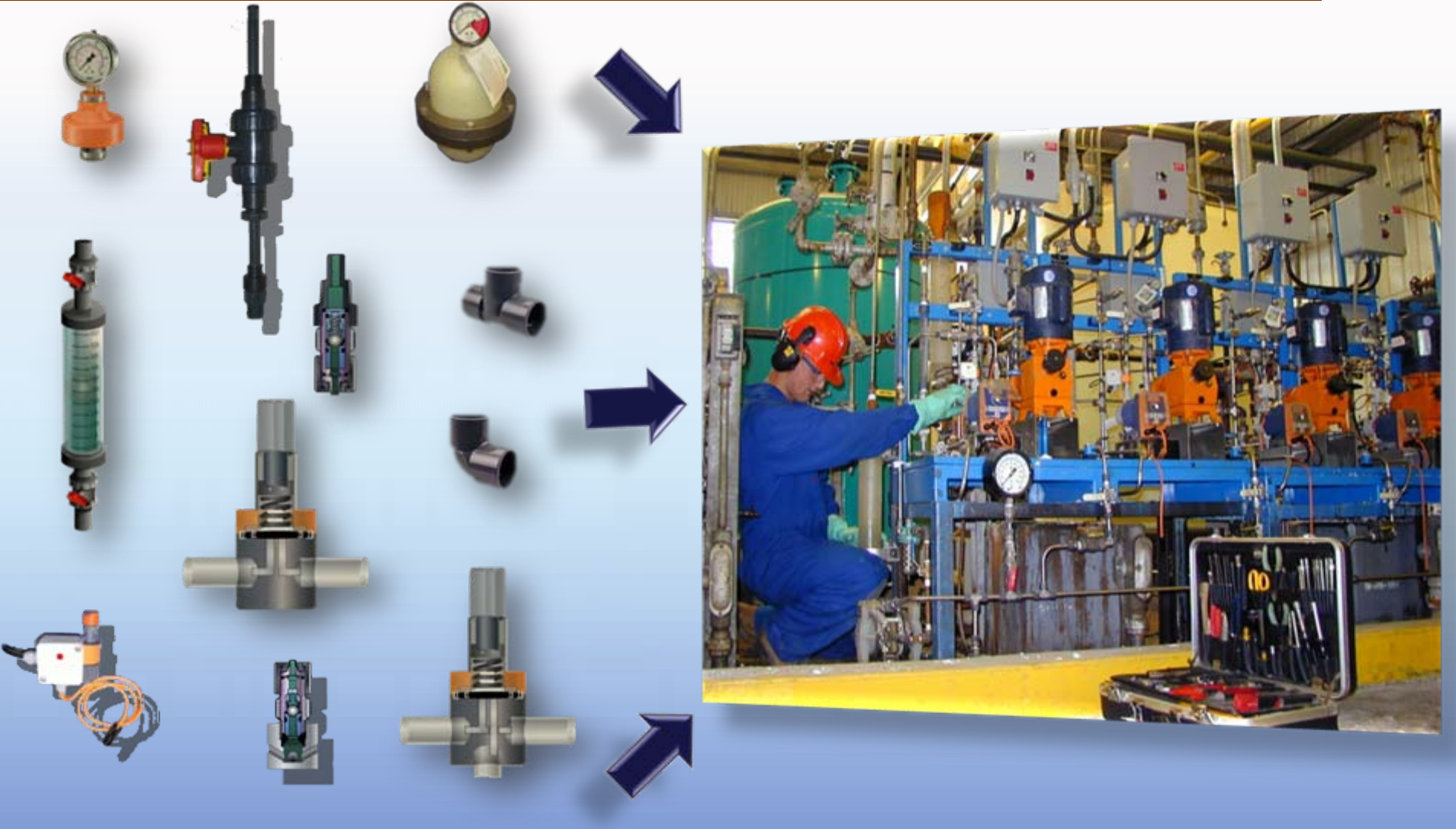
- Threaded (NPT)
- Socket Fusion
  - Solvent Weld (PVC, CPVC)
  - Heat Fusion (PVDF)
- Flanges
- Pipe Unions

