Ex 1.13-Use of ppm

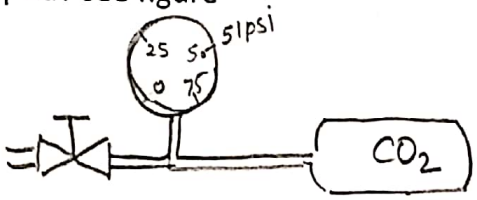
The Current OSHA 8 hour limit for HCN in air is 10.0 ppm . A lethel dose of HCN in air (From the merck index) is 300 mg/kg of air at room temperature. How many mg HCN/kg air is the 10.0ppm? what fraction of the lethel does is 10.0 ppm?

Ex1.19- Temperature conversion

The thermal conductivity of aluminium at 32 °F is 117 Btu/(hr)(ft^2)(°F /ft). find the e quivalent value at 0°C in term of Btu/(hr)(ft^2)(K/ft).

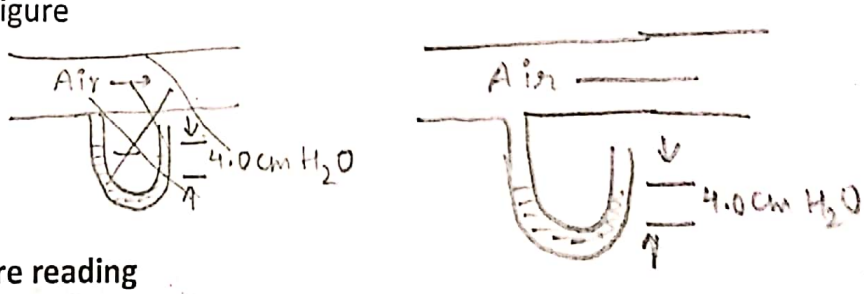
Ex1.21-Pressure conversion

The pressure gauge on a tank of CO_2 used to fill soda- water bottels reads 51.0 psi. At the same time barometer reads 28.0 in. Hg. What is the absolute pressure in the tank in psia? see figure



Ex-1.22 Pressure Conversion

Air is flowing through a duct under a draft of 4.0 cm H_2O. The barometer indicates that the atmospheric is 730 mm Hg. What is the absolute pressure of the gas in inches of mercury? see figure



Ex1.23 Vacuume pressure reading

Small animal such a mice acn live at reduced air pressure down to 20kPa (althought not comfotably). In a test a mercury manometer attached to a tank as shown in figure E1.23 reads 64.5cm Hg and the barometer reads 100kPa. Will the mice survive?

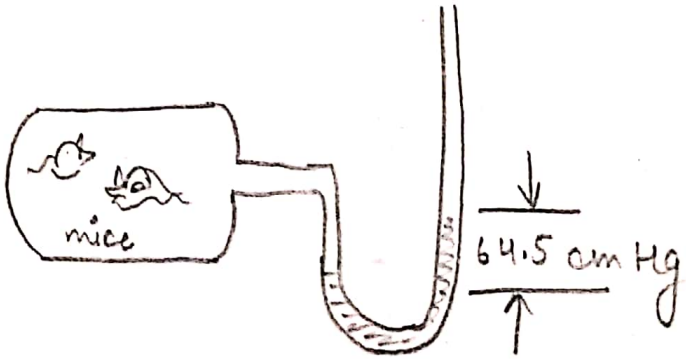


figure E1.23

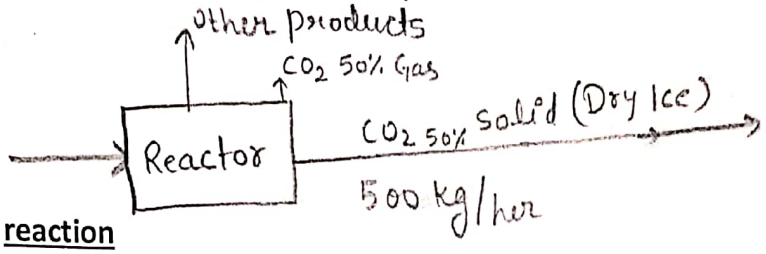
No-1

1:1 B
3:2 →
2:4 C

limiting reactant
excess reactant
Conversion
yield
selectivity

Ex 1.25- Use of the chemical equation

In the combusting of heptane, CO_2 is produced . Assume that you want to produce 500kg of dry ice per hour and that 50% of the CO_2 can be converted into dry ice as shown in figure E1.25 . How many kilograms of heptane must be burned per hour?



