Pump Technologies and Applications

Marty Davidson, BL Anderson Company

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Agenda

- Centrifugal Pumps
  - Pump Curves
  - Applications
- Positive Displacement Pumps
  - Pump Curve
  - Types
  - Applications

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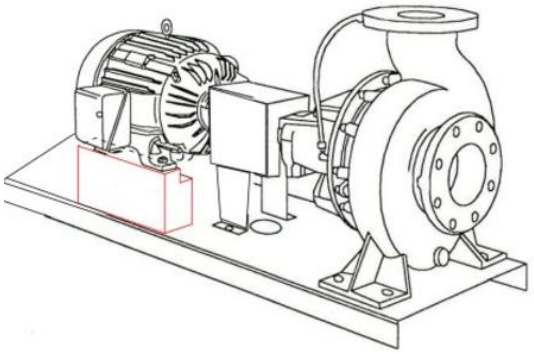
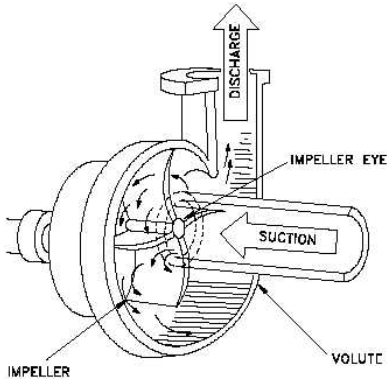
Centrifugal Pumps

- Centrifugal pumps are dynamic (kinetic) pumps
- The impeller shape and rotational motion imparts centrifugal force on fluid particles
- This force is converted to pressure as the fluid is pushed against the pump casing
- There are several considerations that must be taken into account when sizing a centrifugal pump for a given application





Radial Flow Centrifugal Pump

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Now The Fun Part!

Theory & Pump Curves!

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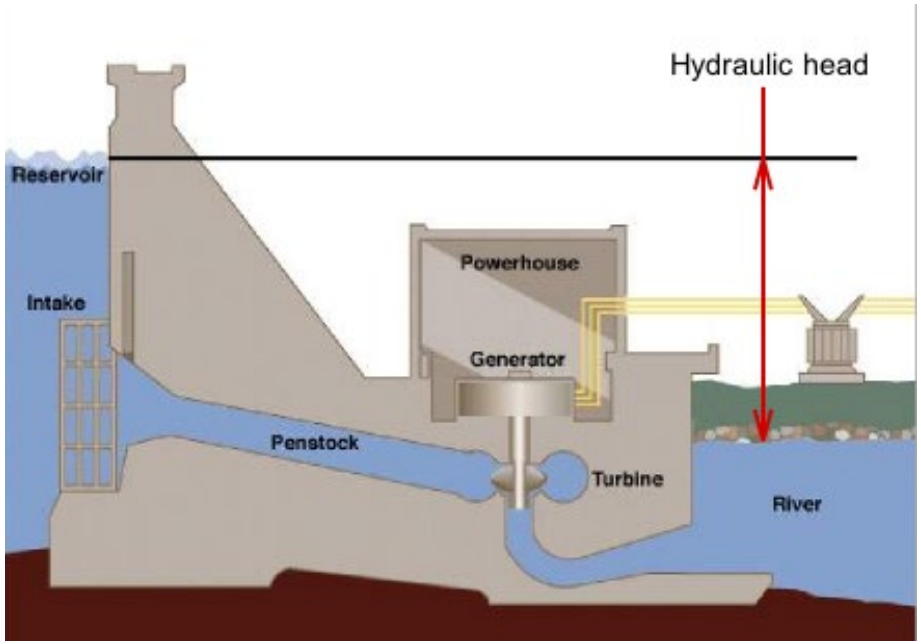
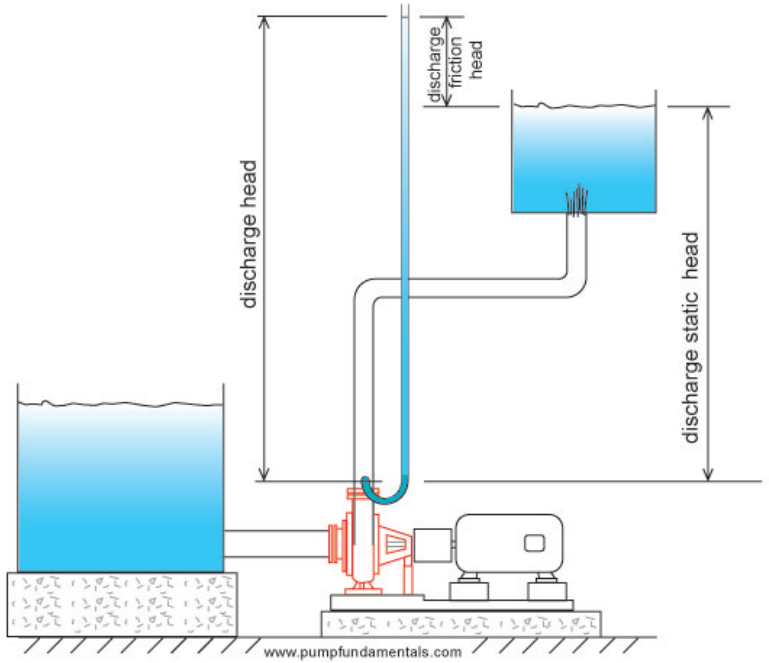
Static Head (SH or StH)

- Head is measured in **feet of liquid**





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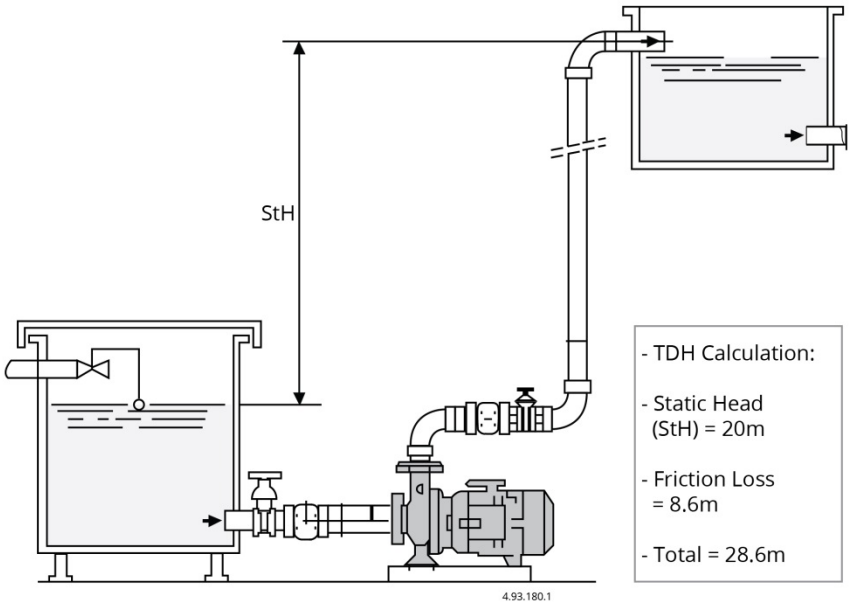
Total Dynamic Head (TDH)

- In fluid dynamics, **Total Dynamic Head** (TDH) is the **total** equivalent height that a fluid is to be pumped, taking into account friction losses in the pipe
- TDH = Static Height + Static Lift + Friction Loss.



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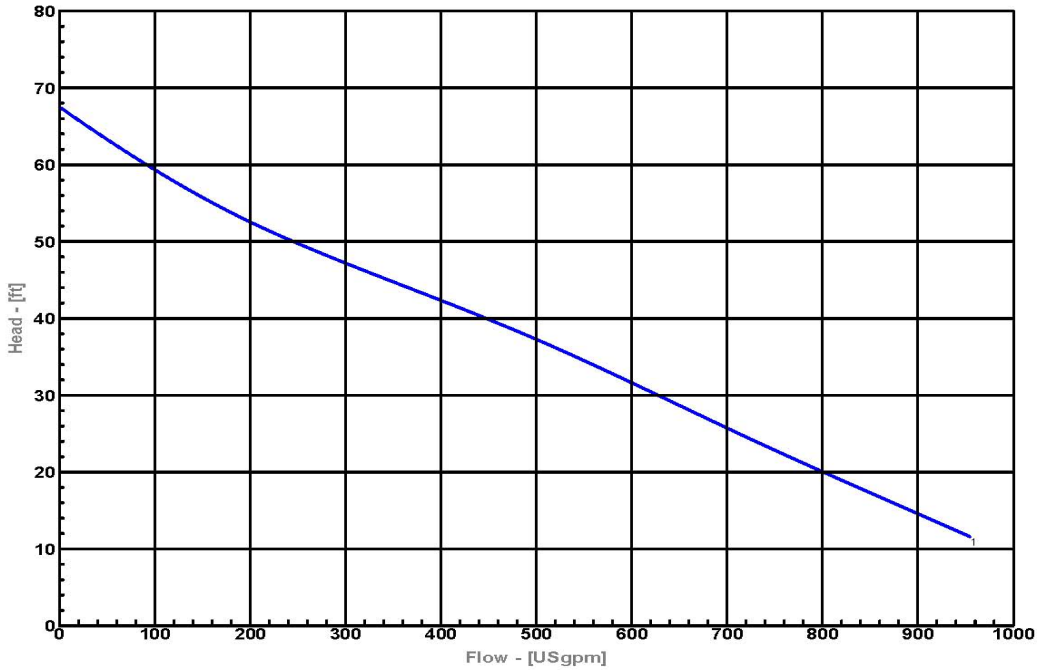
Centrifugal Pump Curves