ASTM D 1785



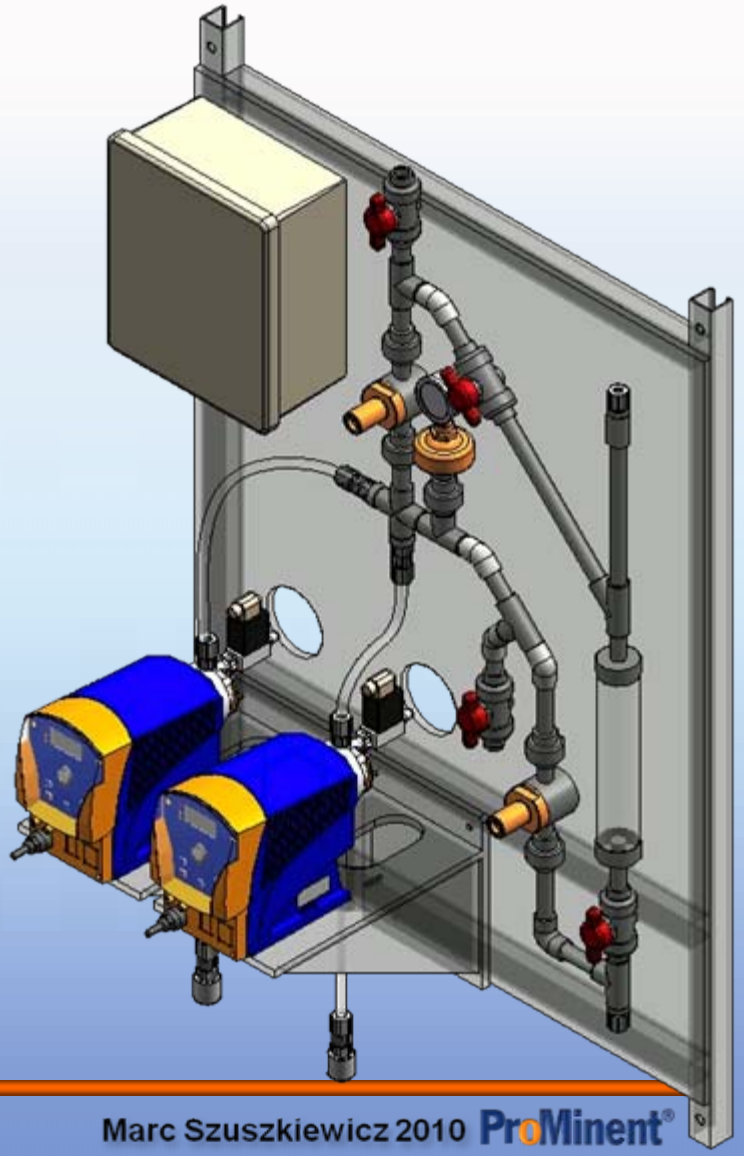
½" SCH 80

Reliable system integration

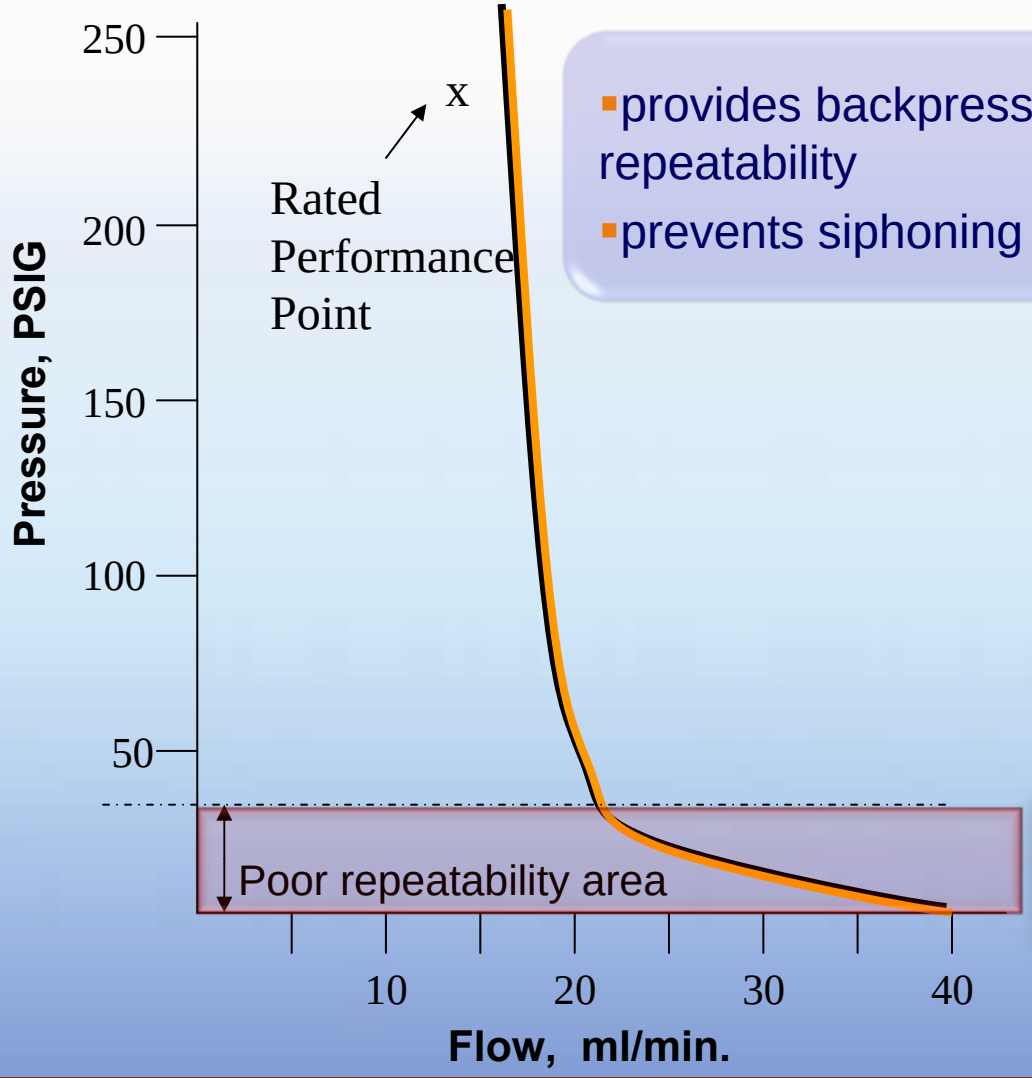


Dosing equipment considerations

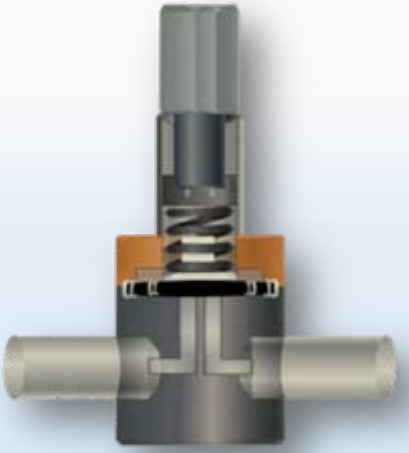
- Foot Valve
- Calibration Column
- Metering Monitor
- Isolation Valves
- Drain Ports
- Pressure Relief Valve
- Pulsation Dampener
- Backpressure Valve
- Pressure Gauge
- Injection Valve



Back Pressure Valve



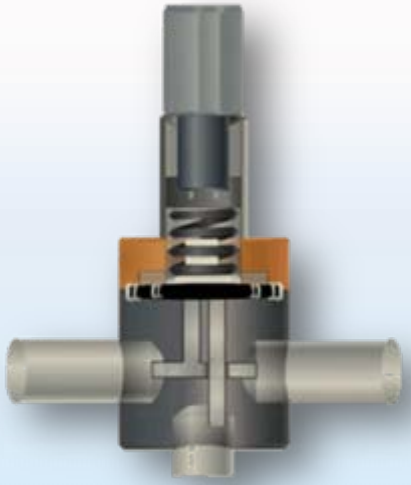
- provides backpressure for repeatability
- prevents siphoning