Ex1.27 Incomplete reaction

Antimony is obtained by heating pulverized stibnite (Sb_2S_3) with scarp iron and drawing off the molten antimony from the bottom of the reaction vessel.

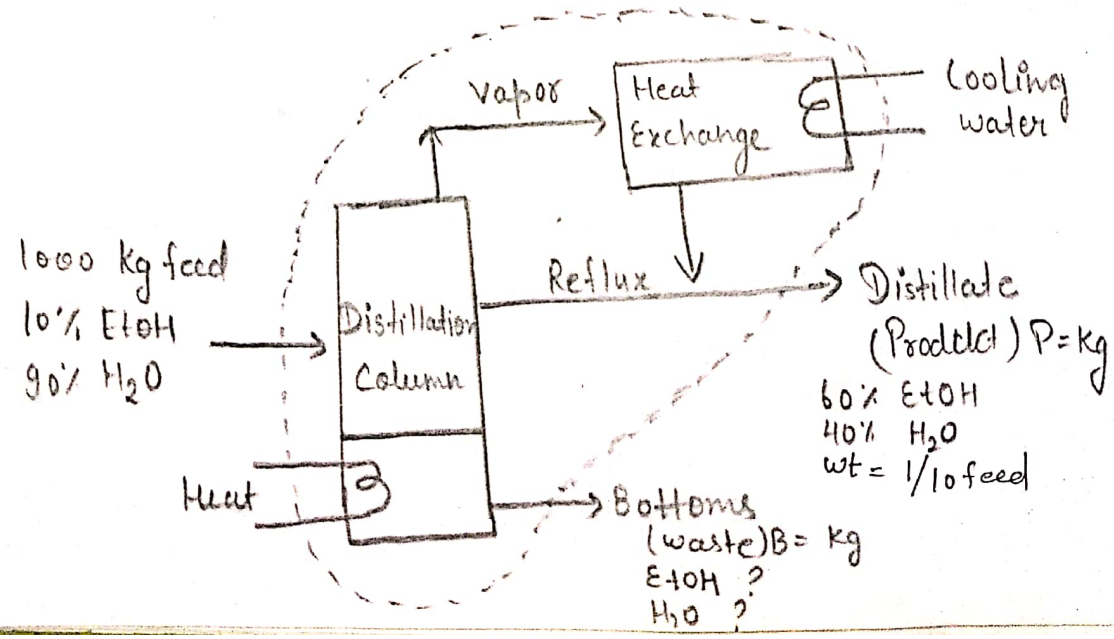
$$Sb_2S_3 + 3Fe \text{ ----------} \rightarrow 2Sb + 3FeS$$

Suppose that 0.600 kg of stibnite and 0.250 kg of iron turning are heated together to give 0.200 kg of Sb metal . Determine.

(a) The limiting reactant
(b) The percentage of excess reactant
(c) The degree of complection (fraction)
(d) The percent conversion
(e) The yield

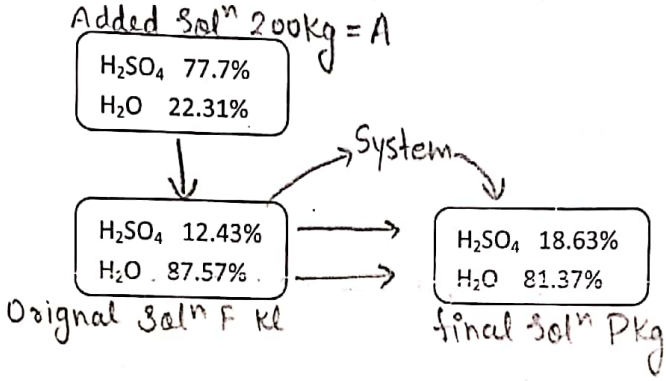
Ex 3.6 Continuous Distillation

A novice manufacturer of alcohol for gasohol is having a bit of difficulty with a distillation column. The operation is shown in figure E3.6 . Techicians think too much alcohol is lost in the bottoms (waste). Calculate the composition of the bottoms and the mass of the alcohol lost in the bottoms.