When looking at pump curves, we look at **FLOW** (x-axis) and **TDH (y-axis)**

- FLOW = **GPM**
- TDH = **FEET**



- Where will the pump operate?
- Where it reaches a **balance** with the **piping system**

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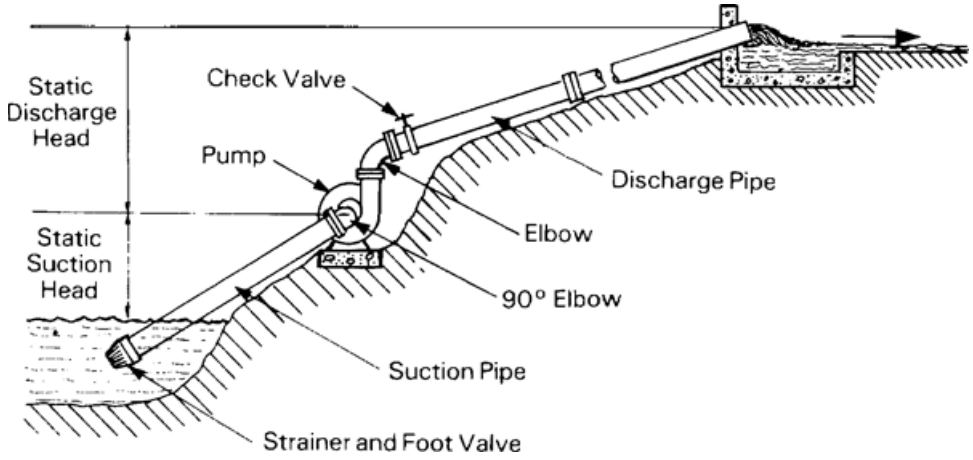
The Piping System

- Factors that need to be taken into consideration:
  - How far? The longer the pipe run, the greater the resistance
  - How high? Elevation difference is the static head
  - Through what size and type of pipe? Each of these creates friction
  - How many valves, bends, and turns?



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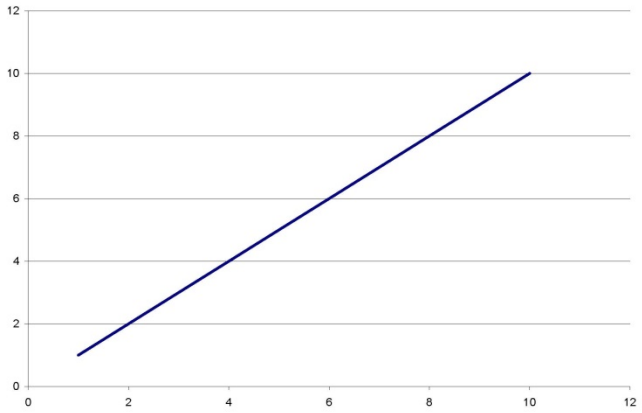
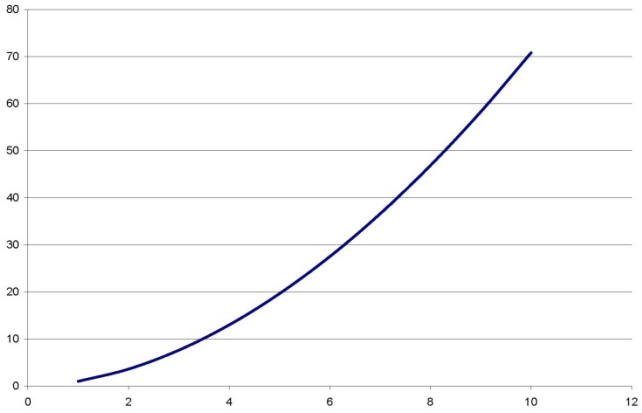
How the Piping System Effects the Curve

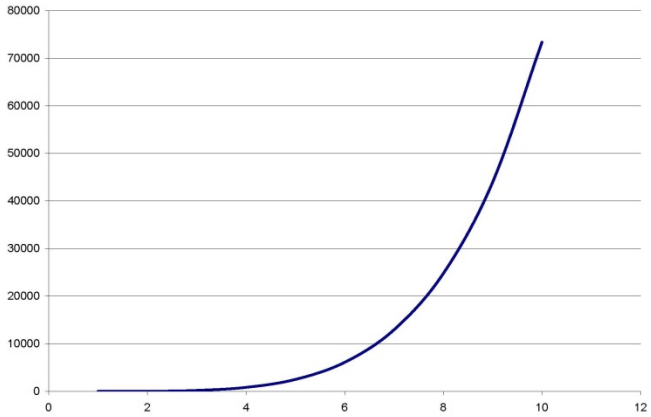
Effect of Pipe Length



Effect of Pipe Roughness



Effect of Pipe Diameter



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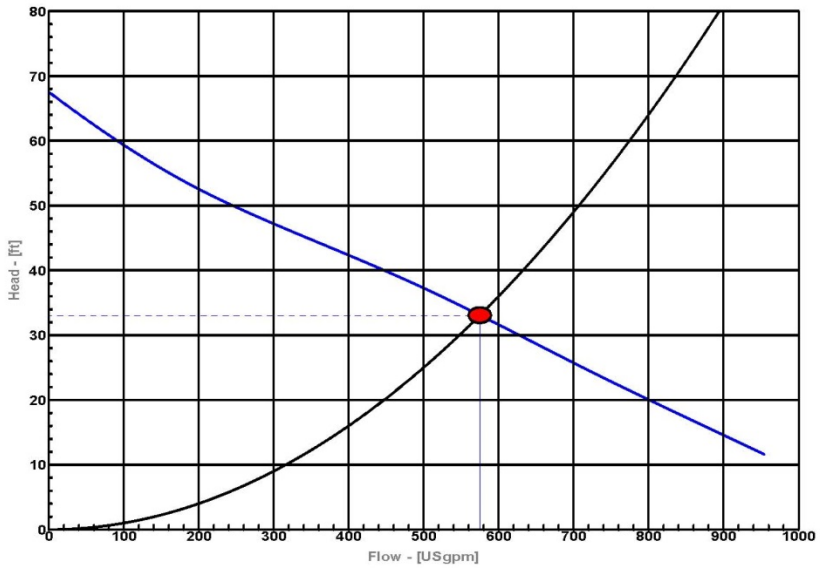
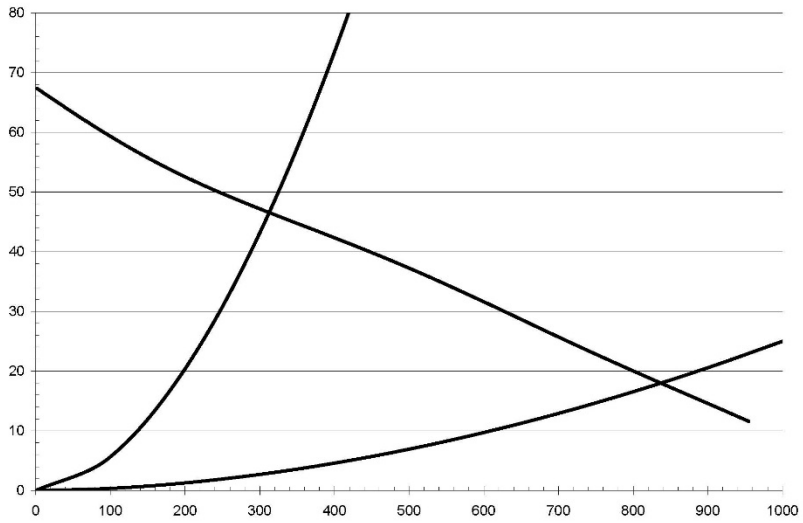
The System Curve

- We can show the resistance of a piping system with a **System Curve**
- The pump(s) will run at the intersection of the **pump and system curve**
- The system curve matters





