

Chapter 1

Lecture # 3-3

- **Piping and instrumentation Diagram (P&ID)**
- **Additional Diagrams**
- **3-Dimensional Plant Model**

P&ID

- P&ID – Construction Manual
- Contains: plant construction information (piping, process, instrumentation, and other diagrams)
- P&ID construction convention is explained in Table 1.9
- Conventions for instrumentation are shown in Table 1.10.

P&ID

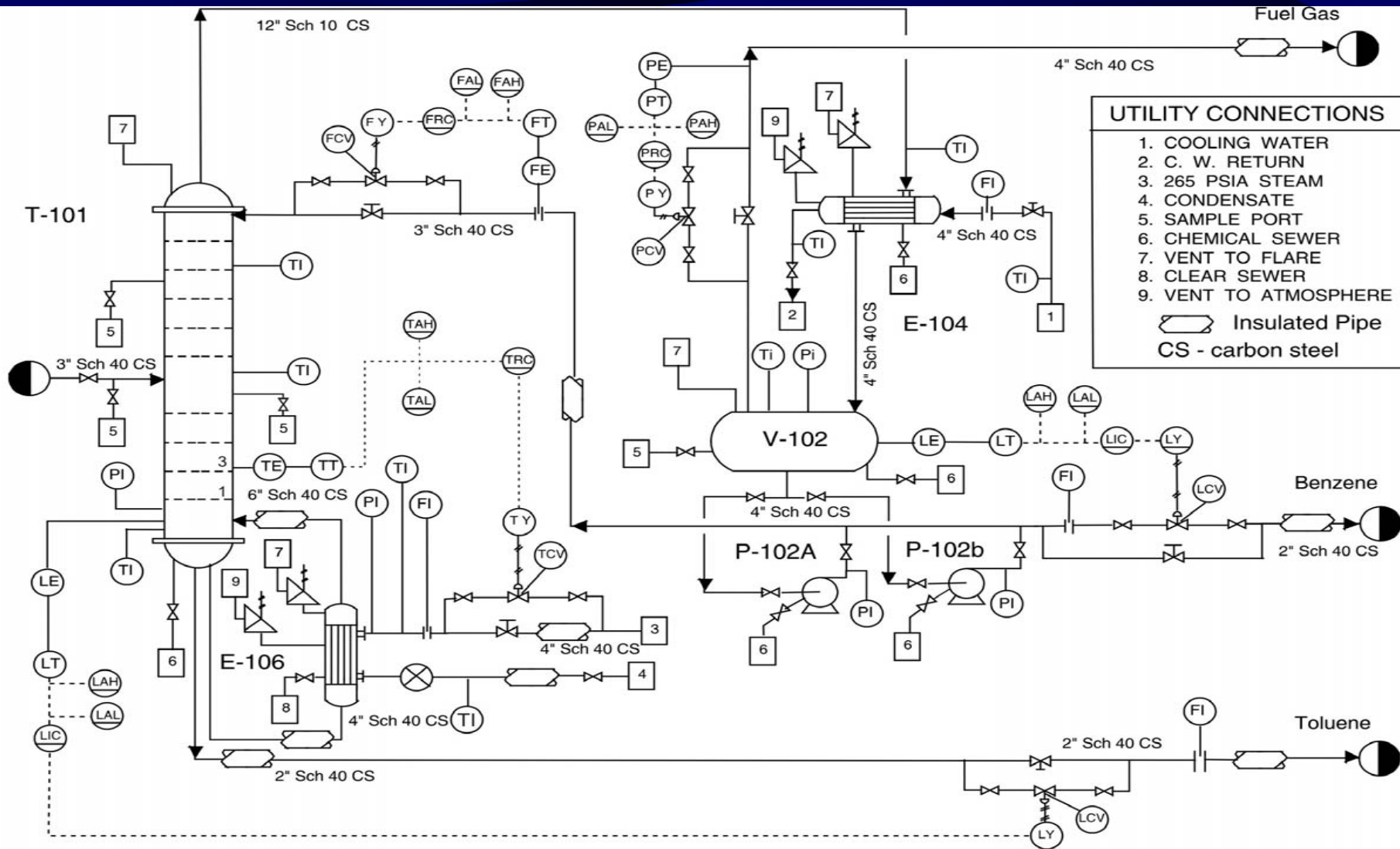


Figure 1.7 : Piping and Instrumentation Diagram for Benzene Distillation (adapted from Kauffman, D, Flow Sheets and Diagrams," AIChE Modular Instruction, Series G: Design of Equipment, series editor J. Beckman, AIChE, New York, 1986, vol 1, Chapter G.1.5, AIChE copyright (C) 1986 AIChE, all rights reserved)