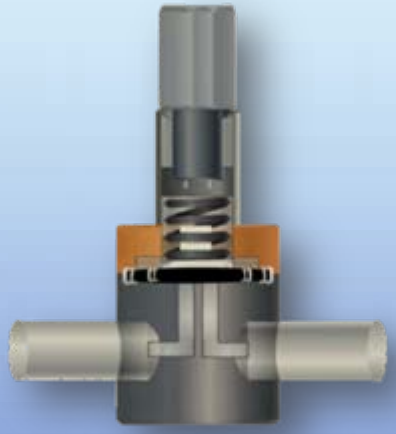


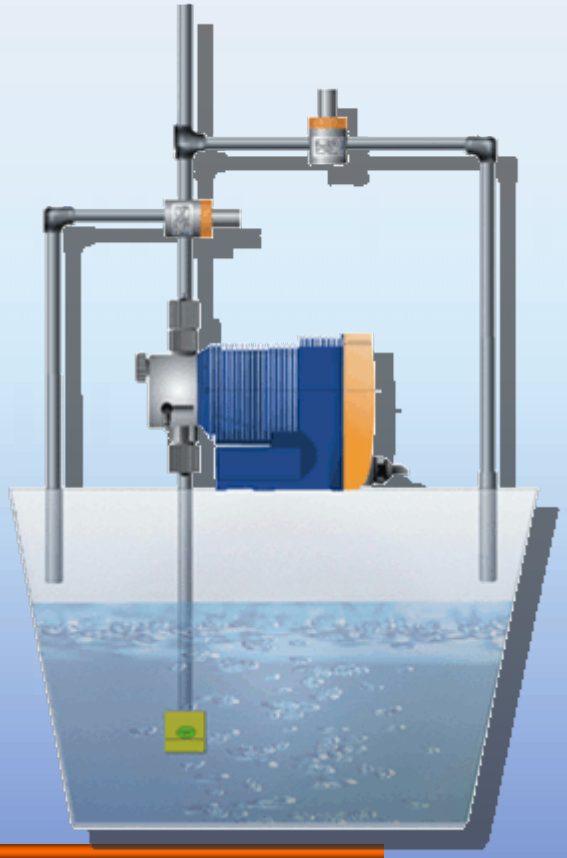
Pressure Relief Valve

- Pressure relief valve protects system components

2 port or 3 port PRV







Monitor performance

Pressure Gauge with chemical isolator

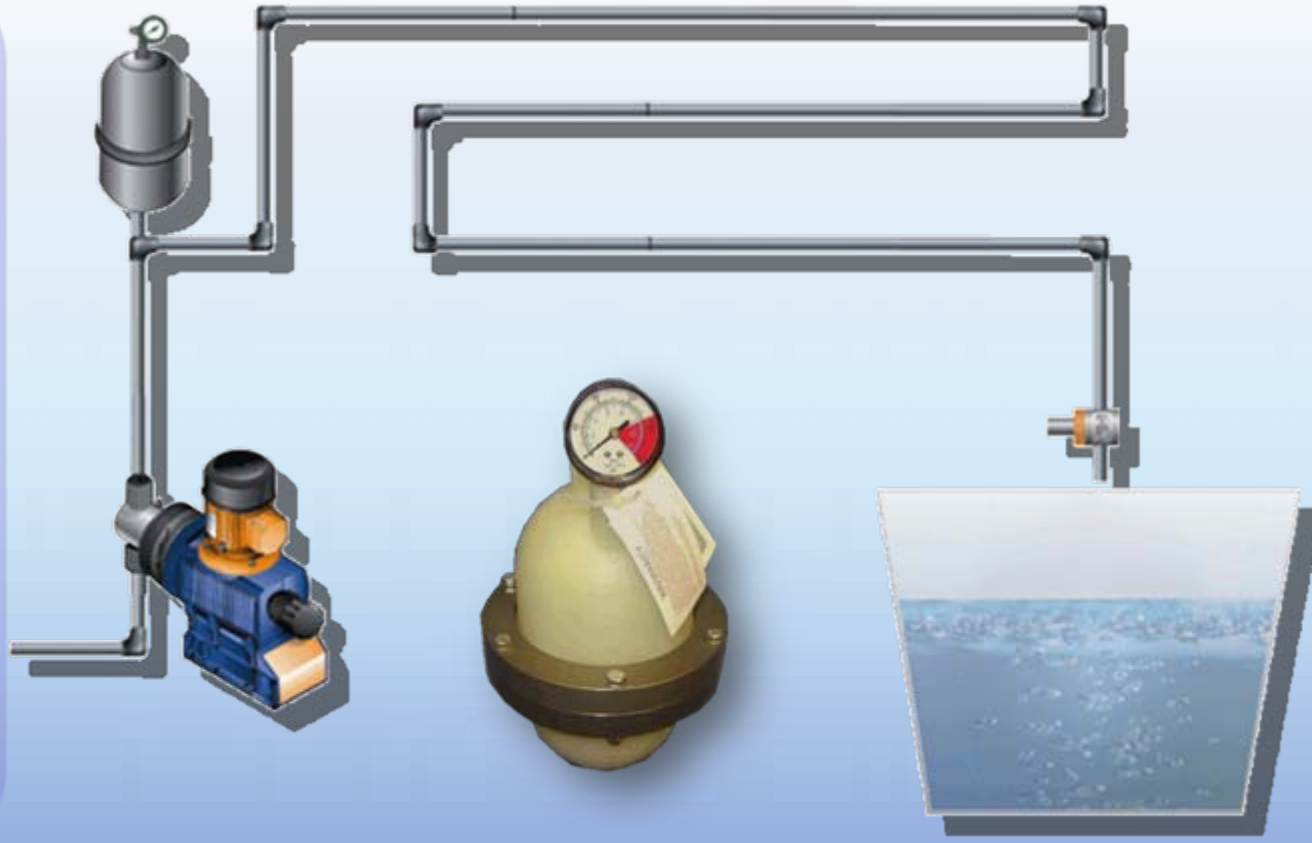
Calibration Column

Flow Monitor

Pulsation Dampener

- Hydraulic shock is the term used to describe the momentary pressure rise in a piping system which results when the liquid is started or stopped quickly.