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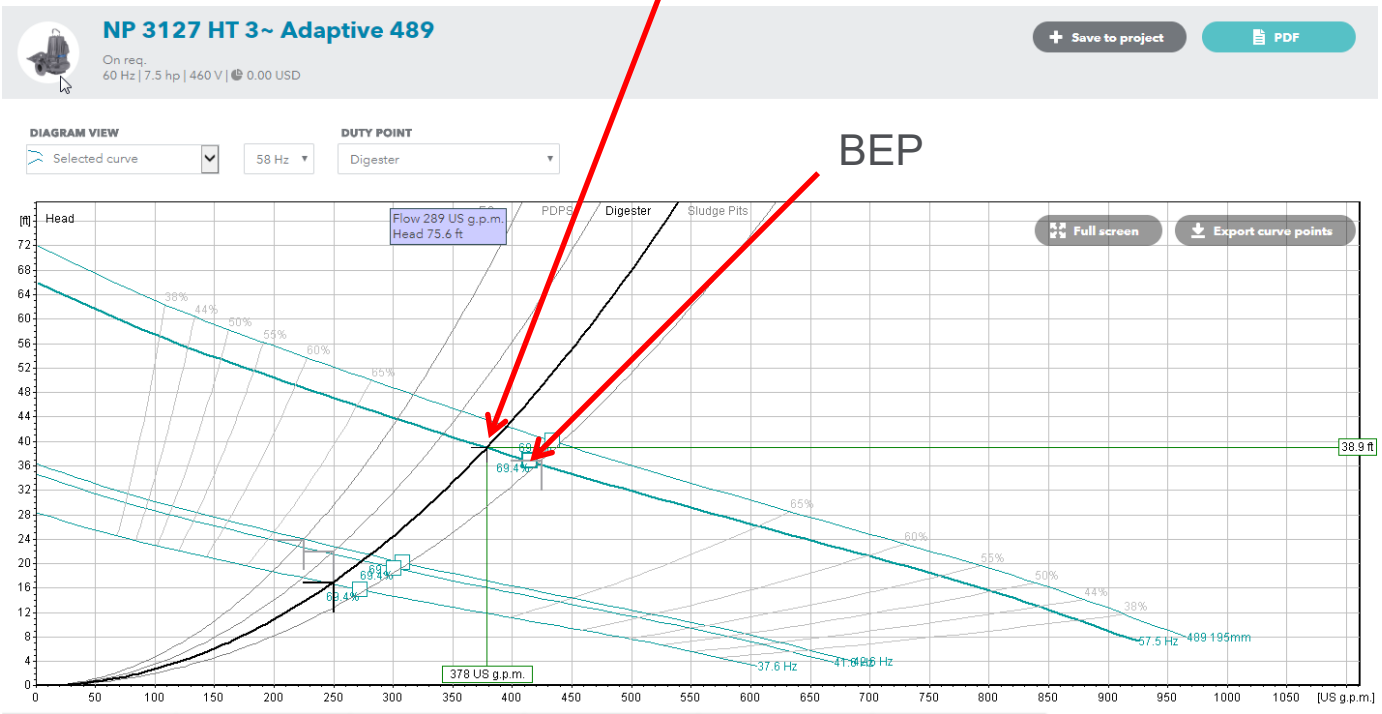
Best Efficiency Point (BEP)

- The pump is happiest at its **Best Efficiency Point**
- However, pump selections **always involve trade-offs**
  - Solids handling size
  - Speed
  - Cost

Balance with piping system

BEP



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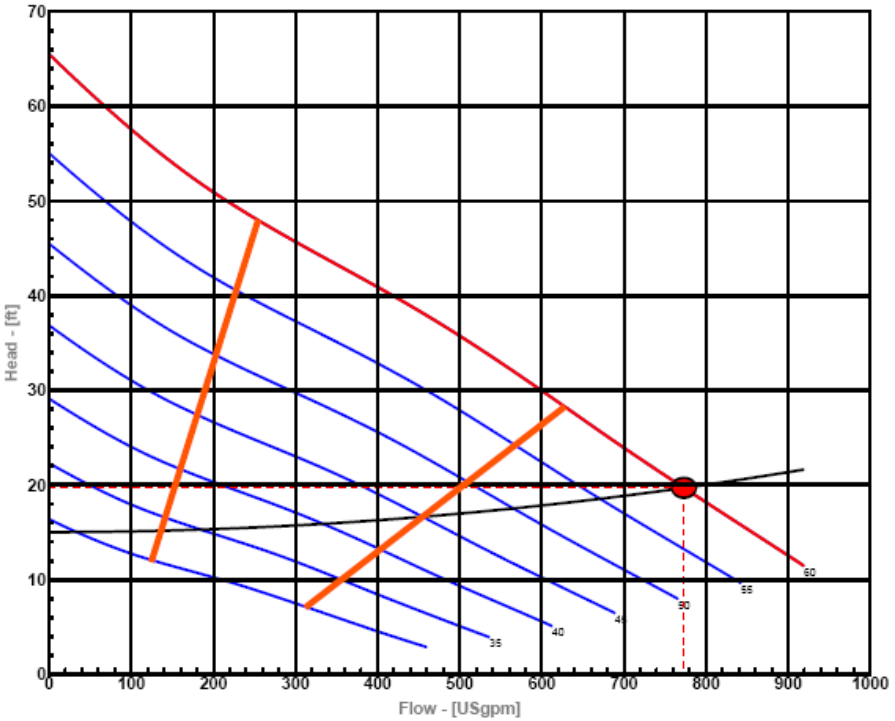
Allowable Operating Range (AOR)

- Industry standard is 50% to 125% of BEP flow rate at any operating speed

- Continuously left of AOR can cause:
  - Low efficiency
  - Higher bending forces
  - Vibration
  - Clogging
  - Temperature rise



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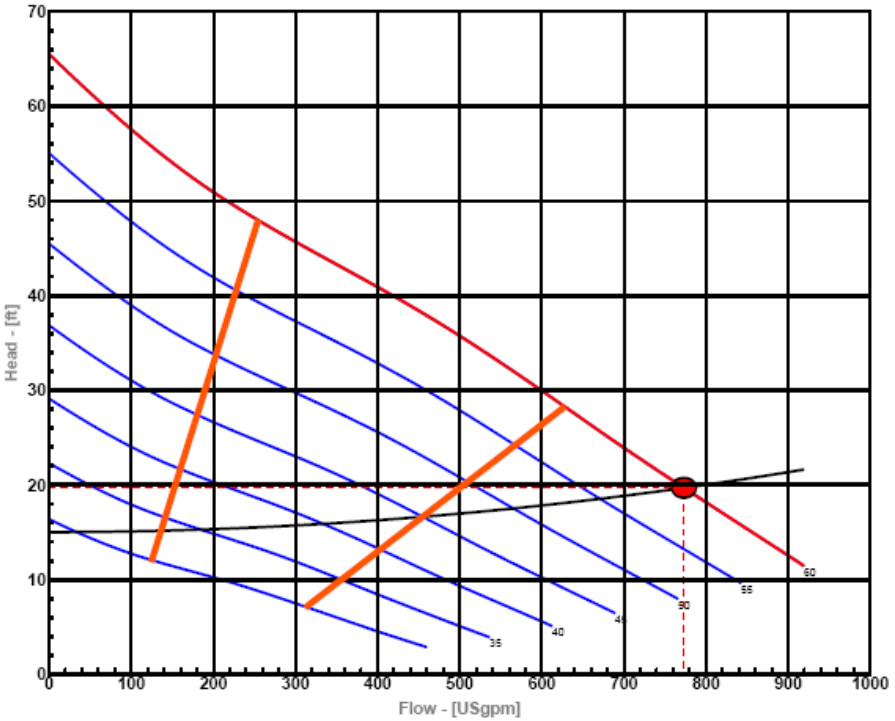
Allowable Operating Range (AOR)

- Continuously right of AOR can cause:
  - Increased power demand
  - Cavitation
  - Higher bending forces



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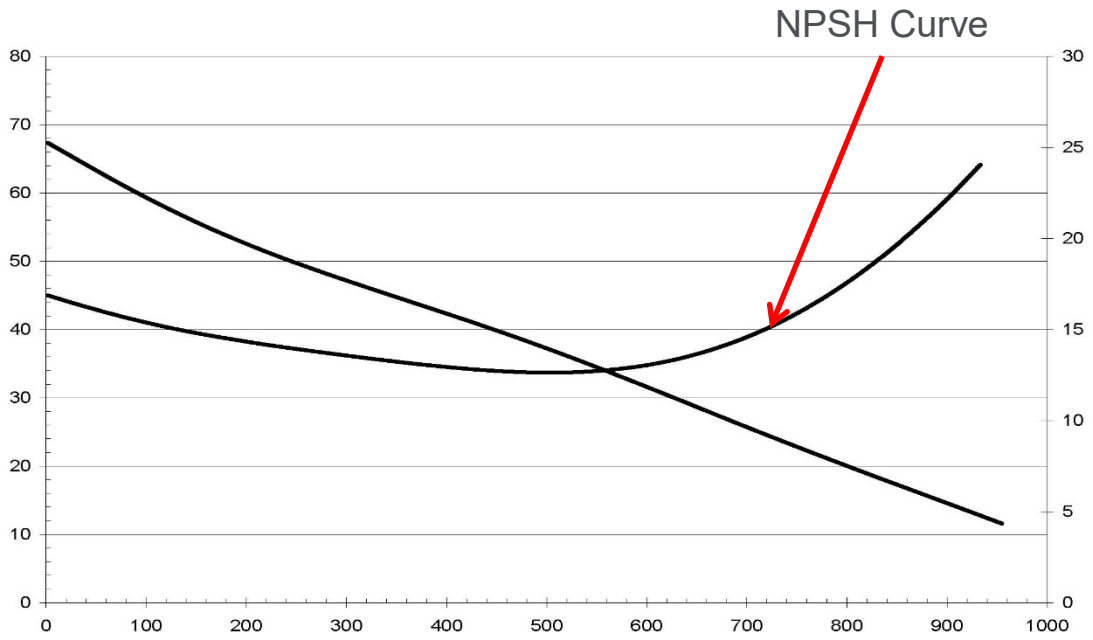
Net Positive Suction Head (NPSH) Curve

