Specifying the Optimal Chemical Pump

Nancy Westcott
President, GoatThroat Pumps
Overview

- Pump Locations and Uses
- Classification of Pumps
- Pump Selection
  - Define the Application Environment
  - Define the Specs
    - Flow Rates
    - Materials of Construction
    - Hazardous Locations
Wetted System Parts Must Be Inert to the Liquid and Its Fumes
Pump System Components
Pump Locations in a Plant

Graphic courtesy of GRAINGER®

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Specifying the Optimal Pump
In-Line Pump Locations

Graphic courtesy of GRAINGER

Specifying the Optimal Pump
Point of Use Locations

Graphic courtesy of GRAINGER

Specifying the Optimal Pump
Classification of Pumps

Positive Displacement (more efficient and deliver higher flow rate)
- Reciprocating
  - Piston
  - Plunger
  - Diaphragm
- Rotary
  - Gear
  - Screw
  - Vane

Kinetic (simple, reliable, variable flow, more versatile)
- Pressure
  - Centrifugal
    - Radial Flow
    - Axial Flow
    - Mixed Flow
    - Special High Speed (High Head and Low Flow)
      - Single Suction
        - Multistage
        - Single Stage
      - Double Suction

After R.P. Sharma, "Selection of Pumps for the Process Industries"
After R.P. Sharma, "Selection of Pumps for the Process Industries"
Centrifugal Pumps

engineeringtoolbox.com
Centrifugal Pump


Specifying the Optimal Pump
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Pressure
- Centrifugal
  - Radial Flow
  - Axial Flow
  - Mixed Flow
  - Single Suction
  - Double Suction
  - Multistage
  - Single Stage
  - Screw
  - Centrifugal
  - Jet Ejector
  - Booster
  - Gas Lift
  - Rotating Casing
  - Electromagnetic

Peripheral

Kinetic (simple, reliable, variable flow, more versatile)
- Special High Speed (High Head and Low Flow)

After R.P. Sharma, "Selection of Pumps for the Process Industries"
Gear Pumps

From Wikipedia.com
Progressive Cavity Pumps

From Wikipedia.com
Lobe Pumps

From Wikipedia.com
Rotary Vane Pump

From Wikipedia.com
Classification of Pumps

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- Electromagnetic

Double Suction
- Multistage
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After R.P. Sharma, "Selection of Pumps for the Process Industries"
Piston Pump

From Wikipedia.com
Piston Pump

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After R.P. Sharma, "Selection of Pumps for the Process Industries"
Pressure Pump
**Pump Selection: Define the Need**

- **Centrifugal**
  - Variable Flow Rate depending on pressure head and flow rate
  - Not good with viscous fluids
  - Changing pressure or head will have a dramatic effect on flow rate

- **Positive Displacement**
  - Fixed Flow Rate
  - Good with Viscous fluids
  - Changing system pressure or head will have no effect on flow rate
Pump Selection: Define the Need

• Centrifugal
  – Variable Flow Rate depending on pressure head and flow rate
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Pump Selection: Define the Specs

- KIND OF MATERIAL BEING PUMPED

- PUMP OPERATION

- OPERATING ENVIRONMENT

- HOW POWERED

- ++++++++ many more
Pump Selection: Define the Specs

• KIND OF MATERIAL BEING PUMPED
  – Food
  – Base, Acid, Solvent
  – Flammable or combustible liquid
  – Slurry, Solid Or Clear
  – Viscosity Of Material
  – Hot or Cold Liquid Temperature

• PUMP OPERATION

• OPERATING ENVIRONMENT

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• PUMP OPERATION
  – Adjustable Or Fixed Flow Rate
  – Continuous Or Occasional Duty
  – Continuous Flow Vs Pulsing
  – Might It Need To Run Dry?

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• OPERATING ENVIRONMENT
  – Temperature
  – Wet vs Dry Environment

• HOW POWERED
  – Electric, Pneumatic Or Hand Operated
  – ++++++ many more
Pump Selection: Define the Specs

- **KIND OF MATERIAL BEING PUMPED**
  - Food
  - Base, Acid, Solvent
  - Flammable or combustible liquid
  - Slurry, Solid Or Clear
  - Viscosity Of Material
  - Hot or Cold Liquid Temperature

- **PUMP OPERATION**
  - Adjustable Or Fixed Flow Rate
  - Continuous Or Occasional Duty
  - Continuous Flow Vs Pulsing
  - Might It Need To Run Dry?