- Minimizes the pressure peaks and protects the joints and pumps
  - Long lines
  - High Viscosity Chemicals
  - Undersized lines
  - High SG chemicals

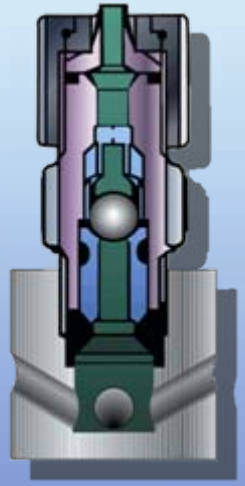


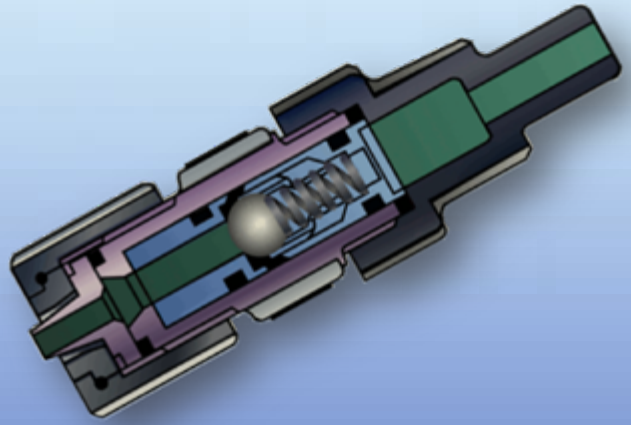
Flush and Drain Ports – Isolation Valves

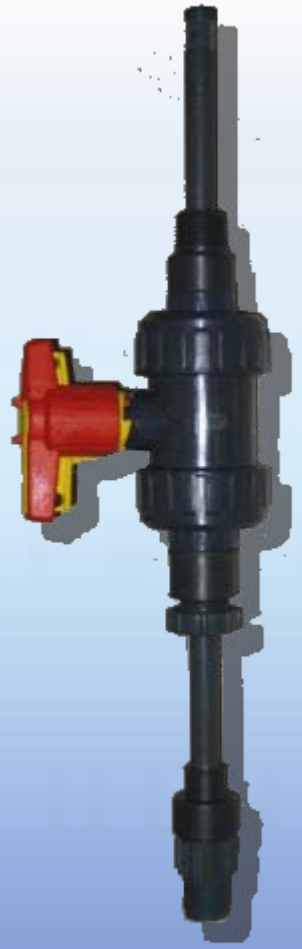
Foot Valve- Injection Valve- Injection Lance

- Keep suction line vertical
- Prevent debris from entering system
- Prevents back flow to tank
- Increases Metering pump performance in suction lift conditions