- NPSHA (Available) is the absolute pressure at the suction port of the pump
- NPSHR (Required) is the minimum pressure required at the suction port of the pump to keep the pump from cavitating



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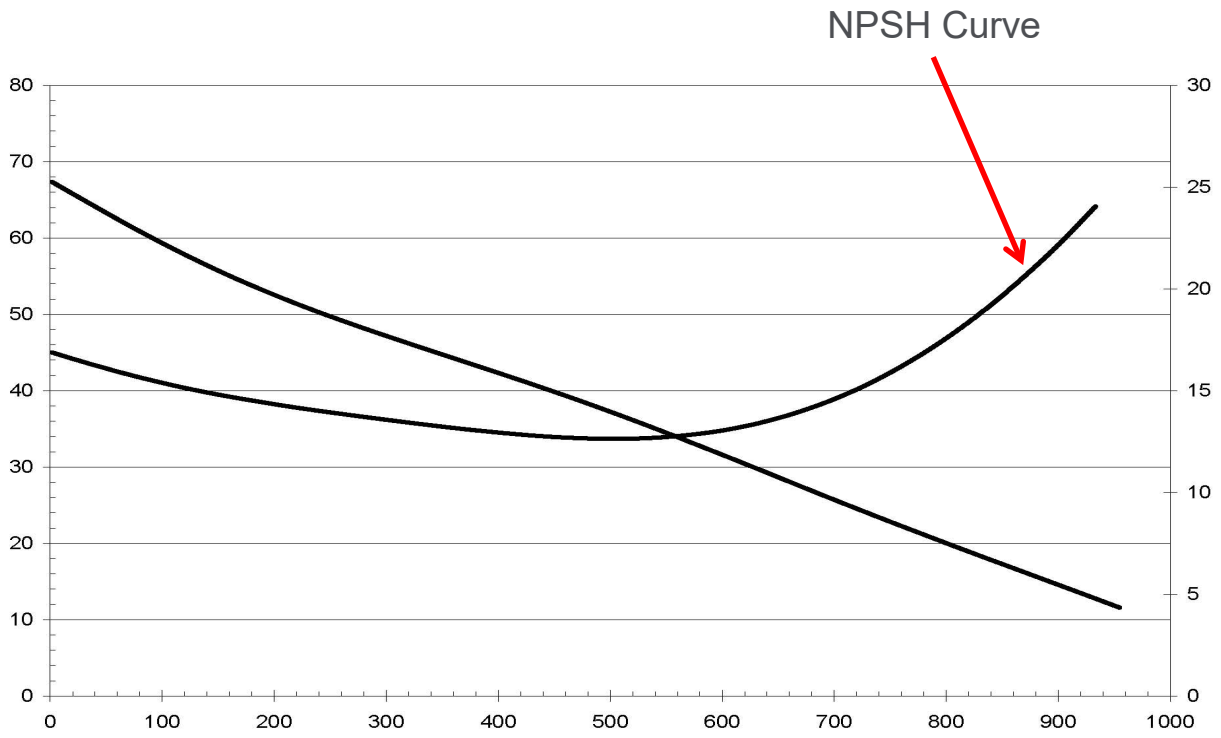
Net Positive Suction Head (NPSH) Curve

- What helps the NPSH Curve?
- Atmospheric pressure 14.7 psia (at sea level)
- Suction head



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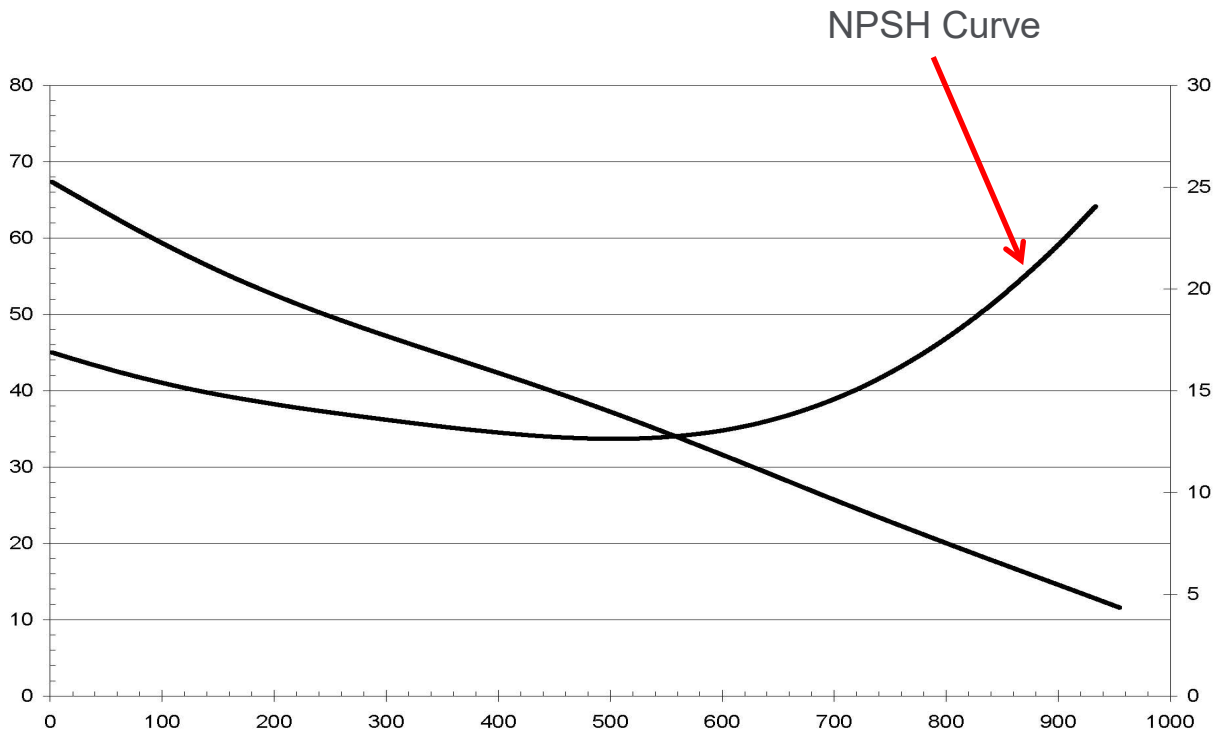
Net Positive Suction Head (NPSH) Curve