P&ID

Table 1.8 Exclusions from Piping and Instrumentation Diagram

1. Operating conditions T, P
2. Stream flows
3. Equipment locations
4. Pipe routing
 - a. Pipe lengths
 - b. Pipe fittings
5. Supports, structures, and foundations







P&ID

Table 1.9 Conventions in Constructing Piping and Instrumentation Diagrams

For Equipment—Show Every Piece Including
Spare units Parallel units Summary details of each unit
For Piping—Include All Lines Including Drains, Sample Connections and Specify
Size (use standard sizes) Schedule (thickness) Materials of construction Insulation (thickness and type)
For Instruments—Identify
Indicators Recorders Controllers Show instrument lines
For Utilities—Identify
Entrance utilities Exit utilities Exit to waste treatment facilities

P&ID

Table 1.10 Conventions Used for Identifying Instrumentation on P&IDs (ISA standard ISA-S5-1, [4])

Location of Instrumentation	
	Instrument located in plant
	Instrument located on front of panel in control room
	Instrument located on back of panel in control room
Meanings of Identification Letters (XY)	
<i>First Letter (X)</i>	<i>Second or Third Letter (Y)</i>
A Analysis	Alarm
B Burner flame	
C Conductivity	Control
D Density or specific gravity	
E Voltage	Element
F Flowrate	
H Hand (manually initiated)	High
I Current	Indicate
J Power	
K Time or time schedule	Control station
L Level	Light or low
M Moisture or humidity	Middle or intermediate
O	Orifice
P Pressure or vacuum	Point
Q Quantity or event	
R Radioactivity or ratio	Record or print
S Speed or frequency	Switch
T Temperature	Transmit
V Viscosity	Valve, damper, or louver
W Weight	Well
Y	Relay or compute
Z Position	Drive
Identification of Instrument Connections	
	Capillary
	Pneumatic
	Electrical

P&ID/ Example

- V-102 contains an LE (Level Element)
 - LE senses liquid level in separator and adjusts flow rate leaving
 - LE opens and closes a valve depending on liquid level
 - LE and valve represent a feedback control loop

The final control element in nearly all chemical process control loops is a valve

P&ID/ Example

- Based on the P&ID diagram:
- Mech and Civil Engrs will design and install pieces of equipment.
- Instrument Engrs will specify, install and check control systems.
- Piping Engrs will develop plant layout and elevation drawings.
- Project Engrs will develop plant and construction schedules.

Additional Diagrams

- UTILITY FLOWSHEET
- VESSEL SKETCHES
- WIRING DIAGRAMS
- SITE PLANS
- PLOT PLANS
- ELEVATION DIAGRAMS

Additional Diagrams

- Plot Plans – plan or map drawn looking down on plant (drawn to scale with all major equipment identified)
- Elevation Diagrams – show view from side and give information about equipments distance from ground

