NPSHA: How Much is Enough

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Familiar Situation in Pump Hydraulics

Naphtha Splitter Product Pump	
Pump Flowrate, m3/hr	50
Pump differential head, m	270
NPSHA, m	2.5
Assumed Pump C/L elevation, m	1
Assumed Column elevation, m	4.8
Required Pump NPSHR, m	1.5
Pump suction line velocity, m/s	0.8
Pump Offers - NPSHR, m	
Vendor A	2.1
Vendor B	2.3
Vendor C	2.9

Next few slides on making best guess to avoid rework when vendor data is received

NPSHA - NPSHR < 1 m
None of the Pumps suitable

Rework → Increase column elevation

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Consequences of Incorrect First Guess

Skid/Module dimensions are going to change with lot of rework to Piping / Civil / Static teams

Possible impact on tech structures, pipe rack, platforms may need to be rearranged, nozzle orientations may change

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Pump Center Line

- Pump NPSHR is specified at pump center line
- Pump C/L is not known at first hydraulic estimation
- Typical guidelines for pump C/L assumption

Criteria 1

Flow, m3/hr	C/L, mm
0 - 50	700
50-200	1000
> 200	1500

Criteria 2

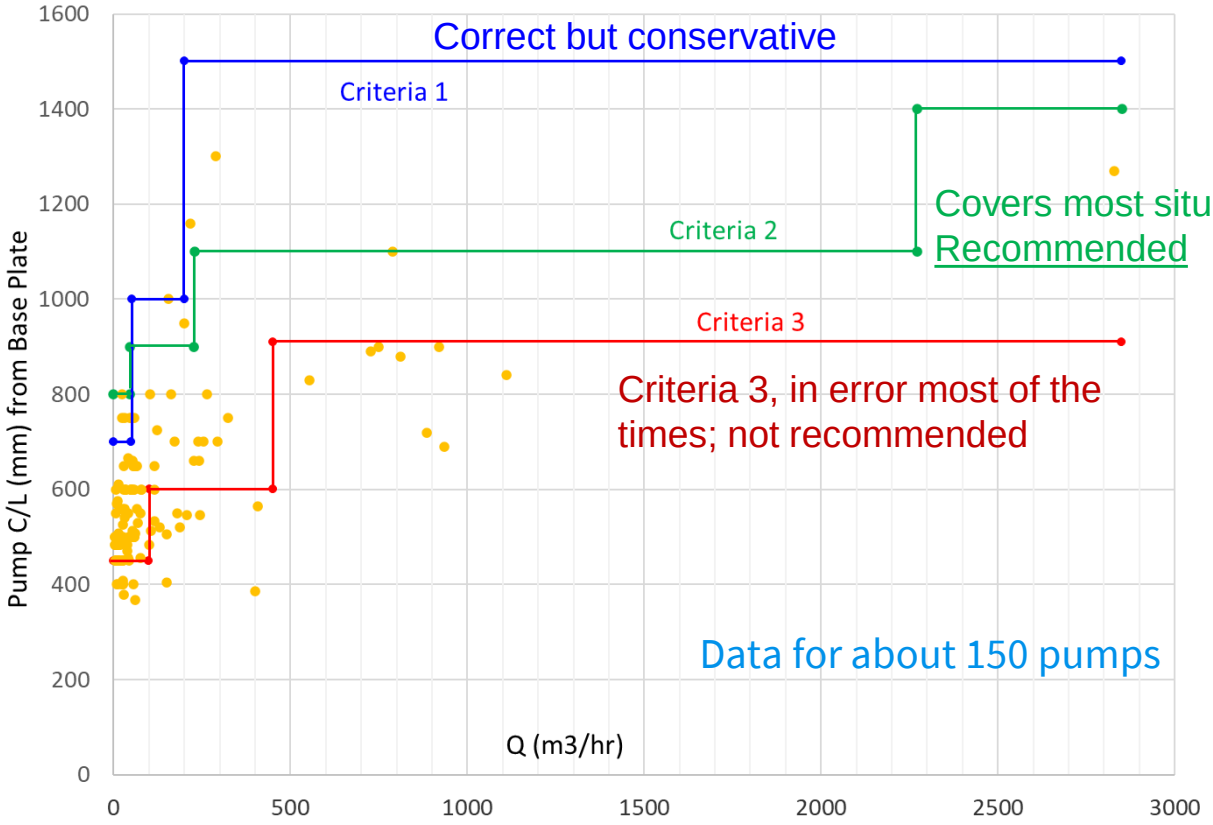
Flow, m3/hr	C/L, mm
0-45	800
45-230	900
230-2300	1100
>2300	1400

Criteria 3

Flow, m3/hr	C/L, mm
0-100	450
100-450	600
>450	900

Do not forget to mention considered C/L in pump datasheet so that vendor can correct if different

Pump C/L: What Story Does Data Tell?



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Can Process Engineer Determine Pump NPSHR?