- **OPERATING ENVIRONMENT**
  - Temperature
  - Wet vs Dry Environment

- **HOW POWERED**
  - Electric, Pneumatic Or Hand Operated
Pump Selection: Flow Rate

Selection Based on Flow "Decision Tree"

Case - I: Fluid flow less than 1 gpm

System Pressure

Less than 30 Psig → Fluid contains Particulate Matter

Less than 30 Psig → Requires a Pulseless Flow

Yes → Progressing Cavity Pump

No → Peristaltic Tubing Pump

Greater than 30 Psig → Fluid contains Particulate Matter

Greater than 30 Psig → Requires Self Priming Pump

Yes → Peristaltic Tubing, Progressing Cavity or Bellows

No → High Accuracy Dispensing

Yes → Diaphragm (metering) Piston or Peristaltic Tubing

No → Gear or Peristaltic Tubing

Gear Pump

Peristaltic Tubing or Piston Pump

Diaphragm Metering or Peristatic Tubing

R.P. Sharma: "Selection of Pumps for the Process Industry"
Pump Selection: Flow Rate

Selection Based on Flow "Decision Tree"

Case - II: Fluid flow 1 to 20 gpm

System Pressure

- Less than 30 Psig
- Greater than 30 Psig

Fluid contains Particulate Matter

- Yes
  - Requires a Pulseless Flow
    - Yes: Progressing Cavity
    - No: Bellow Diaphragm
  - No: Centrifugal Gear, Progressing Cavity or Rotary Vanes

- No
  - Requires Self Priming Pump
    - Yes: Progressing Cavity or Flexible Liner
    - No: Double Diaphragm or Peristaltic Tubing

- Yes
  - Requires a Pulseless Flow
    - Yes: Gear, Progressing Cavity or Rotary Lobe
    - No: Double Diaphragm or Peristaltic Tubing

R.P. Sharma: "Selection of Pumps for the Process Industry"
Materials of Construction

• Match the liquid with the pump components to avoid corrosion or deterioration of either the product or the pump.
Materials of Construction

Centrifugal Pump

Materials of Construction

• FOOD GRADE PUMPS
  – Must be made of FDA compliant materials
  – Must be cleanable to appropriate standards with heat or chemical
    • Stainless Steel
    • Food grade plastics and elastomeric parts (rubber parts)
Materials of Construction

- Hazardous chemicals require MSDS
- This special paperwork can help figure out what pump materials are correct.
Materials of Construction

- Hazardous chemicals require MSDS
- This special paperwork can help figure out what pump materials are correct.

- The MSDS, Material Safety Data Sheet has a new name – SDS.
- See more at:
  [http://www.msdsonline.com/blog/2012/08/from-msds-to-sds/](http://www.msdsonline.com/blog/2012/08/from-msds-to-sds/)
Materials of Construction

• ON-LINE RESOURCES FOR MATERIALS SELECTION

• http://www.coleparmer.com/Chemical-Resistance

• http://www.flw.com/datatools/compatibility/

• http://goatthroat.com/complete-chemical-liquid-compatibility-guide/

Materials of Construction
1. Select a Material or Chemical.
2. Optional - select another category (Material, Chemical, or Rating) to narrow your results for a specific combination or compatibility rating.
3. Click "See results"
   Note: You can not choose Rating with BOTH Material and Chemical selected.

**Material**
- All
- ABS plastic
- Acetal (Delrin®)
- Aluminum
- Brass

**Chemical**
- Oils: Ginger
- Oils: Hydraulic Oil (Petro)
- Oils: Hydraulic Oil (Synthetic)
- Oils: Lemon
- Oils: Linseed

**Rating**
- All

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**WARNING**
The information in this chart has been supplied to Cole-Parmer by other reputable sources and is to be used ONLY as a guide in selecting equipment for appropriate chemical compatibility. Before permanent installation, test the equipment with the chemicals and under the specific conditions of your application.

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**Specifying the Optimal Pump**

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### Chemical Compatibility Results

Material and their Compatibility Rating with your selected Chemical are listed below:

**Chemical Selected:** Oils: Hydraulic Oil (Petro)

<table>
<thead>
<tr>
<th>Material</th>
<th>Compatibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABS plastic</td>
<td>N/A</td>
</tr>
<tr>
<td>Acetal (Delrin®)</td>
<td>B-Good</td>
</tr>
<tr>
<td>Aluminum</td>
<td>A-Excellent</td>
</tr>
<tr>
<td>Brass</td>
<td>A-Excellent</td>
</tr>
<tr>
<td>Buna N (Nitrile)</td>
<td>A-Excellent</td>
</tr>
<tr>
<td>Carbon graphite</td>
<td>B-Good</td>
</tr>
<tr>
<td>Carbon Steel</td>
<td>A-Excellent</td>
</tr>
<tr>
<td>Carpenter 29</td>
<td>A-Excellent</td>
</tr>
<tr>
<td>Cast iron</td>
<td>A-Excellent</td>
</tr>
<tr>
<td>Ceramic Al203</td>
<td>N/A</td>
</tr>
<tr>
<td>Ceramic magnet</td>
<td>N/A</td>
</tr>
<tr>
<td>ChemRaz (FKM)</td>
<td>A-Excellent</td>
</tr>
<tr>
<td>Copper</td>
<td>A-Excellent</td>
</tr>
<tr>
<td>CPVC</td>
<td>N/A</td>
</tr>
<tr>
<td>EPDM</td>
<td>D-Severe Effect</td>
</tr>
<tr>
<td>Epoxy</td>
<td>A-Excellent</td>
</tr>
<tr>
<td>Fluorocarbon (FKM)</td>
<td>A-Excellent</td>
</tr>
</tbody>
</table>

