Design Problem 3 – Hydraulics & Pump Characteristics Part 2 - CHEMCAD

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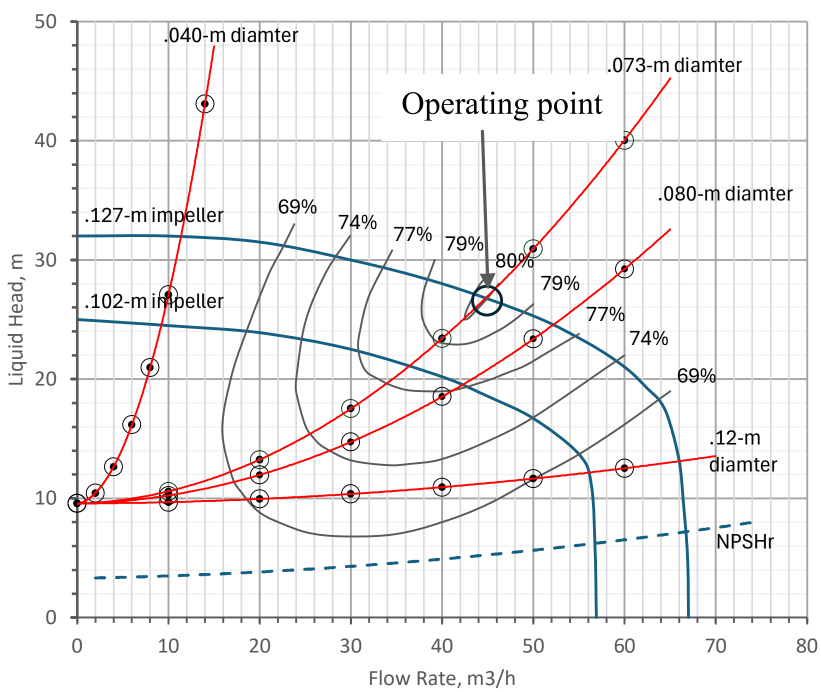
Objective

The objective is to use CHEMCAD to determine the operating point for a pump-pipe system using the pump characteristics curve and to optimize the pipe diameter.

Problem Statement

This exercise accompanies the pump video by Jacques Chaurette. Watch the video before doing the lab. The video illustrates several properties of pumps that we will simulate in this lab. Recall from labs 1 and 2 that the flow rate through a pipeline is throttled by the frictional losses in the pipeline, elevation changes, and an increase in the external pressure. The system curve is the plot of these pressure losses versus flow rate. Since the pump is pushing against that pressure and it operates along its own characteristics curve, the pump operates at a single flow rate at the intersection of the characteristics curve and the system curve. That is, there is a single operating point at the intersection of the two curves.

This was illustrated in lab 2. Recall in that lab you calculated several system curves and plotted them with the pump characteristic curves to find the operating points (intersections). By comparing the system curves to the efficiency contours, the most efficient system diameter was determined (0.073 m). Recall that in lab one, to do this in CHEMCAD, the pump outlet pressure (or pump pressure increase ΔP) had to be iterated several times to put the pipe outlet pressure on spec. At the same time, CHEMCAD computed the optimum pipe diameter.



From lab 2, the pipeline is 100 m long and is 80 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. While the optimal pipeline diameter was found to be 73 mm in Lab 2, we will also use the 80 mm pipe because that is the closest standard size to the optimal.

In this lab, your job is to use CHEMCAD to simulate the pump and pipe system described in Design Problems 1 and 2 and use it to complete the design table below. Your instructor will provide you with two items to help you do this: (1) a PowerPoint slide deck that has instructions for how to build the process, and (2) an Excel file that has the pump characteristic curve in it. The Excel file is explained in PowerPoint. Follow the instructions in PowerPoint carefully and use the results to complete the data table below. Note: Details of the CHEMCAD simulation such as feed composition are provided in the PowerPoint slide deck.

0.102-m impeller			
Diameter, m	0.08 (By Hand)	0.08 (CC)	Opt:
Act. Flow Rate, m^3/h	42.1		
Liquid head, m	19.3		
Efficiency, %	77		
$NPSH_R$, m	5.0		
$NPSH_A$, m	---		
Power input, W	2943.4		
Purchase Cost, \$ (Feb 2026)			
0.127-m impeller			
	Hand/Plot, .08 m	CC, .08 m	Opt:
Act. Flow Rate, m^3/h	52.1		
Liquid head, m	24.3		
Efficiency, %	78		
$NPSH_R$, m	6.0		
$NPSH_A$, m	---		
Power input, W	3835.2		
Purchase Cost, \$ (Feb 2026)			

Submission Requirements

1. Completed table with signed cover sheet. You may use the fillable form in CANVAS to complete the table.

3. Answers to the questions in PowerPoint slide 18.

3. Single PDF bundle of coversheet, table and questions and CHEMCAD file submitted in Canvas.

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