



PROCESS ENGINEERING AND DESIGN

1. Outline processes for manufacturing (a) HCl, (b) hydrogen, (c) acetic acid, (d) ammonia (e) sulfuric acid, (f) nitric acid, (g) HF, (h) NaOH, (i) chlorine, (j) methanol, (k) phosphoric acid, (l) EO, (m) PE, (n) HCN, (o) sulfur (p) formaldehyde, (q) ethanol, (r) acetone, (s) benzene, (t) phenol, (u) vinyl chloride (v) styrene, (w) urea.
2. Why is distillation done at high pressure? polyethylene
3. If you have an HCl gas stream and an N₂ stream how do you dispose of them? P₂
4. Which has larger diameter, the suction or discharge on a pump? 7. (C) $\frac{1}{2} > \frac{1}{4}$
5. Sketch typical temperature and composition profiles in a distillation column. A.V. = 2.5 V₂
6. How would you remove 1% phenol from water? pure water
7. How would you control a distillation column? distillation
8. How is syn gas made from coal?
9. How would you go about estimating the cost of a distillation column, pump or heat exchanger?
10. Suggest several methods for obtaining fresh water from sea water. Which would you use? NaOCl & CaOCl
11. What is bleach? How is it made? 1) multi effect evaporator 2) chlorine (salt) 3) reverse osmosis 4) electrolysis
12. Outline a method for separating two organic compounds with similar boiling and melting points. 3) flash expansion (pressure reduction)
13. How would you obtain pure oxygen from air?
14. Living in Phoenix, Arizona where the temperature is 100F, how would you cool a room using 120F water? cooling tower (indirect) cool to wet bulb temp (indirect)
15. Consider an exothermic, zeroth order reaction in a CSTR. What happens if there is a step change increase in the feed temperature?
16. Sketch and describe a multi-effect evaporator. How does the pressure vary through the system?
17. How would you separate ethanol and water?
18. How does an ice skate work? (P - dynamic)
19. Increasing the heat to the boiler of a steamboat caused the boat to slow down. Why?
20. Consider two pressurized vessels connected in series with recycle. If the recycle is cut off, how will the pressure in each vessel vary with time?
21. How would you remove water vapor from Ar gas to a level of 1ppb (volume%) if

adsorb (silica, etc.)

the water is initially present at a level of 200ppb?

22. What is the lowest temperature water can be cooled to in a cooling tower? *T_w = 60°F*
- ~~23.~~ Several years ago there was a report of a boiler explosion in a church. When interviewed the janitor explained that he lit the gas flame in the boiler. After a time he noticed the pressure gauge readings were too high. He immediately extinguished the burners. Five minutes later the boiler blew up. Why?
24. Given the pressure drop, L and D for a pipe, how would you find the velocity? *$\frac{\pi \Delta P R^4}{8 \mu L} = Q$*
- ~~25.~~ What is the reflux ratio and a pinch point? *top returned to column / top product composition doesn't change between stages*
26. Diagram an HCl or SO₂ absorber. *Hagen - Poiseuille - Laminar $\left(\frac{\Delta P}{P} = E_v\right)$ Turb $\left(\frac{\Delta P}{P} = E_v\right)$*
27. How do you make pure N₂ from air without cryogenic techniques?
28. Know how to establish a scheme to separate a multicomponent system of liquids.
29. Consider two pressurized vessels connected in series. If the downstream vessel suddenly develops a large leak what happens to the flowrate in the pipe connecting the two vessels? Sketch a flow vs. time curve.
30. How does a heat pump work in winter? How is it different in the summer?
31. What temperature and pressure are used in the synthesis of ammonia? Is the reaction reversible? exothermic? (why?). To carry it out economically what must you know about the reaction? How do you get K_{eq} without experimental data? How does K_{eq} depend on T? *400°C, 500 atm, \rightarrow $\frac{d \ln K}{dT} = \frac{\Delta H}{RT^2}$*
32. Give expressions for:
a. reversible heat in an electrochemical cell *$\Delta G = -nF \Delta E$*
b. irreversible heat in an electrochemical cell *$w = nF \Delta E$*
b. net work in an electrochemical cell
33. You have a continuous distillation set-up. What can you do to save energy (i.e. reduce heat duty at the reboiler).
34. You want to extract mechanical energy from geothermal steam which contains 1 % incondensable gases CO₂, H₂S, NH₃. What exit T, P would you choose? Would you get rid of the incondensibles? How?
35. Derive the Fenske equation. *\rightarrow 30 sec w/ eqn. done*
36. What is the procedure for designing a multicomponent distillation column?
37. Outline the principles underlying pressure swing absorption. When would you use it?
38. Give a method for manufacturing acetylene, starting from inorganic compounds only. *(CaC₂ + H₂O) \rightarrow C₂H₂ + Ca(OH)₂ + H₂*
39. How would you separate a single temperature sensitive component (e.g. a protein) from a stream containing a multicomponent mixture of similar sized molecules? *charge separation (electrophoresis)*

40. Where does bromine come from, e.g. that used in bromo-seltzer? See 11:5
41. Why is there so much concern about high and low frequency outage to the electrical power of compressors feeding gas into tanks?