- What hurts the **NPSH Curve?**
- Low suction head
- Hot liquids



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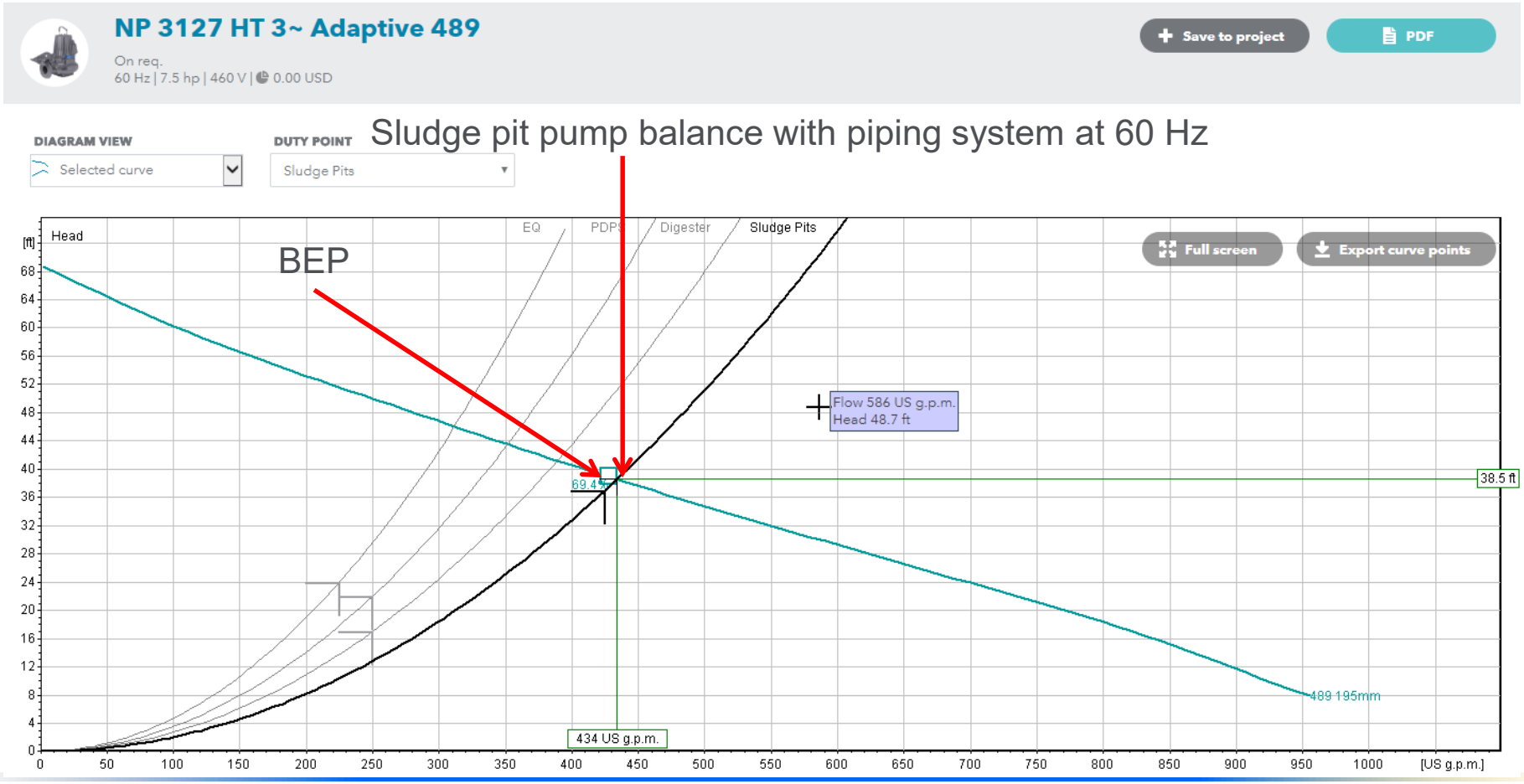
Let's Look at Some Real Pump Selections

- Sometimes the application flow and head results in a great or at least good fit
- Other times, not so much

A Good Example Including VFDs

This application uses the exact same pump, impeller, and motor for (4) different applications inside the same plant.



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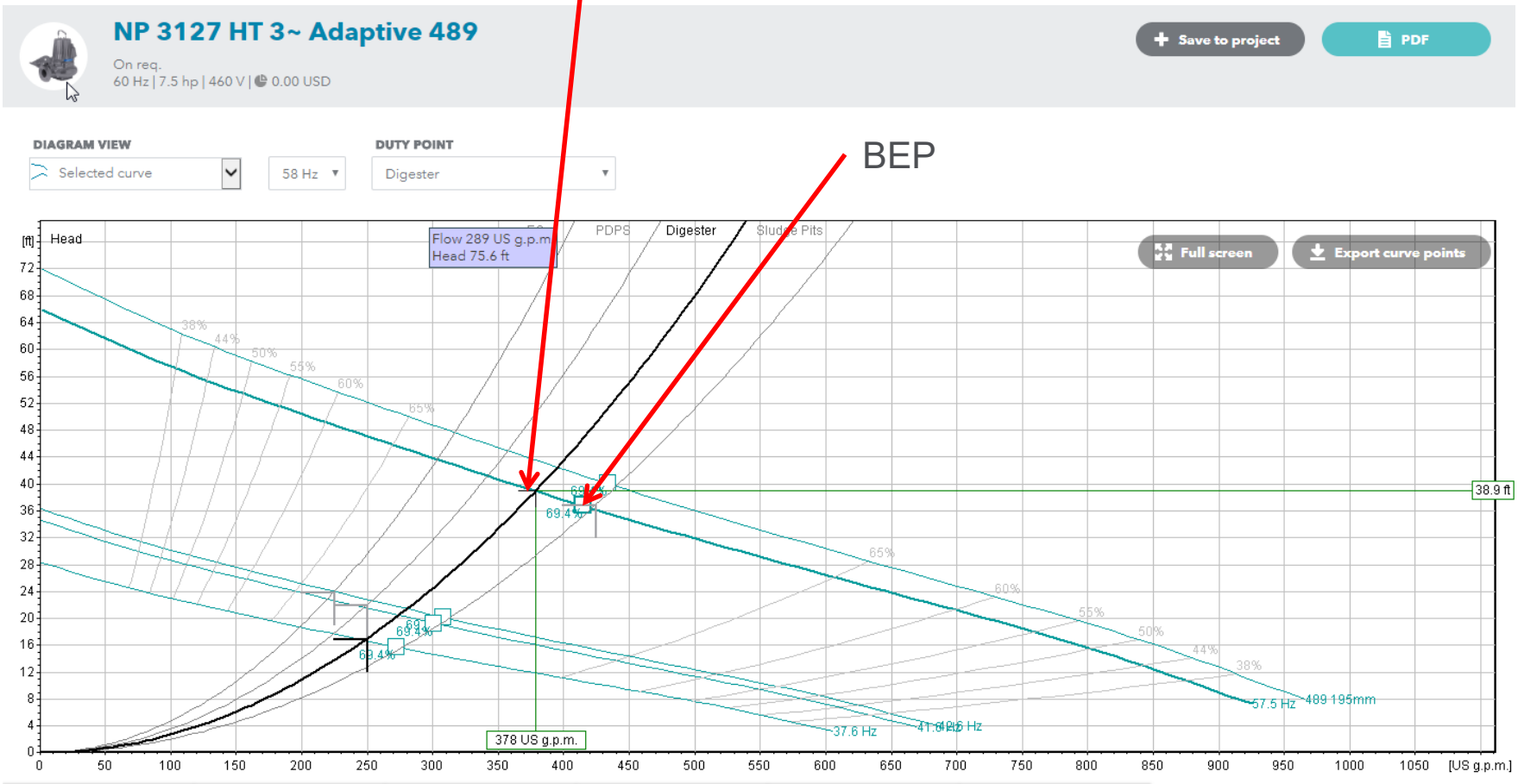
A Good Example Including VFDs

Digester pump balance with piping system at 58 Hz



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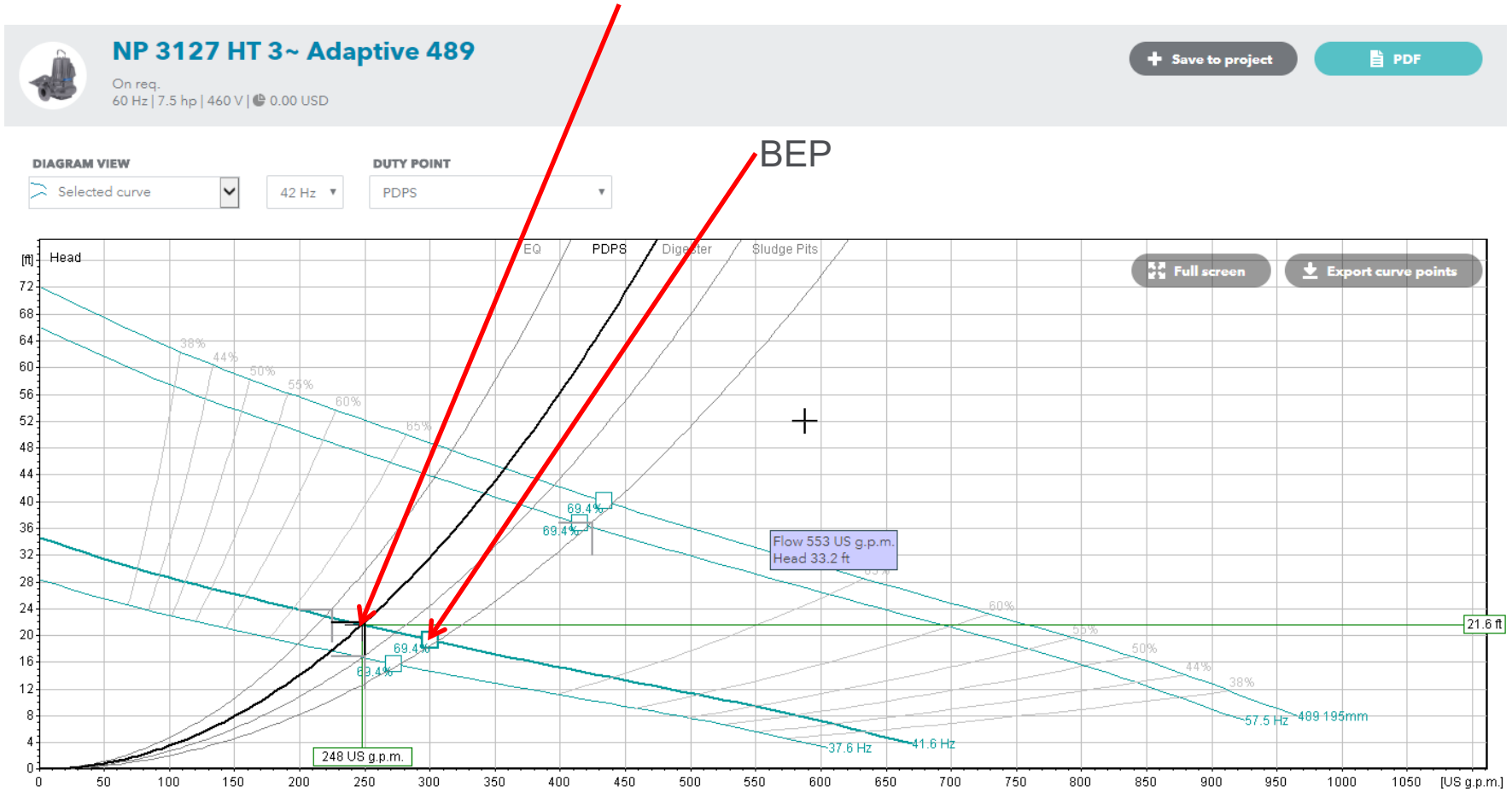
A Good Example Including VFDs

