

Process Design

How would you remove water vapor from argon gas to a level of 1 ppb if the water is initially present at a quantity of 200 ppm?

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

Discuss a distillation column for a separation involving ethane, propane, butane, and pentane with the split to be made between C3 and C4. Tell how to determine column temperature and pressure given a steam heated reboiler and a water-cooled condenser.

With 60 F cooling water and 100 psig steam, devise a process to provide water at 32 F without refrigeration.

Suppose superheated geothermal steam were available with a composition of 99% H₂O, 1% CO₂ (incondensable).

Outline a process to derive the most work or energy possible from this steam.

How could you further decrease the outlet pressure (below ambient) for a turbine?

What should you do with the CO₂

You want to extract mechanical energy from geothermal steam which contains one percent incondensable gases (CO₂, H₂S, NH₃).

What exit temperature and pressure would you choose? Would you get rid of the incondensibles? How?

How would you separate CO₂ from air?

How would you separate H₂ from air?

Give a number of possible methods for making H₂.

How would you reduce CH₃Br in air from 1% to 0.02%?

Draw an adsorption diagram assuming Raoult's Law.

Find the minimum reflux.

How much more than minimum should actual reflux be?

Find the column height.

How do you find Kg?

How do you find Kw?

What would you do with the CH₃Br oil? Why?

Where does Br⁻ occur naturally?

How would you obtain Br₂ gas from an aqueous solution of NaCl, NaBr and other salts?

Where does iodine come from?

Draw the McCabe-Thiele diagram for a distillation column that uses a chemically reacting adsorbent?

How is sulfuric acid made commercially?

How is sodium hydroxide made commercially?

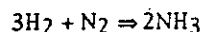
When you make syn-gas from coal, what are the products? Is(are) the reaction(s) endothermic or exothermic? How would you separate CO₂ from the gaseous products?

You want to extract mechanical energy from geothermal steam which contains one percent incondensable gases (CO₂, H₂S, NH₃). What exit temperature and pressure would you choose? Would you get rid of the incondensibles? How?

Draw the x-y diagram for ethanol-water. How do you obtain ethanol above 95%? (two ways)

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

Consider the Haber process:



Is the reaction reversible? Is the reaction exothermic? Why? To carry out this reaction commercially what must you know about the reaction? How do you calculate K without experimental data? How does K depend on temperature?

How would you remove dissolved O_2 from seawater? Suppose you are processing significantly large volumes so that energy intensity is a strong consideration.

What thermodynamic variables affect solubility?

Where is the mass transfer resistance?

What type of unit operation would you use?

How would you design it?

What is a maximum boiling azeotrope? Does it exhibit positive or negative deviations from Raoult's Law? If a solution of this type is distilled, will the azeotrope be recovered in the distillate or the bottoms of the distillation column?

Outline processes for manufacturing:

- a. hydrochloric acid
- b. hydrogen gas
- c. acetic acid
- d. ammonia
- e. sulfuric acid
- f. nitric acid
- g. hydrofluoric acid
- h. sodium hydroxide
- i. chlorine gas
- j. oxygen gas
- k. nitrogen gas

Why is distillation done at high pressure?

If you have an HCL gas stream and an N_2 gas stream, how might you dispose of them?

Which has a larger diameter, the suction or the discharge on a pump?

Sketch typical temperature and composition profiles in a distillation column.

How would you remove 1% phenol from water?

How would you control a distillation column?

How is syn gas made from coal?

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

Suggest several methods for obtaining fresh water from sea water.

Which would you use?

What is bleach?

How is it made?

Outline a method for separating two organics with similar boiling points and melting points.

How would you obtain pure oxygen from air?

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

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

Sketch and describe a multi effect evaporator.

How does the pressure vary through the system?

How does an ice skate work?

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

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?

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

Given the pressure drop, L and D for a pipe, how would you find the velocity?

What is the reflux ratio and a pinch point?

Diagram an HCL or SO₂ absorber.

How do you make pure N₂ from air without cryogenic techniques?

Discuss how to establish a scheme to separate a multi-component system of liquids.

What methods could be used to purify a stream of a polar organic substance from trace nonpolar impurities?

Which would you choose and why?

Why is distillation done at high pressure?

Develop a process for separating NH₃ from an NH₃-air gas stream at low pressure ($P \ll 1 \text{ atm}$). Because of the low pressure one cannot afford to have any pressure drops in the process.

How would you separate air into pure O₂ and N₂?

How would you separate two organic compounds with similar melting points and boiling points?



$$q = \dot{m} \Delta T = \dot{Q}$$