Additional Diagrams

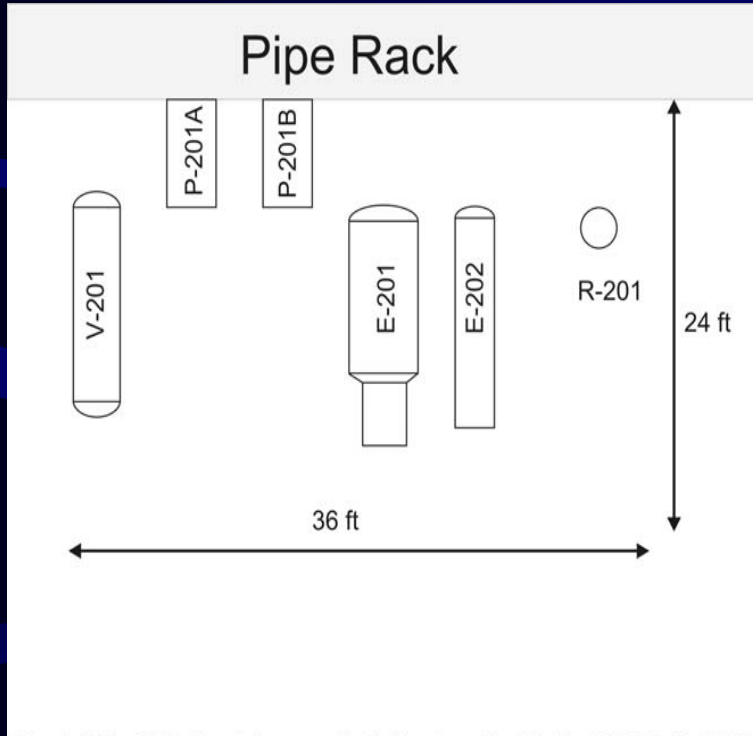


Figure 1.11: Possible Equipment Arrangement for the Reactor and Feed Section of DME Facility, Unit 200

Section of Plot Plan

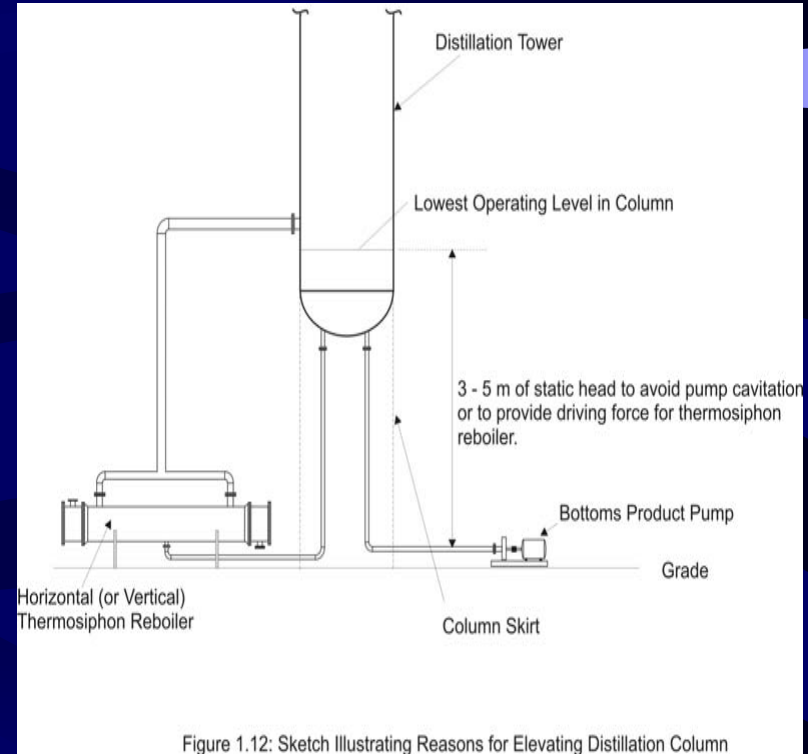


Figure 1.12: Sketch Illustrating Reasons for Elevating Distillation Column

Section of Elevation Diagram

Additional Diagrams

Piping Isometrics – show piping in 3-dimensions

Vessel Sketches – show key dimensions of equipment and locations of inlet and outlet nozzles etc.