Plant drain pump station balance with piping system at 42 Hz



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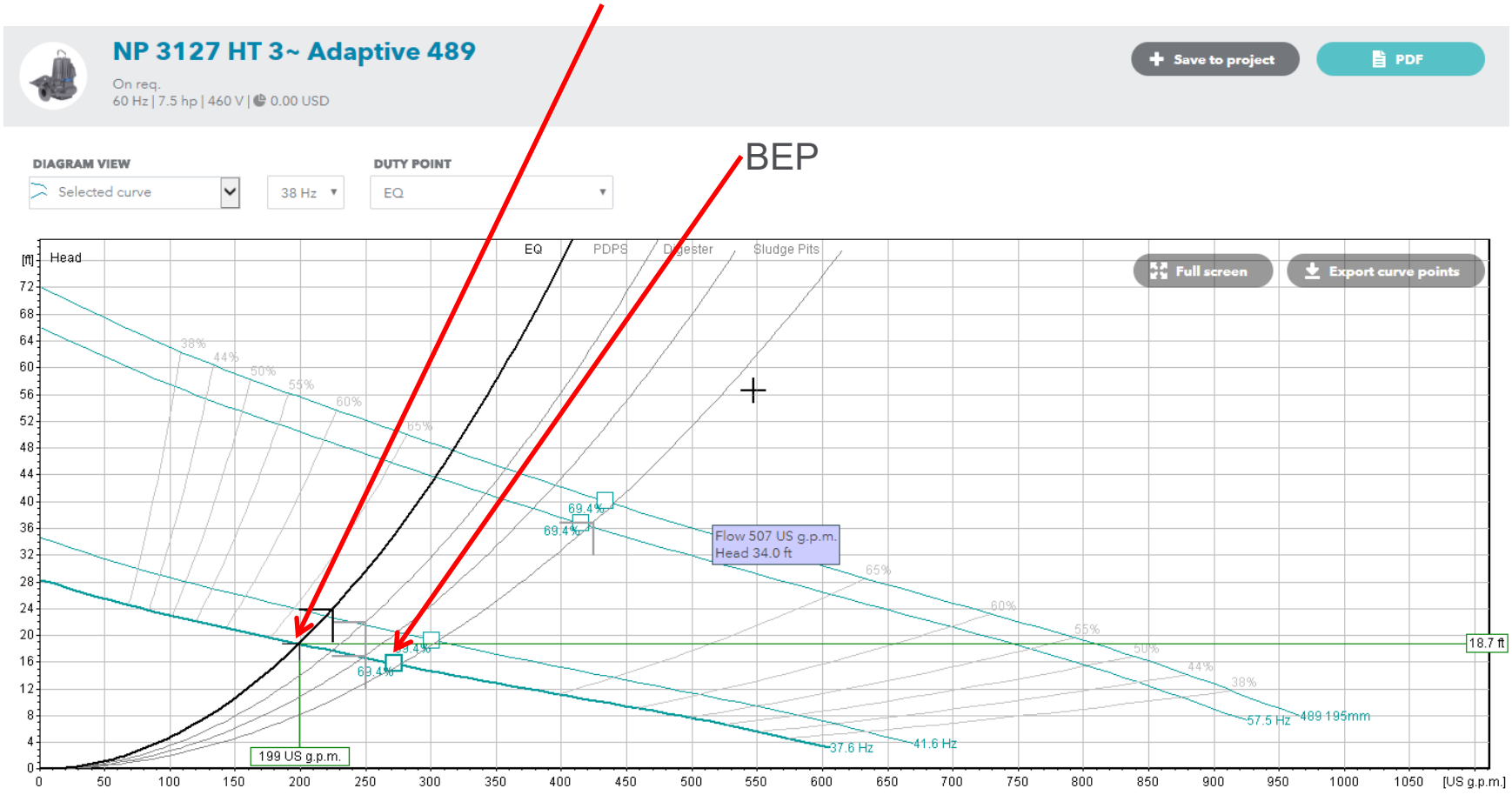
A Good Example Including VFDs

EQ pump balance with piping system at 42 Hz



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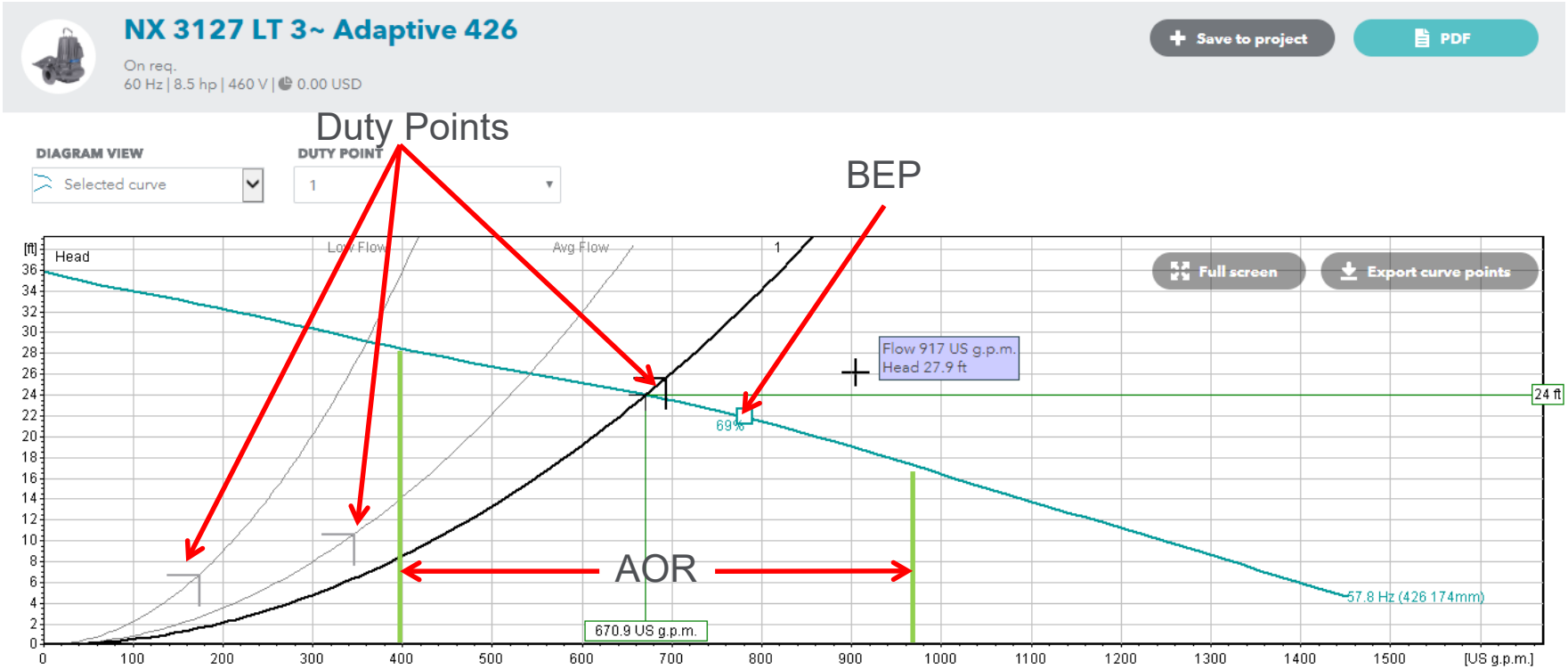
A Challenging Example; Requested Flow Range Too Great

