Course Outline

- Types of Liquid Chemical Metering Pumps
- Advantages and Disadvantages of Each Type
- Feed Control Systems
- System hydraulics
- Accessories
Overview

• Diaphragm Metering Pumps
  – Hydraulic
  – Mechanical
  – Solenoid Pumps

• Peristaltic

• Progressing Cavity
Hydraulic Diaphragm Metering Pumps

• How do they work?
  – Piston reciprocates through hydraulic fluid
  – Chemical is displaced in the process tube
  – Piston is not in direct contact with diaphragm; less wear

Illustration courtesy of Pulsafeeder
Hydraulically Actuated Metering Pumps

Advantages
- Very accurate
- Can feed “difficult” chemicals (hypo, slurries, etc)
- Capable of feeding high pressures
- Long pump life

Disadvantages
- High capital costs
- Low Suction lift
- Maintenance (hydraulic fluid checks, changes, etc)
Materials Matter

- Common pump head materials
  - PVC
  - Kynar
  - stainless steel
  - cast iron (for tube diaphragms)

- Check several chemical compatibility charts; they do differ
Lessons learned- Flexible Connections

- Not always so flexible

- Look at the specification
  - How is it connected?
  - Are the fittings compatible with the chemical?
Mechanically Actuated Pumps

• How do they work?
  – Piston actuates directly on the diaphragm
  – No intermediate fluid needed
Mechanically Actuated Pumps

- Typically have lower discharge pressures
- Not a good application for slurries or polymers
Mechanically Actuated Metering Pumps

Advantages
• No intermediate hydraulic fluid
• Easier maintenance
• Lower cost

Disadvantages
• Lower discharge pressures
• Material compatibility
Mechanically Actuated Pumps

- Materials Matter

- Chemical concentration matters
  - Sodium hydroxide
  - Sulfuric acid (Kynar is compatible below 93%, not above)
Solenoid Actuated Pumps

- Pump is opened or closed via an electrical impulse
Solenoid Actuated Pumps

Photograph courtesy of Pulsafeeder
Solenoid Pumps

Advantages
• Low capital cost
• Easy installation, simple controls
• Discharge pressures up to 300 psi (but usually low flow applications)

Disadvantages
• High flow applications, low pressure
• Not very rugged
• High pulsation can result in high spikes in discharge pressure

Rule of thumb- Most solenoids at VERY low flowrates have high discharge pressures; As flowrates increase, discharge pressures drop significantly
What is a Turndown Ratio?

- The operating range for a pump; ratio of maximum capacity to minimum capacity
- Literature can promise low turndown (greater than 100:1)
- Beware at very low turndown, accuracy often lost
Turndown Ratios - Stroke Length

- Typically, manually adjusted
- If stroke length changes, use the calibration chamber to verify flow
- 10:1 turndown typical
Stroke Frequency

- Typically automatically adjusted (4-20 mA signal)

- When looking at a pump, do not typically want a high stroke frequency (diaphragm can wear out)

<table>
<thead>
<tr>
<th></th>
<th>Pump 1</th>
<th>Pump 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flowrate (gph)</td>
<td>15.9</td>
<td>14</td>
</tr>
<tr>
<td>Discharge Pressure (psi):</td>
<td>145</td>
<td>145</td>
</tr>
<tr>
<td>Stroke Frequency (spm)</td>
<td>246</td>
<td>172</td>
</tr>
</tbody>
</table>
Peristaltic Pumps

• Also known as “hose” or “tube” pumps

• Chemical in contact with the hose or tube only

• Rollers travel along the hose and push the chemical out

• Positive displacement
Peristaltic Pumps

Advantages

• Chemical is only in contact with hose

• Good suction lift

• Good for slurries or abrasive chemicals

• Backflow/siphoning not an issue
Peristaltic Pumps

Disadvantages

• If a hose fails, chemical leaks all over; could result in complete replacement of the pump

• Hose wear is an issue; regular maintenance item

• Capital cost
Progressing Cavity

- Commonly used for sludge in wastewater applications
- Used for polymers and viscous chemicals
Progressing Cavity

Advantages
• Does not shear chemicals apart
• Can pump to high pressure applications
• Reliability

Disadvantages
• Capital costs
• Turndown
• Controls
Controls

• What types of controls do you need?

• Flow pacing
  – Chemical is fed based on the flow rate (raw water, finished water, etc) and an input dosage rate

• Compound Loop Control
  – Chemical is fed based on several different inputs
    • Flow rate
    • Residual (chlorine residual)
  – For each I/O point, good rule of thumb (cost) is $1,000
Local Control Panels

Some are pump mounted

• Be careful what you are specifying

• Different pumps and manufacturers have different capabilities
Local Control Panels

- Need to coordinate on size of local control panels
- Is there enough space?
Mag Flow Meters

• Provide real time information on how much chemical is being fed

• 1 ft/s velocity minimum

• Make sure there is a bypass line!

• Is there enough wall space?
Discharge Piping & Controls for metering pumps

- Flow Switch - Tells you if there is flow or not, signal sent to SCADA

- Flow Indicator - a local indicator of flow

- Pressure Indicator - Pressure gauge; requires a diaphragm seal (watch the materials!)

- Pressure Transmitter - Transmits pressure back to SCADA
Diaphragm Metering Pump Hydraulics

• Unlike centrifugal pumps, metering pumps hydraulics need to take into account the acceleration losses

• From “Designing a Trouble Free Installation” from PULSAfeeder

FIGURE 1
Piston velocity profile for a reciprocating metering pump.
Hydraulics - Discharge Piping

• Why does this matter? What are you feeding into? Can you change the feed point to a lower pressure application?