Explanation of Footnotes:
1. Satisfactory to 72°F (22°C)
2. Satisfactory to 120°F (49°C)

**Ratings -- Chemical Effect**

- **A = Excellent.**
- **B = Good -- Minor Effect, slight corrosion or discoloration.**
- **C = Fair -- Moderate Effect, not recommended for continuous use. Softening, loss of strength, swelling may occur.**
- **D = Severe Effect, not recommended for ANY use. N/A = Information not available.**
Materials of Construction

<table>
<thead>
<tr>
<th>Material</th>
<th>Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hastelloy-C®</td>
<td>A-Excellent</td>
</tr>
<tr>
<td>Hypalon®</td>
<td>A-Excellent</td>
</tr>
<tr>
<td>Hytrel®</td>
<td>N/A</td>
</tr>
<tr>
<td>Kalrez</td>
<td>A-Excellent</td>
</tr>
<tr>
<td>Kel-F®</td>
<td>N/A</td>
</tr>
<tr>
<td>LDPE</td>
<td>C-Fair</td>
</tr>
<tr>
<td>Natural rubber</td>
<td>D-Severe Effect</td>
</tr>
<tr>
<td>Neoprene</td>
<td>A-Excellent</td>
</tr>
<tr>
<td>NORYL®</td>
<td>N/A</td>
</tr>
<tr>
<td>Nylon</td>
<td>A¹-Excellent</td>
</tr>
<tr>
<td>Polycarbonates</td>
<td>N/A</td>
</tr>
<tr>
<td>Polyetherether Ketone (PEEK)</td>
<td>A-Excellent</td>
</tr>
<tr>
<td>Polypropylene</td>
<td>D-Severe Effect</td>
</tr>
<tr>
<td>Polyurethane</td>
<td>N/A</td>
</tr>
<tr>
<td>PPS (Ryton®)</td>
<td>D-Severe Effect</td>
</tr>
<tr>
<td>PTFE</td>
<td>A-Excellent</td>
</tr>
<tr>
<td>PVC</td>
<td>A-Excellent</td>
</tr>
<tr>
<td>PVDF (Kynar®)</td>
<td>A-Excellent</td>
</tr>
<tr>
<td>Silicone</td>
<td>B³-Good</td>
</tr>
<tr>
<td>stainless steel - 304</td>
<td>A-Excellent</td>
</tr>
<tr>
<td>stainless steel - 316</td>
<td>A-Excellent</td>
</tr>
<tr>
<td>Titanium</td>
<td>N/A</td>
</tr>
<tr>
<td>Tygon®</td>
<td>A-Excellent</td>
</tr>
<tr>
<td>Viton®</td>
<td>A-Excellent</td>
</tr>
</tbody>
</table>
Diagram illustrating the process of brewing beer.
Pumps for Hazardous Locations
Pumps for Hazardous Locations

EQUIPMENT CERTIFICATIONS

• WORLDWIDE STANDARDS
  – IECEX

• EUROPEAN STANDARDS
  – ATEX

• U.S. STANDARDS
  – NFPA
  – UL
  – FM
  – INTERTEK
Discussion Groups

• Linked-In has some great discussion groups going and they have answers from all over the world:
  – **Pump engineers**
    • Current discussions – slurry pumps; dry run production devices; fish mortality, injury and removal in cooling water intake systems
  – **Pump Professionals**
    • Current discussion: What is the benefit of having two pressure vessels on discharge header for two pumps instead of one vessel for two pumps, is it possible to select properly one vessel on one side instead of having 2?
  – **Pump Bombas – In English language**
    • Current discussions: Centrifugal Force is Farce !@#$
Contact:
Nancy Westcott
President, GoatThroat Pumps

www.goatthroat.com
nwestcott@goatthroat.com
Call 212.255.6964/ 866.639.4628
Reference Material

- All about plastics in pumps

- When to choose a pd vs centrifugal

- When to choose peristatic
  [http://www.pump-zone.com/topics/pumps/pumps/choosing-right-pump-paint-systems](http://www.pump-zone.com/topics/pumps/pumps/choosing-right-pump-paint-systems)
Reference Material

• Slurry vs others

• Centrifugal vs diaphragm
  http://www.wwdmag.com/pumps-centrifugal/picking-pump

• Ebay's version choose the right pump
  http://www.ebay.com/gds/5-Tips-for-Choosing-the-Right-Pump-/10000000177634171/g.html
Reference Material

- Really good British equipment overview
  http://www.pumpeng.co.uk/choosing-the-right-pump.aspx

- Sizing etc

- Excellent pump selection primer
Reference Material

• Everything about centrifugal pumps

• Immersible pumps
Reference Material

• Electrical energy usage and pump selection

Reference Material

- Life cycle cost