PROCESS DESIGN PRELIM QUESTIONS

1.   Describe your senior design project in detail (Lynn).

2.   Design an acetone-air absorber (solvent = water) with twice the minimum flow rate (Clark).
   - Construct the operating diagram (operating and eq. lines)

3.   When you make syn gas from coal, what are the products? Is (are) the reactions endo- or exothermic? How would you separate CO_2 from the gaseous products?

4.   Draw the McCabe Thiele diagram for a distillation column that uses a chemically reacting absorbent.

5.   Commercially, how is sulfuric acid made? Sodium hydroxide?

6.   Consider two pressurized vessels connected in series with recycle. If the compressor suddenly breaks down (ie recycle = 0), how will the pressure in each vessel vary with time?

7.   Say you are asked to design an automobile that would run on NH_3, but the EPA will not let you burn NH_3 due to NO_x formation so you decide to run the automobile on H_2. Design a flow sheet for this process and discuss problems.

8.   How could you remove water vapor from argon gas to a level of 1 ppb (volume %) if the water is initially present at a quantity of 200 ppb (volume %)?

9.   What is the lowest temperature water can be cooled to in a cooling tower?

10.   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 way too high. He immediately extinguished the burners. Five minutes later the boiler blew up. Why?

11.   Develop a process for separating NH_3 from an NH_3-air gas stream at low pressures (p << 1 atm). Because of the low pressure, one cannot afford to have any pressure drop in the process (ie adsorbers, strippers, and distillation are all ruled out).

12.   How is hydrogen made, on a large scale basis? (Michaels/ Peterson)

13. Draw a hydrogen plant. Include the major reactors, separators, etc., and all auxiliary equipment such as heat exchangers, steam lines, waste stream regenerators, and so on. (Michaels/Peterson)

14. How would you separate air into pure oxygen. (Lynn, Hanson)

15. How does a heat pump work in winter? How is it different in the summer?

16. 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?

17. How would you separate CO_2 from salt water?

18. Outline processes for manufacturing: (a) HCl; (b) H_2; (c) acetic acid; (d) NH_3; (e) H_2SO_4; (f) HNO_3; (g) HF; (h) NaOH; (i) Cl_2; (j) methanol; (k) phosphoric acid, (l) EO; (m) PE; (n) HCN; (o) sulfur; (p) formaldehyde; (q) ethanol; (r) acetone; (s) benzene; (t) phenol; (u) v vinyl chloride; (v) styrene; (w) urea.

19. Why is distillation done at high pressure?

20. If you have an HCl gas stream and an N_2 stream, how do you dispose of them?

21. Which has a larger diameter, the sucton or discharge on a pump?

22. Sketch typical temperature and composition profiles in a distillation column.

23. How would you remove 1% phenol from water?

24. How would you control a distillation column?

25. How is syn gas made from coal?

26. How would you go about estimating the costs of a distillation column, pumps, or heat exchangers?

27. Suggest several methods for obtaining fresh water from sea water. Which would you use?

28. What is bleach? How is it made?

29. Outline a method for separating two organic compounds with a similar boiling and melting points.

30. Living in Phoenix, Arizona, where the temperature is 100°F, how would you cool a room using 120°F water?

31. Consider an exothermic, zero-order reaction in a CSTR. What happens if there is a step change increase in the feed T?

32. Sketch and describe a multi-effect evaporator. How does the pressure vary through the system?

33. How would you separate ethanol and water?

34. How does an ice skate work?

35. Increasing the heat to a boiler of a steamboat caused the boat to slow down. Why?

36. Give expressions for:
   a. reversible heat in an electrochemical cell
   b. irreversible heat in an electrochemical cell
   c. net work in an electrochemical cell

37. Given the pressure drop, L and D for a pipe, how would you find the velocity?
$$\frac{\Delta P}{\rho} + \Delta \frac{u^2}{2} + g \Delta z = 0 \qquad Q = \frac{\Delta P \pi R^4}{8 \mu L} = \pi R^2 v \quad \text{for laminar}$$

38. What is the reflux ratio and a pinch point?

39. Diagram an HCl or SO_2 absorber.

40. How do you make pure N_2 from air without cryogenic techniques?

41. Establish a scheme to separate a multi-component system of liquids.

42. Consider two pressurized vessels connected in series. If the downstream vessel suddenly develops a large leak, what happens to the flow rate in the pipe connecting the two vessels? Sketch a flow vs. time curve.

43. You have a continuous distillation set-up. What can you do to save energy (i.e. reduce heat duty at the reboiler)?

44. You want to extract mechanical energy from geothermal steam which contains 1% incondensible gases CO_2, H_2S, NH_3. What exit T, P would you choose? Would you get rid of the incondensibles? How?

45. Derive the Fenske equation.

46. What is the procedure for designing a multicomponent distillation column?

47. Outline the principles underlying pressure swing absorption. When would you use it?

48. Give a method for manufacturing acetylene, starting from inorganic compounds only.

49. How would you separate a single temperature sensitive component (e.g. a protein) from a stream containing a multicomponent mixture of similar sized molecules?

50. Where does bromine come from, e.g. that used in bromo-seltzer?

51. Why is there so much concern about high and low frequency outage to the electrical power of compressors feeding gas into tanks?