CHAPTER 1

SHORT ANSWER QUESTIONS

1.1 Block Flow Diagram (BFD)
Process Flow Diagram (PFD)
Piping and Instrument Diagrams (P&ID)
(a) PFD
(b) BFD
(c) PFD or P&ID
(d) P&ID
(e) P&ID

1.2 P&ID

1.3 It is important for a process engineer to be able to review a 3-dimensional model prior to the construction phase to check for clearance, accessibility, and layout of equipment, piping, and instrumentation.

1.4 Things that would affect the locations of different pieces of equipment when determining the layout of equipment in a process unit
(1) Clearance for tube bundle removal on a heat exchanger.
(2) NPSH on a pump affects the vertical separation of feed vessel and pump inlet.
(3) Accessibility of an instrument for an operator must be able to read a PI or change/move a valve.
(4) Separation between equipment for safety reasons reactors and compressors.
(5) Crane access for removing equipment.
(6) Vertical positioning of equipment to allow for gravity flow of liquid.
(7) Hydrostatic head for thermosiphon reboiler affects height of column skirt.

1.5 Why are accurate plant models (made of plastic parts) no longer made as part of the design process? What function did these models play and how is this function now achieved?
Plastic models are no longer made because they are too expensive and difficult to change/revise. These models have been replaced with virtual/e-models using 3-D CAD. Both types of model allow revision of critical equipment and instrument placement to ensure access, operability, and safety.

1.6 OTS = Operator Training Simulator ITS = Immersive Training Simulator

1.7 Augmented reality refers to a feature of an immersive training system (ITS) where by an operator can obtain additional information about equipment by "peeling back" the wall of a vessel, etc., and looking inside the equipment.

1.8 What are the two principle methods for the layout of process equipment in a chemical plant?
(a) Grade-Mounted, Horizontal, In-line Arrangement and (b) Structure-Mounted Vertical Arrangement

1.9 When is it appropriate to add a flag to a stream in a PFD rather than including the stream in the stream flow table?
When only temperature or pressure changes in the equipment. So for example at the outlet of a pump or the outlet of a heat exchanger. Flags should also be considered around critical equipment for example reactors.

1.10 What problems would you foresee in naming equipment in a process that had a unit number of 10 (for example, pumps starting with P-11, P-12, etc.)?
By having a unit number with only 2 digits (10, 20, 30, etc.), the maximum number of equipment items within an equipment class is 9. For example, pump 11 in unit 20 would become P-31, which could be in conflict with the first pump of unit 30. By numbering units in the hundreds (200, 300, etc.), the maximum number of items in an equipment class is 99 so there will never be a conflict of this type.

1.11 What diagram would you refer to in order to estimate the frictional loss

through a certain piping run within a process?
This would require a piping isometric(s) for the whole piping run.
1.12 In the vast majority of cases what is the final control element in a process control loop?
Nearly always, this control element will be a control valve.
1.13 What is the most effective way of communicating information about a process?
Through the use of diagrams (or computer generated models) – but always a visual representation.
1.14 Vessel V-307 is to be replaced in a plant with a vessel that is designed to withstand a higher pressure and which has a larger volume. Should this vessel be numbered V-307 to correspond with the vessel it is replacing? Explain your answer.
Generally, the answer is No. Unless the replacement equipment is essentially identical in function and characteristics to the original equipment a new number should be chosen to avoid confusion when locating information about the equipment. For the case considered in this question, calling the vessel V-307A would probably be ok.

PROBLEMS

1.15 There are two common reasons for elevating the bottom of a tower by means of a "skirt." One reason is to provide enough $NPSH_A$ for bottoms product pumps to avoid cavitation. What is the other reason?
Another reason to elevate the bottom of a tower is to provide enough hydrostatic head driving force to operate a thermosiphon reboiler
1.16 (a) PFD or P&ID
(b) PFD
(c) PFD
(d) P&ID
(e) BFD (or all PFDs)
1.17 A pipe rack provides a clear path for piping within and between processes. It keeps piping off the ground to eliminate tripping hazards and elevates it above roads to allow vehicle access.
1.18 A structure mounted vertical plant layout is preferred when land is at a premium and the process must have a small foot print. The disadvantage is that it is more costly because of the additional structural steel.
1.19 (a) BFD - No change
PFD - Efficiency changed on fired heater, resize any heat exchanger used to extract heat from the flue gas (economizer)
P&ID - Resize fuel and combustion air lines and instrumentation for utilities to fired heater. Changes for design changed of economizer (if present)
(b) BFD - Change flow of waste stream in overall material balance
PFD - Change stream table
P&ID Change pipe size and any instrumentation for this process line
(c) BFD - No change
PFD - Add a spare drive, e.g. D-301 → D-301 A/B
P&ID - Add parallel drive
(d) BFD - No change
PFD - No change
P&ID - Note changes of valves on diagram
1.20 (a) A new vessel number need not be used, but it would be good practice to add a letter to donate a new vessel, e.g. V-203 → V-203N. This will enable an engineer to locate the new process vessel sheet and vendor information.
(b) P&ID definitely
PFD change/add the identifying letter.

1.21

Solution to Problem 1.21

1.22 (a) (i) Open globe valve d
(ii) Shut off gate valves a and c
(iii) Open gate valve e and drain contents of isolated line to sewer
(iv) Perform necessary maintenance on control valve b
(v) Reconnect control valve b and close gate valve e
(vi) Open gate valves a and c
(vii) Close globe valve d
(b) Drain from valve e can go to regular or oily water sewer.
(c) Replacing valve d with a gate valve would not be a good idea because we loose the ability to control the flow of process fluid during the maintenance operation.
(d) If valve d is eliminated then the process must be shut down every time maintenance is required on the control valve.