• Check the instantaneous peak velocity, not the average velocity

\[ V_P = \frac{Q}{C_3 d^2} \]

\[ C_3 = 46.8 \]
Diaphragm Metering Pump Hydraulics

• Do not use Hazen-Williams

• Net Positive Suction Head (NPSH) and system backpressure calculated differently for chemicals above and below 50 centipoise

• “Designing a Trouble Free Installation” from PULSAfeeder provides excellent information for this
Pump Hydraulics- Peristaltic and Progressing Cavity

• Hazen-Williams DOES apply at low viscosities (less than 50 centipoise)

• To be conservative, multiply the max feed rate by 1.5.
### Viscosities of Common WTP Chemicals

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Viscosity (centipoise)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alum (48%)</td>
<td>60 cps @ 30ºF</td>
</tr>
<tr>
<td>Ferric Sulfate (46%)</td>
<td>20 cps</td>
</tr>
<tr>
<td>Glycerin</td>
<td>&gt; 1000 (depending on concentration/temp)</td>
</tr>
<tr>
<td>Magnesium Hydroxide</td>
<td>200</td>
</tr>
<tr>
<td>Sodium Hydroxide (50%)</td>
<td>70 cps @ 68ºF</td>
</tr>
<tr>
<td>Sodium Hydroxide (25%)</td>
<td>8 cps @ 68ºF</td>
</tr>
<tr>
<td>Sodium Hypochlorite (15%)</td>
<td>2.6 cps</td>
</tr>
<tr>
<td>Sulfuric Acid (93%)</td>
<td>25 cps</td>
</tr>
</tbody>
</table>
Why is this tank on a platform?

• Suction lift varies with pump type

• Typically, mechanical and hydraulic diaphragm pumps have low suction lift
Discharge piping- Double Check it!!

• Hydraulics often based on preliminary designs

• Did the suction lift take into account
  – Tank Height? Is it on a pedestal?
  – Pump Height? Is it on a table? Elevated platform?
Typical Feed Schematic (Diaphragm pump shown)
Accessories

- Back Pressure Valves
- Anti-Siphon Valves
- Pulsation Dampener
- Needle Valves
- Strainers/Wye Connections
- Calibration Columns
- Static Mixers
- Diaphragm Valves
- Ball Valves
Valves and Accessories

• Ball Valves
  – Used for isolation of pumps, feed lines
  – Chemicals that off-gas need to have vented ball valves
  – Sodium hypochlorite vapors can build up behind the valve
Valves and Accessories

• Diaphragm Valves

• Use for throttling applications

• Also work well for chemicals that crystallize or off gas

• Inlet to calibration columns
Pulsation Dampener

• Acts like a “shock absorber” for flow

• On the discharge side of a pump, will help prevent “spikes” in flow from peak flow and pressure

• On the suction side, can allow smaller pipe size between pump and tank
Back Pressure Valves

• Provide backpressure for systems with less than minimum required pressure differential on the suction and discharge side of the pump

• Have pump manufacturers preset pressures
Anti-Siphon Valves

• Prevent the full tank from draining in case of piping failure
Calibration Columns

• Make sure the column is sized correctly for the pump
  • Too big - takes a long time to fill
  • Too small - difficult to calibrate
  • Rule of thumb - 2 minutes at max flow
Lessons learned- Calibration Columns
Y- strainers and flushing connections

- Chemical debris can build up in the lines
- Provide a means of cleaning the suction lines
- Protect the pumps!
Needle Valves

- Careful control of flow
- Often used for calibration columns
Static Mixers

- Used for dispersing chemical
- Good for exothermic reactions (materials matter)
- Viscous chemicals, acids
Overall Chemical Injection Schematic
Skid Mounted Pumps

- Efficient on space
- Maintenance issues - shop drawing review is key
Carrier Water

When is it a good idea?

- Low velocity application points where mixing/dispersion is needed
- Heat/exothermic reaction
- Dilution is necessary
- Applications where flushing the line is a good idea

When is it a bad idea?

- Limited water
- Coagulants should be fed neat
- High water hardness
- Is it going to affect the instrumentation? Chlorine residual?
# Summary Table

<table>
<thead>
<tr>
<th></th>
<th>Diaphragm Pumps</th>
<th>Peristaltic</th>
<th>Progressive Cavity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Applications</strong></td>
<td>Most chemicals; not recommended for polymers or slurries</td>
<td>Chemical slurries; polymers; sodium hypochlorite; high viscosity applications</td>
<td>Polymers; chemical slurries or high viscosity chemicals</td>
</tr>
<tr>
<td><strong>Typical Manufacturers</strong></td>
<td>Pulsafeeder, Prominent, Wallace and Tiernan, LMI</td>
<td>Watson Marlow, Blue-White</td>
<td>Moyno; Seepex</td>
</tr>
<tr>
<td><strong>Suction Lift</strong></td>
<td>Low ((&lt; 5’))</td>
<td>High</td>
<td>High (20’ +)</td>
</tr>
<tr>
<td><strong>Turndown Ratio</strong></td>
<td>High published ratios</td>
<td>NA</td>
<td>Low (typically 20:1)</td>
</tr>
<tr>
<td><strong>Discharge Pressures</strong></td>
<td>Can be very high (200 psi +)</td>
<td>Varies with hose specified</td>
<td>High</td>
</tr>
</tbody>
</table>
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Questions?

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