BBIFMAC EEIG
Matching a pump to a pipeline system – Mackay Dec. 2014

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Introducing Pump Curve

- Describes the relationship between the head and discharged produced for a specific pump configuration

- For a given pump make & model
- For a given speed
- For a given impeller trim
Pump Curve

TDH, Total Dynamic Head (m)

Q, Flowrate (m³/s)
Pump performance Curve – Electric Motor

Suction lift shown is based on clear water at not over 85°F, at sea level and is static lift plus friction losses.

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Reducing & Increasing Speed

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Reducing (trimming) your Impeller or replacing with new Larger Impeller

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Pump Duty point – operating point of pump

- The single discharge (flowrate) and Total Dynamic Head (TDH) at which a pump operates.
- Called “Duty Point” or “Operating point”.
- The one point on the pump curve where the pump operates, giving single flowrate and total dynamic head, at any one time.
- Pump can only operate at one point at a time.
Pump discharge or flowrate

- Discharge or flowrate measured with any variety of flowmeter types
- Discharge or flowrate is the most important information you can obtain about pumped systems
- Flowrate can be determined for big guns from pressure, nozzle type and nozzle size – from manufacturer’s chart
Total Dynamic Head

- Total Dynamic Head
  - Is a measure of the energy per unit weight imparted to the water by the pump

- Calculate from:
  - the discharge dynamic head minus the suction dynamic head
  - suction dynamic head – measured relative to the pump centreline
Five key parts involved in pump Total Dynamic Head

- Pressure Head
- Elevation Head
- Velocity Head
- Friction Headloss
- Minor Headloss
Pressure Head

- Pressure Head – strictly is energy per unit weight held in water when under pressure
- Units of metres head of water
- Measure pressure with a gauge
- Pressure Head (m)
  \[ \text{Pressure Head (m)} = 0.102 \times \text{pressure (kPa)} \]
  \[ = \text{pressure (kPa)} \div 9.81 \]
Elevation Head

- Elevation Head – strictly is energy per unit weight held in water when at height – potential energy
- Units of metres head of water
- Measured as elevation above datum
- Elevation Head (m) = simply measure elevation above some R.L., datum, or benchmark
Velocity Head

- Velocity Head – strictly is energy per unit weight held in water when moving with velocity – kinetic energy
- Units of metres head of water
- Measured from discharge (flowrate) and cross-sectional area of flow

Velocity Head (m) = 0.051 \times \text{velocity}^2
= 0.0826 \times \text{discharge}^2 \div (\text{int. diam.})^4

Discharge m^3/s and diameter in m
Friction Headloss

- Friction Headloss – distributed energy loss in pipes from roughness of pipe
- Units of metres head of water
- Calculated from formulae, off tables, from graphs etc
- Occurs all the way along pipe
- Example: 26.5 L/s in 201.2 m of 4” n.b. soft hose is 9.98 m (14.2 psi) headloss
Minor Headloss

- Minor Headloss – energy loss due to bends, valves, changes in diameter
- Units of metres head of water
- Not always “minor” (small)
- Calculated from velocity head × “K” factor from tables
- Occurs at bend, valve, reduction
- Example: 26.5 L/s in 90° elbow 4” n.b. = 0.243 m headloss (0.345 psi)
Energy or TDH Line

- Energy line is made up of the five components of Head and Headloss just discussed above
- Shows all parts of Total Dynamic Head
- Units of metres head of water
- Graphical way of “seeing” the energy line and change through a pumped system
Pump Total Dynamic Head & Energy Line
System Resistance Curve = Pipeline Resistance Curve

- Describes the relationship between the head and discharge for a specific pipeline configuration
- Accounts for the static, friction & minor head loss over a wide range of discharge
- Developed for increments of flowrate, calculating headlosses for each
System Resistance and Pump Curve

- **Pump Curve**
- **Duty Point**
- **System Resistance Curve**

**TDH, Total Dynamic Head (m)**

**Static Head**

**Q, Flowrate (m^3/s)**
Altering System Curve

- Pump Curve
- Duty Point
- More System Resistance
  - Valve Shut or Smaller Pipe

Graph showing:
- TDH (Total Dynamic Head) vs Q (Flowrate)
- Static Head

Q, Flowrate (m³/s)
Altering System Curve

- Pump Curve
- TDH, Total Dynamic Head (m)
- Static Head
- Q, Flowrate (m³/s)

Duty Point

Less System Resistance
- Valve Open or Larger pipe
System Curve

TDH, Total Dynamic Head (m)

High Static Head

Duty Point

Q, Flowrate (m³/s)

Q
System Curve

TDH, Total Dynamic Head (m)

Q, Flowrate (m³/s)

Duty Point

Low Static Head

Q
Pump Efficiency Curves

Lines of equal pump efficiency

TDH, Total Dynamic Head (m)

Q, Flowrate (m³/s)
Pump Curve + Efficiency

Highest pump efficiency

Lower pump efficiency
Pump performance Curve – Electric Motor

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Pump Curve + Efficiency

Highest pump efficiency

Lower pump efficiency
Altering Duty Point

- TDH: Total Dynamic Head
- Q: Discharge (m³/s)
- Pump Curve
- Duty Point
- Static Head
- System Resistance Curve
Altering Duty Point

Pump Curve

Less System Resistance - Larger Pipe

TDH, Total Dynamic Head (m)

Static Head

Q, Discharge (m³/s)

Q