Design Problem 2 – Hydraulics & Pump Characteristics

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Objective

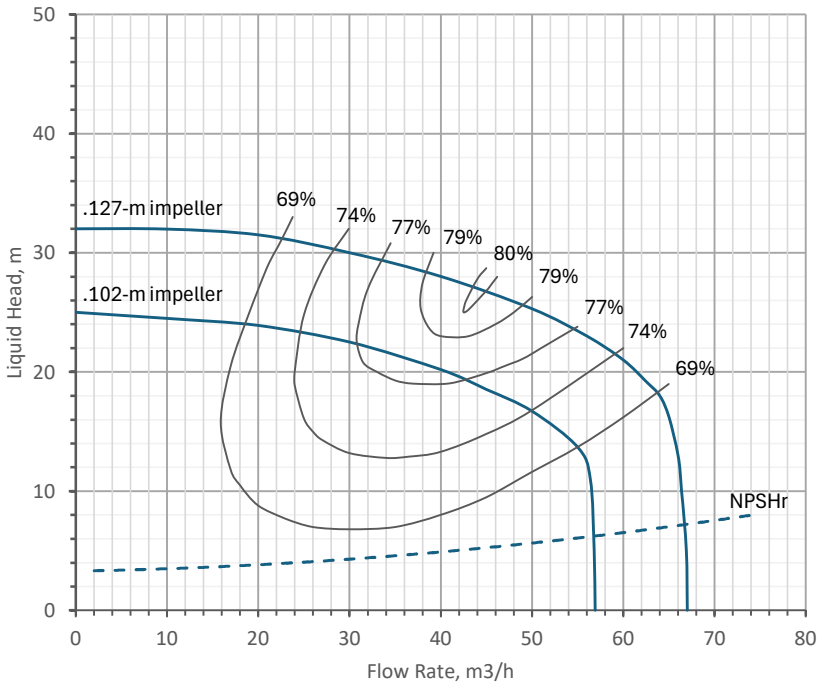
The objective is to determine the optimum operating point for a pump-pipe system using the pump characteristic curve.

Problem Statement

A process liquid is pumped from a storage tank to a distillation column using a centrifugal pump. The pump characteristic curve is shown below. The pipeline is 100 m long and is 40 mm-internal-diameter commercial carbon steel pipe. Miscellaneous losses from fittings and valves are equivalent to 600 pipe diameters. The storage tank operates at atmospheric pressure and the column at 1.7 bara. The lowest liquid level in the tank is 1.5 m above the pump inlet, and the feed to the column is 3 m above the pump inlet. The density of the fluid is 868 kg/m^3 and its viscosity is 0.631 mNs/m^2.

Part 1. Generate and plot the system curve for the system described above. The plot must be on the same axes as the characteristic curves. An Excel template is posted in CANVAS to assist with this. Use the plot to determine the operating point, pump efficiency, and NPSH for the 0.102-m and .127-m impellers and complete the 0.04-m column in the table on page 2. A fillable pdf table form is posted in CANVAS.

Part 2. Optimize the system curve by changing the pipe diameter using the efficiency of the pump as an optimization metric. Use the diameters given in the table on page 2, then use your results to complete the table.



Diameter	0.04 m	0.08 m	0.12 m	Optimum:
0.102-m impeller				
Flow Rate, m^3/h				
Liquid head, m				
Efficiency, %				
NPSH, m				
Power input, W				
0.127-m impeller				
Flow Rate, m^3/h				
Liquid head, m				
Efficiency, %				
NPSH, m				
Power input, W				

Submission Requirements

1. A plot of the required system curves on the same axes as the characteristic curves, with a minimum of six points for each curve and a "smooth" curve sketched through the points. You may use the Excel template in CANVAS to complete this requirement. You should have a minimum of four separate plots.

2. Completed results table (all four columns completed). You may use the pdf template in CANVAS to complete this requirement.

3. A pdf of each of the four required plots, a pdf of the completed table, and a signed cover sheet, bundled into a single pdf.

4. Completed pdf and Excel documents submitted in Canvas.

Supporting Calculations *(Use space below. Append additional sheets as necessary)*