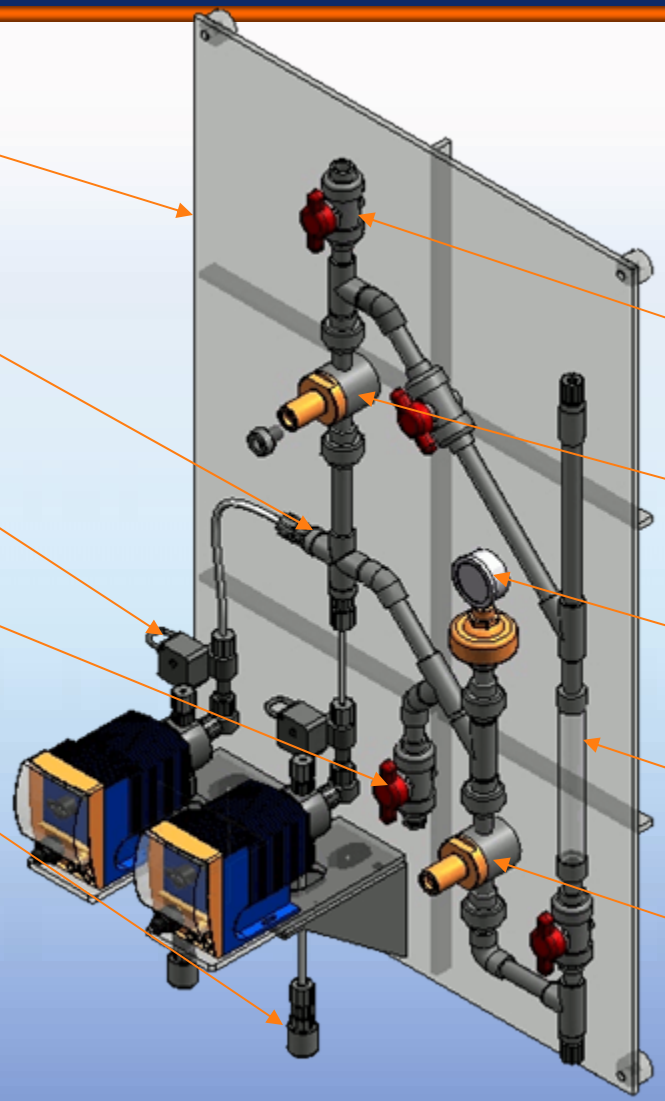
- Prevents water backflow in chemical line
- Maintains 7 psig back pressure
- Increases chemical mix in the process line
- When installed properly minimizes injection point clogging







Sodium Hypochlorite Injection Systems



- PE Backboard
- Injection valve
- Flow Monitor
- Drain valve
- Foot valve
- Discharge isolation valve
- Back pressure valve
- Pressure Gauge & Isolator
- Calibration Column
- Pressure relief valve

Chemical Metering Controls

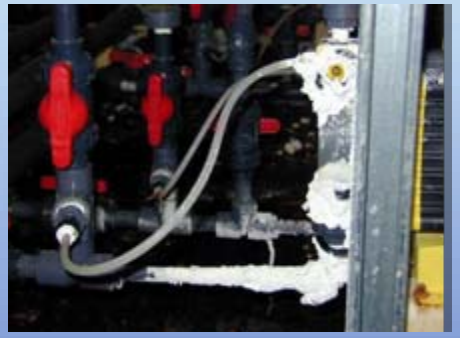
Manual ON/OFF	•Water Pump and Metering Pump both on or both off. •Water flow must be constant when on.
Flow Proportional	•Addition of chemical to water in constant proportions. •Flow meter
Close loop	•Based on a set point from sensor measurement downstream of the injection •Proportional control •Integral control •Derivative control
Compound loop	Combination of Flow Proportional and Closed Loop control.

Troubleshooting

- **Troubleshooting**
  - Unstable Residuals
  - Pump Reliability
  - Corrosion and Leaks
  - Golden Rules






Troubleshooting: Unstable Residuals?

- Sampling Method
  - Fresh representative sample
  - Avoid plastic containment, use clean glass
  - Always repeat same procedure
- Verify Pump sizing
  - Ex. Pump stroking every 10 seconds = bad dispersion
- Pump System Design

Troubleshooting: Unreliable Pump?

- Auto-Degassing Pump Liquid End
- System Design
  - Minimize Fitting Number on Suction
  - Minimize Fluid Volume on Suction Side
  - Material Selection
  - Avoid Trapping Gas
- Maintenance
  - Seals
  - Diaphragms
  - Check valves

Troubleshooting: Corrosion or Leaks?

- Check Material Selection
- System Design (Accessories to minimize pulsation)
- Avoid Threaded Connections
- Maintenance

Hypo Systems: Golden Rules

- Pump sizing
- Fresh Sodium Hypochlorite
- Short suction Line
- Vertical Suction and Discharge lines
- Small volume suction/discharge line
- Maintenance and operation
- Accessories
- Material compatibility PVC viton
- Mechanical/hydraulic stress