Design Problem 1 – Piping Design

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Problem Statement

The feed to a multicomponent distillation column is shown in Table DP1-1 below. Your assignment is to design the piping and pump equipment for this stream. You will determine the installed cost for the pump, piping, fittings, insulation, and supporting hardware, as well as the operating energy costs for 1 year of operation.

Table DP1-1. Distillation Feed Stream

Component	Feed Rate, lb-mol/h
Toluene	1.464
Naphthalene	4.797
Biphenyl	50.505
Diphenylenemethane (Fluorene)	3.087
Phenanthrene	2.307
M-Terphenyl	5.757
Total	67.917

The distillation column has already been designed, and contains 10 trays with a 2-foot tray spacing. The feed enters on the third tray from the top. The column rests on a pedestal that is 6 feet off the ground, and the bottom of the column contains a four-foot vertical space for liquid disengagement from the boilup vapors. The feed must enter the column at 298 K and 101.325 kPa. You may also assume that the liquid is stored in a feed tank also at 298 K and 101.325 kPa.

The information below will be also be useful.

- Energy cost is $0.12/kWh.

- Power cost should be based on one year of operation.

- There are four 90° standard elbows and one flanged gate valve in the feed line.

- Pipe length must be estimated from your design layout. The pump should be at least 15 feet away from the column.

- Pipe schedules and costs can be found in PTW.

- Pipe costs are also available on the McGraw-Hill web site.

- Pump and motor costs are available in ChemCAD and in PTW.

- Any cost data taken from the textbook or website must be multiplied by 1.3 to correct for age of the data.

- Fitting costs are in the "Lesson 2" section of the course web page, and must be multiplied by 2.5 to correct for age of the data.

- All piping and fittings are welded carbon steel.

- Piping must be painted and insulated. Insulation is 0.038 m 85% magnesia.

- Pipe hangar spacings must be determined from Fig. 13-3 in the "Lesson 2" section.

- Installed cost may be taken as 1.4 times the delivered equipment cost for pipes, fittings, insulation, and hangars.

- Installation factor for pumps is 2.8.

What is Required for Submission

1. A ChemCAD flowchart of the process (piping and pump only).

2. Excel, Mathematica, or ChemCAD results for a single calculation.

3. A spreadsheet or MSWord summary table that includes:

   a. Pipe diameter and cost.

   b. Cost of elbows, gate valve, pipe hangars, and insulation.

   c. Purchased cost of pump and motor.

   d. Pump power, energy, and energy cost.

   e. Total cost of pump, motor, pump, and energy.

4. ChemCAD files on share (make sure to identify the directory).