- Answer is NO
  - Only pump vendor has dimensional details for definitive NPSHR determination
  - It can only be determined by Test and to some extent by CFD
- How is it done by design companies?
  - Mechanical disciplines may have past data; NPSHR of pump similar in condition
  - Pump vendor catalogues e.g. KSB EasySelect, Flowserve Affinity, Sulzer select etc

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Can We Make Educated Guess?

- What data does Process Engineer have?
  - Fluid properties
  - Rated flowrate
  - Rated differential head
  - Pump speed (2 pole or 4 pole motor)
- Methods to make educated guess?
  - Suction specific speed
    - Green's Method (NSS-9000)
  - Yedidiah method
  - Henshaw method

If out of 50 pumps in a typical unit, Method can work for say 40 pumps, that would be significant help

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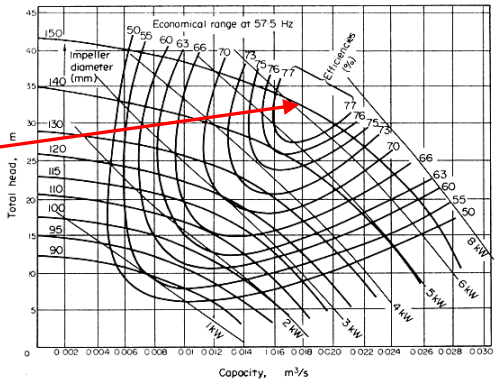
Suction Specific Speed

- NPSHR is related to Suction Specific Speed (Nss) by

$$NPSHR = \left(\frac{rpm \cdot \sqrt{Q}}{Nss}\right)^{\frac{4}{3}}$$



- Typical Nss of pumps in US units (Q in gpm, NPSHR in ft) is 8000 to 12000

Green, Patrick ([201). PT05 - Predicting Centrifugal Pump Type and NPSH in Early Facility Design; Proceedings of the 35th International Pump Users Symposium
https://hdl.handle.net/1969.1/188553

- Green makes two major assumptions
  - Suction specific speed (Nss) of 9000 in US units
  - Rated point is considered for Nss value

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Yedidiah Method

- Yedidiah analyzed NPSHR data of 600 pumps of 12 manufacturers and tried to fit trend
- Exact correlation could not be obtained as pump design is an interplay of many variables
- Correlation for NPSHR
  - Where Q is flowrate in m3/hr, NPSHR is in m and N is pump speed in rpm

For Pump speed less than 1760 rpm

$$NPSHR = 0.340 \cdot Q^{0.382} \cdot \left(\frac{N}{1760}\right)^{1.424}$$

For Pump speed less than 3500 rpm

$$NPSHR = 0.67 \cdot Q^{0.382} \cdot \left(\frac{N}{3500}\right)^{1.424}$$

Henshaw Method

- Henshaw modified Lobanoff / Vlaming formula
  - Where U_1 is inlet peripheral velocity in ft/s
- Inlet peripheral velocity can be estimated from approximations (De formula not from Henshaw article)
- D_e is impeller eye diameter in inch, Q is flowrate in m3/s and N is impeller rpm
- NPSHR estimated from Suction specific speed calculated above

Henshaw article "NPSHA – how much is enough", Hydrocarbon Processing, October 2004, 75-76