Ex 3.7 Mixing

Dilute sulfuric acid has to be added to dry charged batteries at service stations to activate a battery. You are asked to prepare a batch of new 18.63% acid as follows. A tank of old weak battery acid (H_2SO_4) SOLUTION CANTAINS 12.43% H_2SO_4 (the remainder is pure water) . If 200kg of 77.7 H_2SO_4 is added to the tank, and the final solution is to be 18.63% H_2SO_4, How many kilograms of battery acid have been made? See figure E3.7



Ex 3.9 Crystallization

A tank holds 10,000kg of a saturated solutions of Na_2CO_3 at 30°C You want to crystallize from this solution 3000kg of $Na_2CO_3 . 10H_2O$ without any accompanying water. To what temperature must the solutions be cooled?

Solubility
T P
0 7
10 12.5
20 21.5
30 38.8

Ex – 3.10 Excess Air

Fules for motor vehicles other than gasoline are being eyed because they generated lower levels of pollutants than does gasoline. Compressed propane has been suggested as a economic power for vehicals . Suppose that in a test 20kg of C_3H_8 is burned with 400kg of air to produse 44 kg of CO_2. What was the present excess air?

Ex 3.11 Preventing corrosion

Corrosions of pipes in boilers by oxygen can be alleviated through the use of sodium sulfite. Sodium sulfite remove oxygen from boiler feedwater by the following reactions

$$2Na_2SO_3 + O_2 \text{ ----------} \rightarrow 2Na_2SO_4$$

How many pounds of sodium sulfite are theoretically required (for complete reaction) to remove the oxygen from 8,330,000 lb of water (10^6) containing 10.0 parts per million (ppm) of dissolved oxygen ant at the same time maintain a 35% excess of sodium sulfite?

3.13 Combustion with Nonprecise Data

The main advantage of catalytic incineration of odorous gases or other obnoxious sub stances over combustion is the lower cost. Catalytic incinerators operate at lower temperatures-500 to 900 °C Compared with 110 to 1500°C for thermal incinerator and use substantially less fuel. Because of the lower operating temperatures, materials of construction do not need to be as heat resistant, reducing installation and construction costs.

In a test run, a liquid that is proposed for use as fuel in a flare and has the composition of 88% C AND 12% H_2 Is vaporized and burned with dry air to a flue gas (fg) of the following composition on a dry basis:

CO_2 13.4%
O_2 3.6%
N_2 83.0%

To help design the equipment of the continuous steady-state combustion device, determine how many kilograms moles of dry fg are produced of excess air used?

EX 3.14 Combustion of coal

A local utility burns coal having the following composition on a dry basis.(Note that the coal analysis below is a convenient one for our calculations, but is not necessarily the only type of analysis that is reported for coal. some analyses contain much less information about each element.)

Component	precent
C	83.05
H	04.45
O	03.36
N	01.08
S	00.70
Ash	07.36
Total	100.0

The average Orsat analysis of the gas from the stack during a 24- hr test was

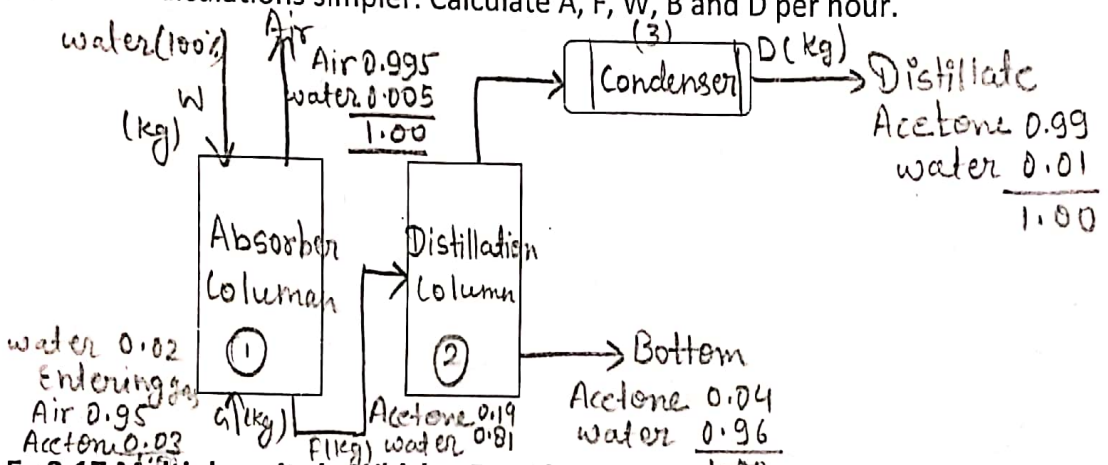
Component	percent
$CO_2 + SO_2$	15.4
CO	0.0
O_2	4.0
N_2	80.6
TOTAL	100.0

Moisture in the fuel was 3.90%, and the air on the average contained 0.0048 lb H_2O/lb dry air. The refuse showed 14.0% unburned coal, with the remainder being ash.