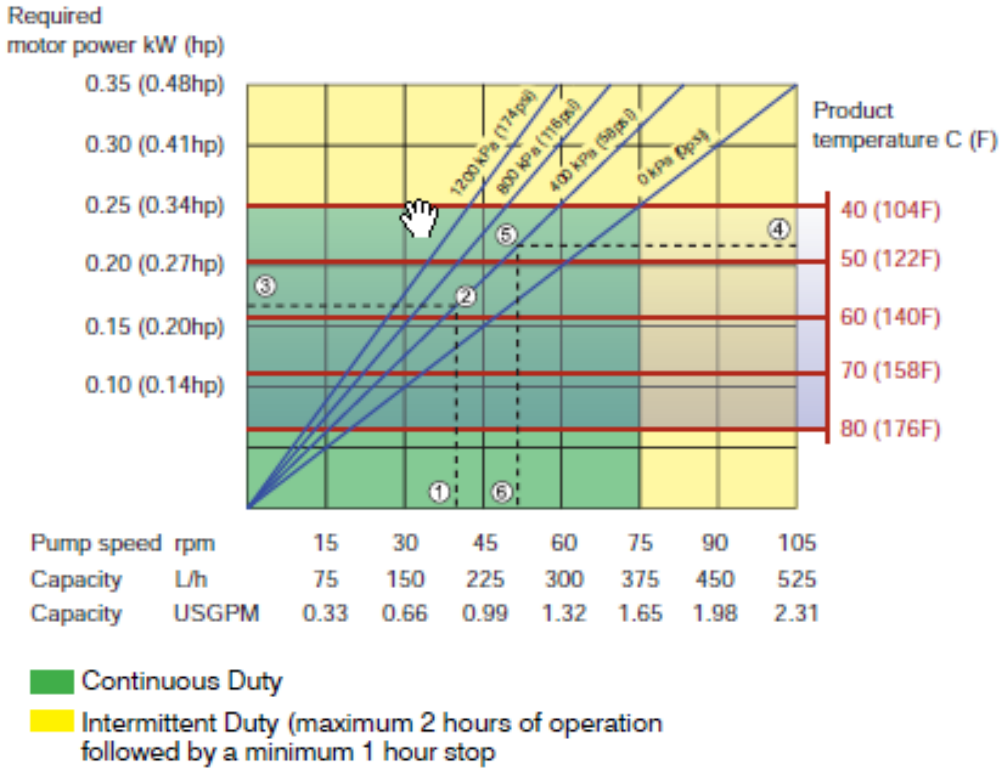
- BEP is 780 gpm
- AOR is therefore 390 – 975 gpm
- Duty points; 175 gpm/6.8 TDH, 347 gpm/10.7 TDH, 694 gpm/25.7 TDH



Positive Displacement Pump Curves

- A **positive displacement pump** makes a fluid move by trapping a fixed amount and forcing (displacing) that trapped volume into the discharge pipe.
- The curve shown here is a peristaltic hose pump curve

How to use the curves
1. Flow required indicates pump speed
2. Calculated discharge pressure
3. Net motor power required
4. Product temperature
5. Calculated discharge pressure
6. Maximum recommended pump speed



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Had Enough Theory and Curves?

ME TOO!

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Centrifugal Pumps

- Submersible Pumps

- Submersible Dry Pit Submersible Pumps

- Centrifugal Screw Pumps

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Centrifugal Pumps

- Split Case Pumps

- Turbine and Propeller Pumps

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Centrifugal Pumps

- Solids Handling Pumps

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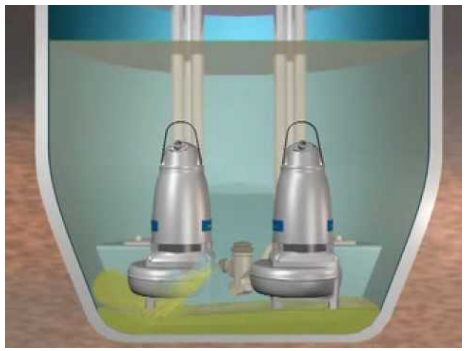
Centrifugal Submersible Pump Common Applications

- Submersible Pump Stations



- Dry-Pit Pump Stations

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Turbine & Prop Pump – Common Applications

- WTP Filter Backwash
- High/Low Service Pumps, Water Distribution

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Solids Handling Pump – Common Applications

RAS/WAS Pumping

Sludge Transfer

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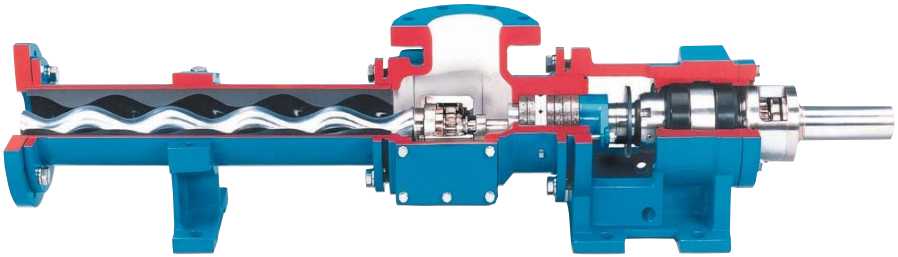
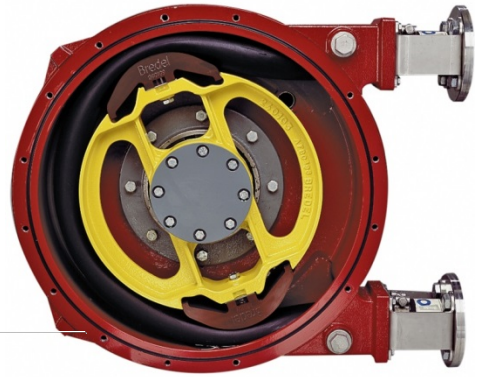
Positive Displacement Pumps

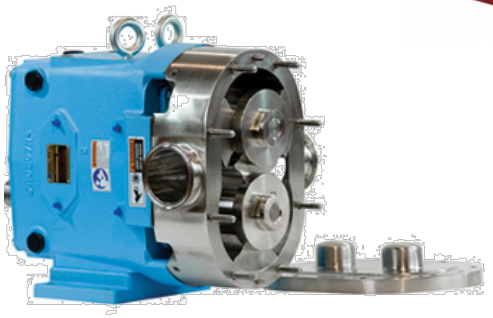
- Positive displacement pumps are those in which energy is imparted to the liquid in a fixed displacement volume.
- Such as a casing or a cylinder, by the rotary motion of gears, screws lobes, reciprocating pistons or plungers, or by repeated occlusion (pinching closed) and restitution (relaxing open) of a hose or tube



Progressive Cavity Pump



Hose Pump



Rotary Lobe Pump

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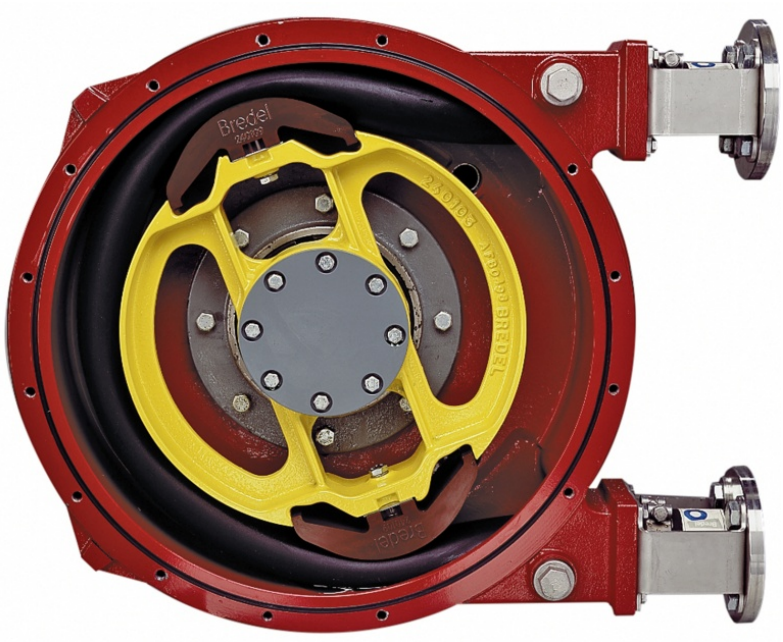
Hose Pumps

- Shoe (Hose Pumps)
- Slides Over Hose
- Shallow Angle Of Occlusion Allows For Higher Pressure Capability
- Lubricant Bath Eliminates Friction & Wear on Hose O.D.