Scale Models and Virtual Plants

- 25 years ago physical models were used for review
- Now virtual or electronic models are generated using software (3-d plant diagrams)
- Purpose of Models – catch errors such as
 - Piping clashes
 - Misaligned piping
 - Equipment not easily accessed
 - Sample points not easily reached by operators

3-D Plant Model

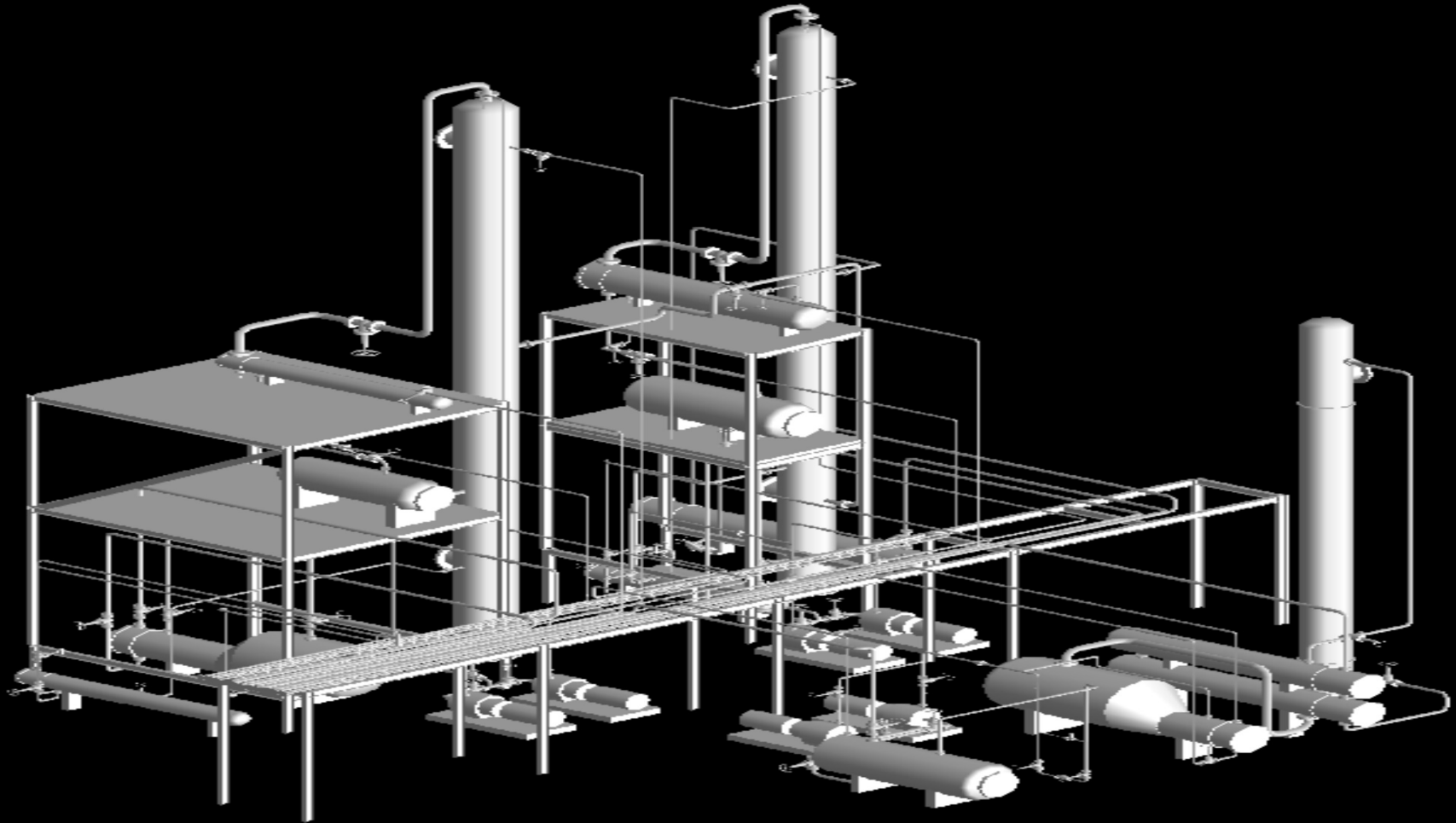
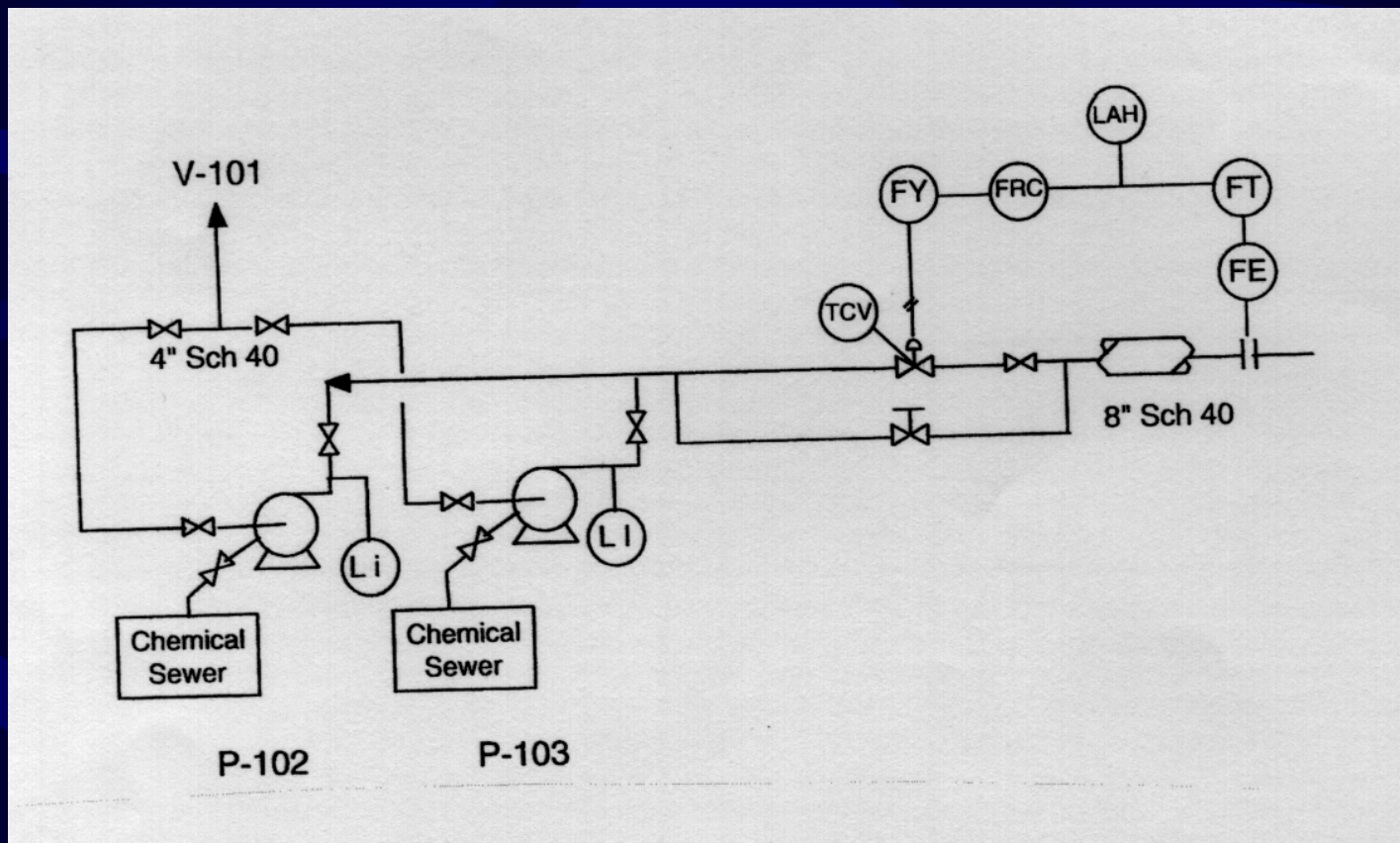


