Pump Sizing and Selection

• First Steps Are to Analyze the System
• Pumps Must Always Be Matched to the System
• Pumps Are Not “Do All” Devices
• A Significant Percentage of Pump Problems Are Due to a Mismatch of the Pump to the System
Pump Systems

There must be enough pressure on the fluid on the suction side of the pump to get the fluid into the pump without cavitating.

Net Positive Suction Head (NPSH)
Pump Systems

Pump must produce sufficient pressure to overcome forces of gravity in lifting fluid, frictional forces associated with moving the fluid through the pipe, and any system back pressure forces that may exist.

Differential Pressure
Pump Systems

• Customers May Not Know Net Positive Suction Head Available & Differential Pressure Required

• Everyone Involved In Applying Pumps Needs to Know How These Numbers Are Calculated
Sample Problem
Storage Tank to a Process Tank
(40 ft. = 12.192 Meters / 20 ft. = 6.096 Meters / 100 ft. = 30.48 Meters)
Sample Problem

Flow Rate: 40 GPM (9 m³/hr.)
Product: Coal Tar
Temperature: 350°F (176 °C)
Specific Gravity: 1.2
Pipe Size: 2” (50 mm)
Viscosity: 1000 SSU

Both tanks open to atmosphere
Sample Problem
Calculating Suction Pressure

Barometric Pressure (PB) 
+ Static Suction Pressure (LH) 
- Friction Loss 

Suction Pressure

Barometric Pressure = 14.7 PSIA (1 bar)
Sample Problem

Static Suction Pressure: Convert 20 Feet of Head to PSI

Head in PSI = \frac{\text{Head in Feet} \times \text{Specific Gravity}}{2.31}

= \frac{20 \text{ Ft. Head} \times 1.2 \text{ S. G.}}{2.31}

= 10.4 \text{ PSI (0.7 bar)}
Sample Problem

Calculate Friction Loss

1. Add Up Length of Pipe
   Pipe length on suction = 20 feet (6 Meters)

2. Count Fittings
   Four long radius elbows and three gate valves
Calculate Friction Loss

\[ CPS = \frac{SSU \times \text{Specific Gravity}}{4.55} \]

Result = 3.64 PSI (0.25 bar)

Enter Data On: www.freecalc.com/fricfram.htm
Sample Problem
Calculating Suction Pressure

14.7 Barometric Pressure (PB) + 10.4 Static Suction Pressure (LH) - 3.51 Friction Loss

\[
\begin{align*}
\text{21.5 PSIA (1.48 bar) = } & \text{21.5 PSIA } \\
\end{align*}
\]

Note: 21.5 PSIA = 6.8 PSIGS (PSIA = PSIG + 14.6959)
Sample Problem

Now Calculate Discharge Pressure
Calculate Discharge Pressure

Storage Tank to a Process Tank
(40 ft. = 12.192 Meters / 20 ft. = 6.096 Meters / 100 ft. = 30.48 Meters)
Calculate Discharge Pressure

**Discharge Pressure** = Static Discharge Pressure + Friction Losses

**Discharge Static Pressure**

\[ 60 \text{ Feet of Head} \times 1.2 \text{ Specific Gravity} = \frac{2.31}{2.31} \]

\[ = 31.17 \text{ PSI (2.14 bar)} \]

**Discharge Friction Loss**

- 160 Feet Actual Pipe Length
- + Loss for 3 Elbows
- + Loss for 1 Gate Valve
- \[ 25.52 \text{ PSI (1.75 bar)} \]

**Discharge Pressure** = \[31.17 \text{ PSI} + 25.52 \text{ PSI} = 56.7 \text{ PSI (3.9 bar)}\]
Sample Problem

Calculate Differential Pressure

\[ \Delta P = P_{\text{discharge}} - P_{\text{suction}} \]

56.7 psig – 21.5 psig = 35.2 psig
3.9 bar – 1.48 bar = 2.42 bar
Sample Problem

Note on Differential Pressure

• You can use either absolute or gauge units
  • As long as they are the same units
  • Doing a subtraction
• Now Select Pump
  • 40 GPM (9.08 m³/hr.)
  • 35.3 psi (2.43 bar) differential pressure
  • 1000 SSU Viscosity
GlobalGear® 090 Curve

Viscosity: 2,500 SSU

Viscosity: 500 cst
Pump Selection

- GlobalGear® Model 090
- Reducer Selection for 640 RPM
- Use 3 HP Motor
# Check for NPSHA vs. NPSHR

## GlobalGear® NPSH Data

### NPSHr for up to 750 ssu (feet of water)

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### NPSHr for up to 165 cst. (meters of water)

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Check for NPSHA vs. NPSHR

- $NPSH_R = 5.2 \text{ psia (0.35 bar)}$
- $NPSH_A = \text{Suction Pressure} - \text{Vapor Pressure}$

\[
\begin{align*}
\text{Suction Pressure} &= 21.5 \text{ psia (1.48 bar)} \\
\text{Vapor Pressure} &= 0.3 \text{ psia (0.02 bar)} \\
NPSH_A &= 21.5 \text{ psia} - 0.3 \text{ psia} \\
&= 21.2 \text{ psia (1.46 bar)}
\end{align*}
\]
Check for NPSHA vs. NPSHR

Compare NPSHA with NPSHR

21.2 psia (1.46 bar) $NPSH_A$ available vs.

5.2 psia (0.35 bar) $NPSH_R$

Tuthill Pump Selection Software
Notes on NPSH #1

• Adequate NPSH is what keeps the liquid from cavitations or boiling on the suction side of the pump

• $\text{NPSH}_A$ is a Function of the system

• $\text{NPSH}_R$ is a function of the pump and pump speed
Notes on NPSH #2

• Take into account the lowest operating liquid level in the supply tank when calculating static head

• Take into account the highest viscosity the system will see when calculating friction losses
Notes on NPSH #3

• Tuthill publishes NPSHR in the engineering data packs

• Slower selected speeds generally mean less than maximum NPSHR
Notes on NPSH #4

• NPSHR for Tuthill gear pumps is among the lowest available for any pump type

• Bigger pumps turning slower is the only practical way to reduce NPSHR
Notes on NPSH #5

• A high percentage of pump problems are on the suction side

• With viscous liquids, pressure drop due to friction losses adds up quickly

• Long suction lines and narrow piping diameters on the pump suction often lead to problems with insufficient NPSH
Notes on NPSH #6

• Be especially careful to account for vapor pressure with solvents or heated liquids

• Viscous liquids at ambient temperatures tend not to have high vapor pressures
Pump Systems: Cavitation?

cavitation (kăvĭ-tă’-shən)— Forming cavities or bubbles

Damage Caused by Cavitation: Pitting and wearing away of solid surfaces as a result of the collapse of these bubbles in surrounding liquid
How Does Cavitation Occur?

• Cavitation occurs when the pressure at the pump inlet drops below the fluid vapor pressure

• The fluid then “boils”
Cavitation

• As the fluid moves toward the discharge, pressure increases and the vapor bubbles are returned to the liquid state
• The vapor bubbles collapse violently, or implode
• Implosions cause erosion and pitting of pumping components in the immediate vicinity
Positive Displacement Pumps

Relationships for PD Pumps

For the same pump in a system:

- Horsepower is proportional to pump RPM at constant differential pressure
- Friction losses a function of flow squared
- Volume displacement is directly proportional to pump RPM
Learn More About Tuthill

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