Click Pump for Video

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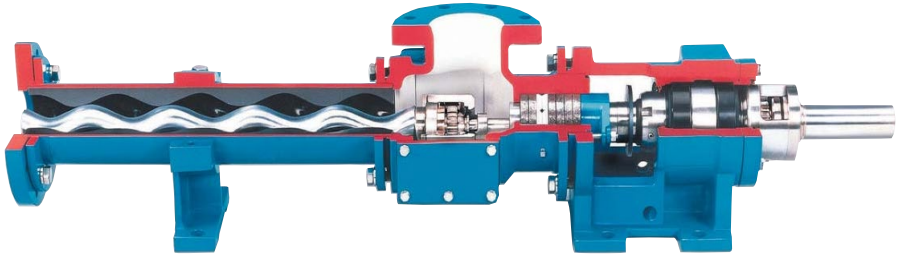
Progressive Cavity Pumps

- Typical Components



Click Pump for Video

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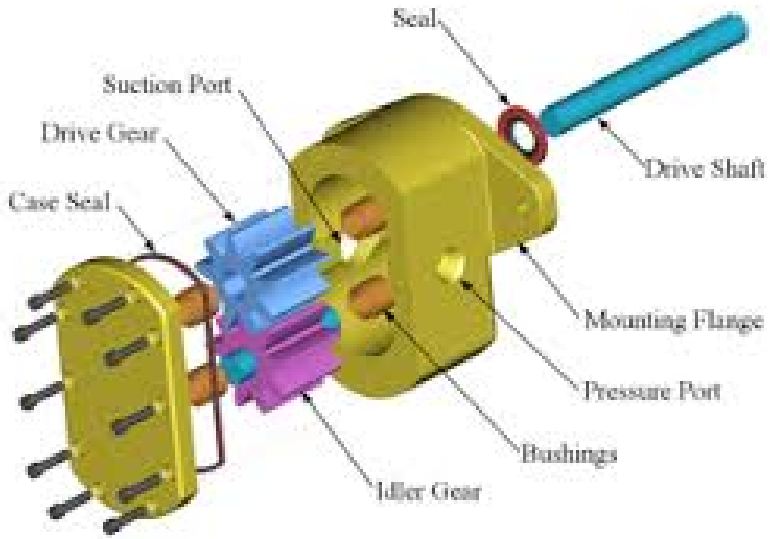
Rotary Lobe Pumps

- Typical Components



Click Pump for Video

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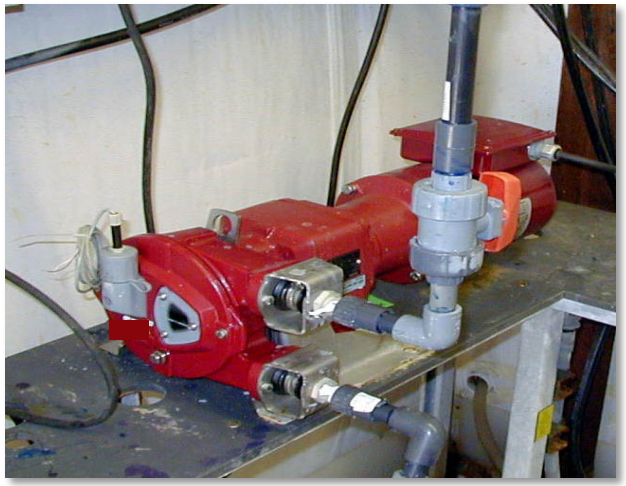
Positive Displacement Pump – Common Applications

- Water/Wastewater Sludge Transfer
- RAS/WAS Pumping
- Chemical Feed
- Mechanical Dewatering Equipment Feed
- And more …..

Sludge Transfer



Sodium Hypo Feed

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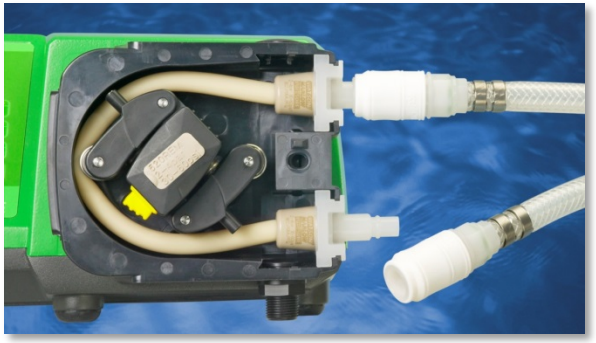
Peristaltic Tube Pumps

- Used for Chemical Feed



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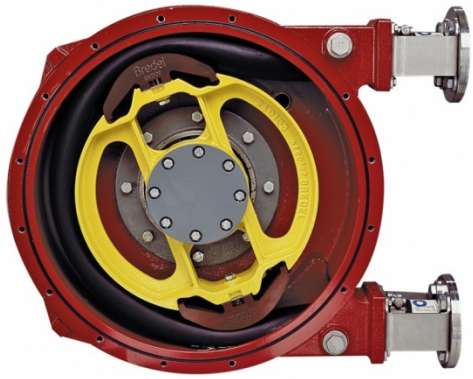
Peristaltic Pump Benefits

- Only one wearing part, the tube or hose
- Very Inexpensive Compared to Other PD Pumps
- No Rotors, stators, universal joints, lobes, gears, seals, etc. to replace
- Accuracy to +/- 0.1%
- Can Run Dry Indefinitely
- True “Dry” Self Priming to 30 Feet
- Reversible
- 100% Volumetric Efficiency



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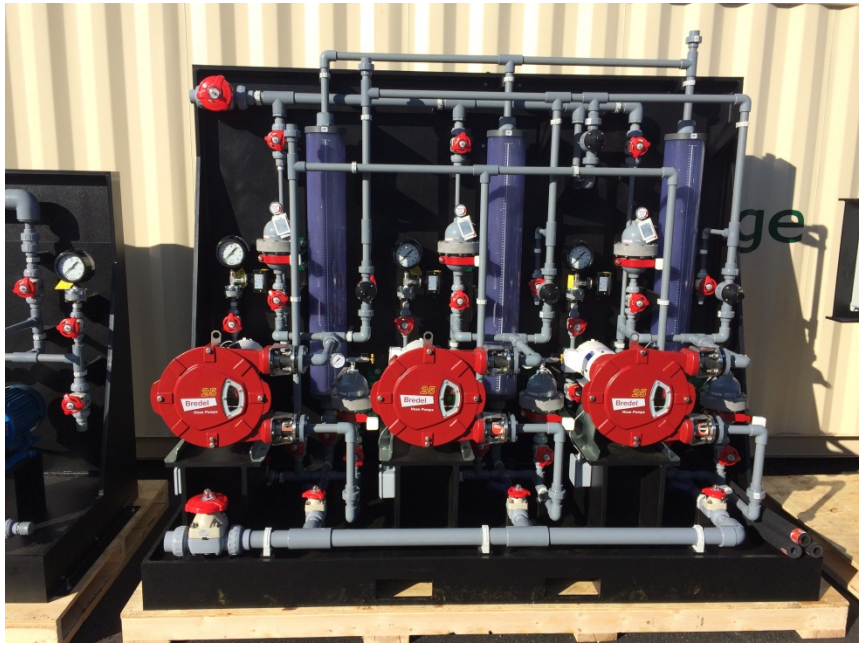
Chemical Feed Skid Systems



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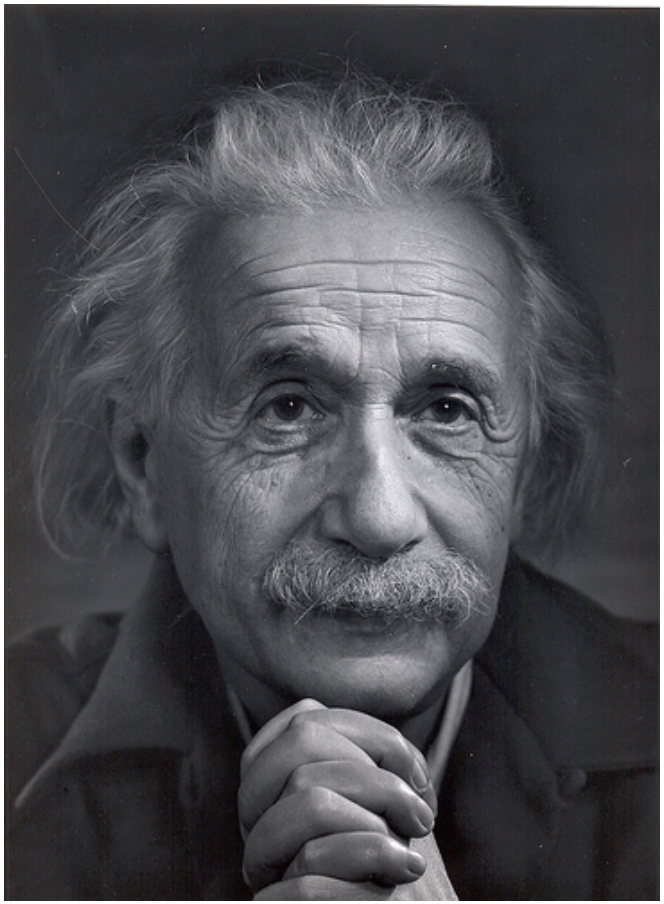
Any Questions?



Thank You!