Figure 1.13: Isometric View of Preliminary 3-D Plant Layout Model for DME Process (courtesy of Cadcentre, Inc.)

Problem 1.9

Figure below is a portion of a PI&D. Find at least six errors in it. All errors are actually shown on the drawing.

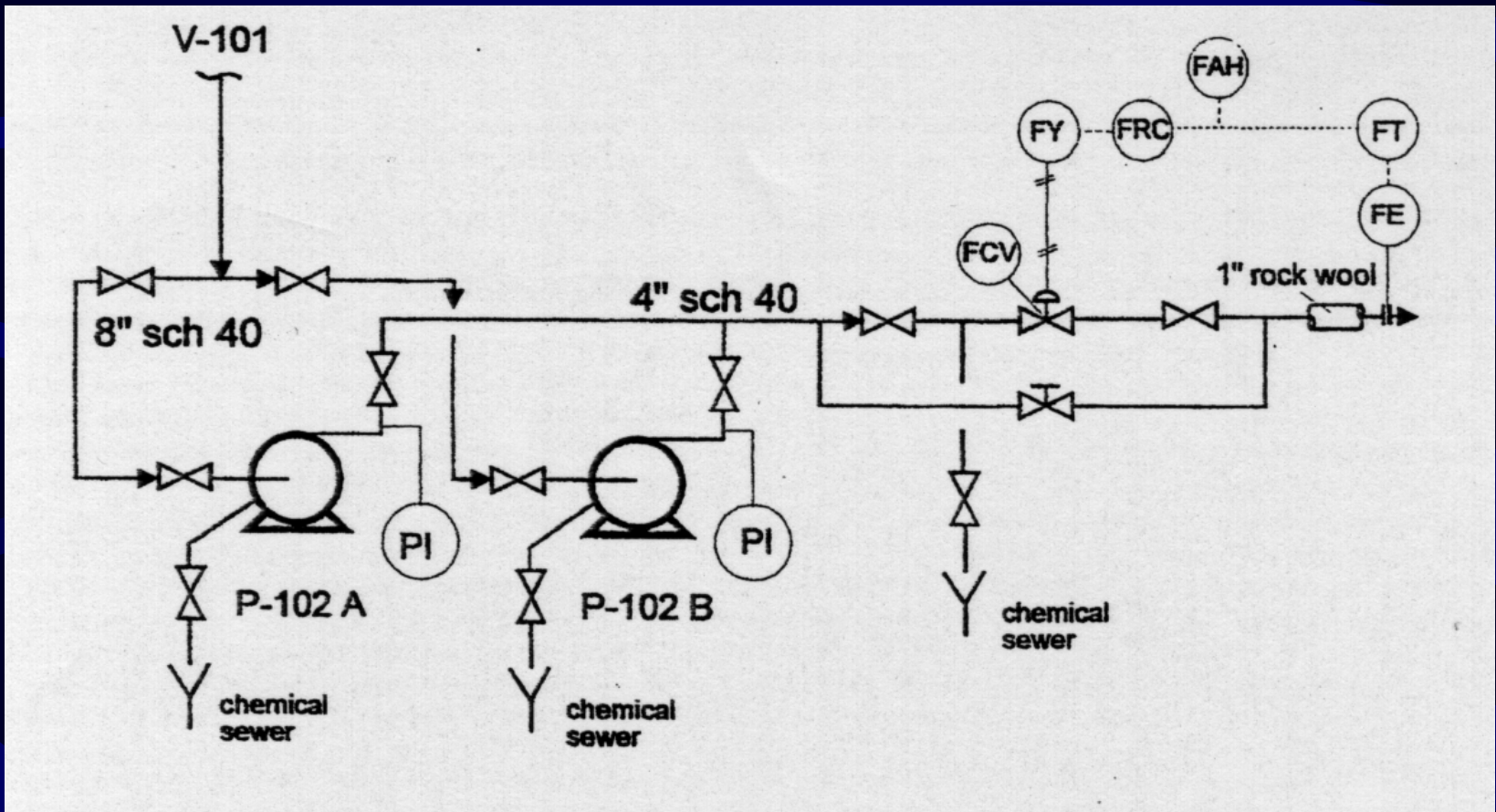


Solution

Errors include:

1. **LI on pump discharge should be PI.**
2. **Direction of arrowheads should be reversed.**
3. **TCV on control valve should be labeled FCV.**
4. **LAH on control loop should be FAH (Since no level signal is shown)**
5. **Add isolation valve to the left of the control valve.**
6. **Add a bleed valve between control valve and isolation valve.**
7. **Suction piping should be larger than discharge piping, switch 4" with 8".**
8. **Label insulation.**
9. **Pumps should be labeled P-102 A and P-102B.**

Corrected Diagram



THANK YOU