$$Nss = 2520 \times U_1^{0.375}$$

$$U_1 = \frac{D_e \cdot N}{229}$$

$$De = 183.46 \times \left(\frac{Q}{N}\right)^{\frac{1}{3}}$$

$$NPSHR = \left(\frac{rpm \cdot \sqrt{Q}}{Nss}\right)^{\frac{4}{3}}$$

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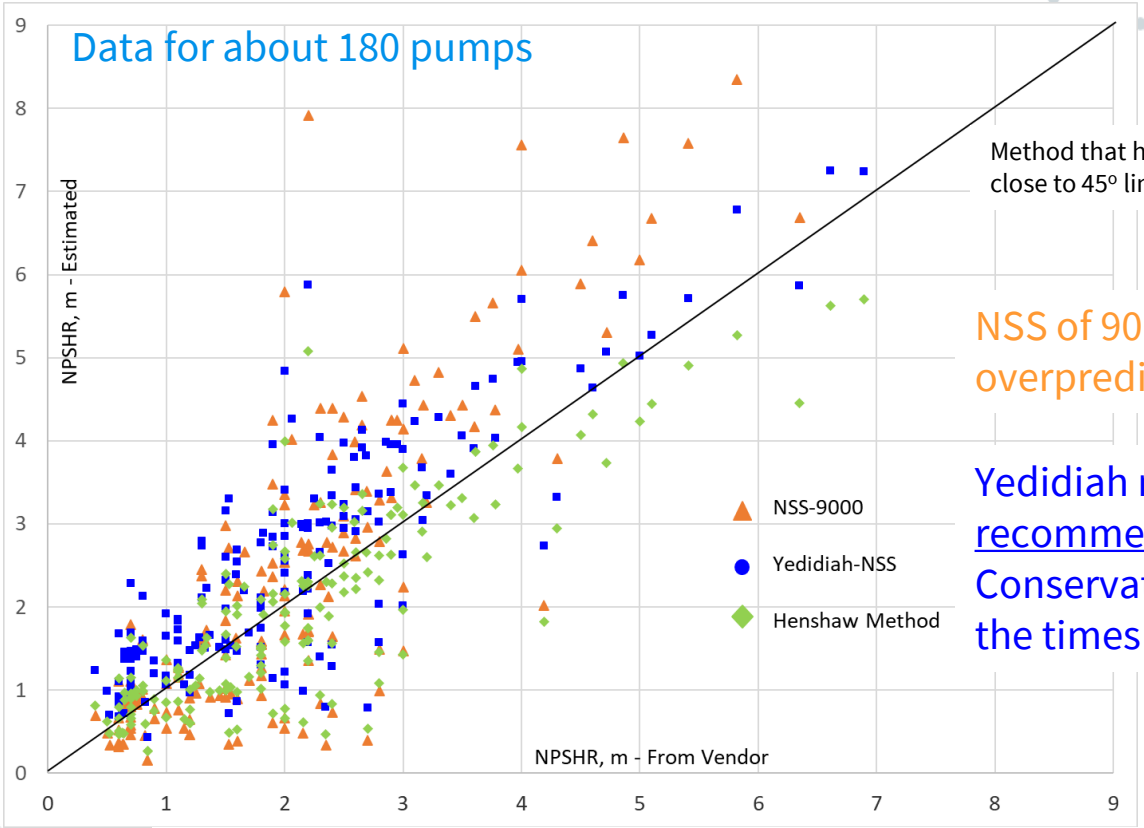
Performance of Methods for OH2 Pumps



Method that has points above and close to 45° line is the best

NSS of 9000 under or overpredicts

Yedidiah method recommended; Conservative most of the times

Henshaw method gives close predictions but in error at low NPSHR (would improve with correct De estimate)

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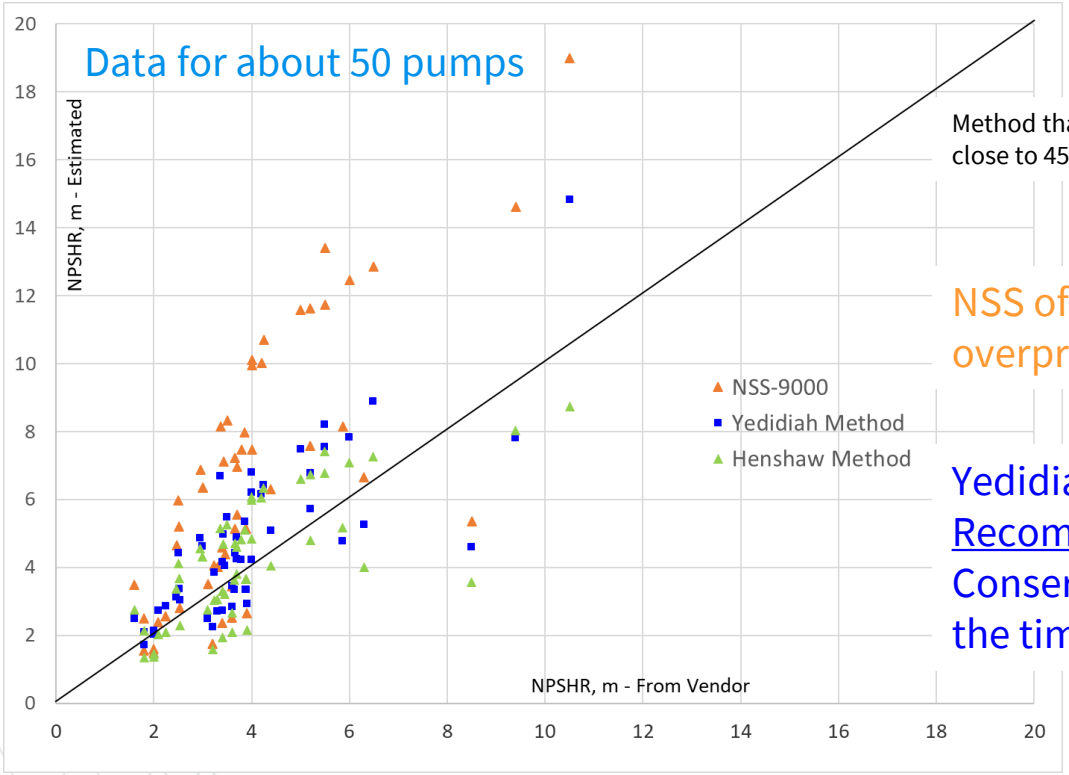
Performance of Methods for BB2/BB5 Pumps



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