You are asked to check the consistency of the data before they are stored in the data base. Is the consistency satisfactory? What is the average percent excess air used?

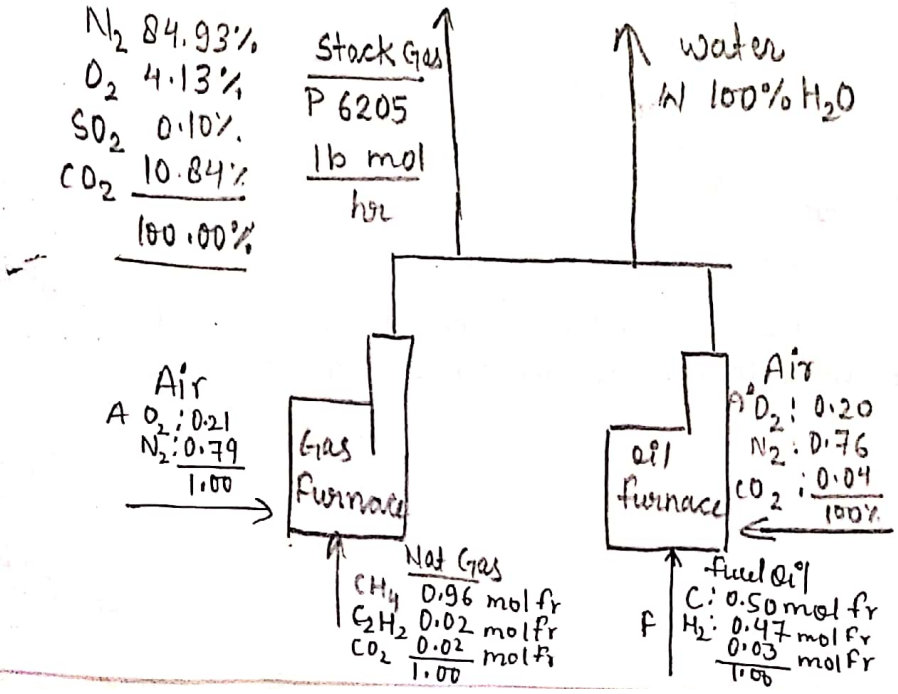
EX 3.16 Multiple Unit in Which No Reaction Occurs

Acetone is used in the manufacture of many chemicals and also as a solvent. In its later role, many restrictions are placed on the release of acetone vapor to the environment. You are asked to design an acetone recovery system having the flowsheet illustrated in figure E3.16 . All the concentrations shown in figure E3.16 of both gases and liquids are specified in weight percent in this special case to make the calculations simpler. Calculate A, F, W, B and D per hour.



Ex 3.17 Multiple units in Which a Reaction Occurs

In the face of higher fuel costs and the uncertainty of the supply of a particular fuel many companies operate two furnaces. One with natural gas and the other with fuel oil. In the RAMAD Corp , each furnace had its own supply of oxygen; the oil furnace used



gas stream that analyzed: O_2 ,20%; N_2,76%; and CO_2,4%, but the stack gases went up a common stack . See figure E3.17

During one blizzard , all transportation to the RAMAD crop. Was cut off , and officials were worried about the dwindling reserves of fuel oil because the natural gas supply was being used at its maximum rate possible . The reserve of fuel oil was only 560 bbl. How many hours could the company operate before shutting down if no additional fuel oil was attainable? How many lb mol/hr of natural gas were being consumed? The minimum heating load for the company when translated into the stack gas output was 6205 lb mol/hr of dry stack gas. Analysis of the fuels and stack gas at this time were:

Natural Gas		fuel oil(API gravity= 24.0)$_{(mol\%)}$		stack gas(Orsat analysis)	
CH_4	96%	C	50	N_2	84.93%
C_2H_2	2%	H_2	47	O_2	4.13%
CO_2	2%	S	3	CO_2	10.84%

The molecular weight of the fuel oil was 7.91 lb/lb mol, and its density was 7.578 lb/gal.

Ex 3.19 Recycle without Chemical Reaction

The manufacture of such products as penicillin, tetracycline, vitamins and other pharmaceuticals, as well as photographic chemicals, dyes, and other fine organic compounds, usually requires separating the suspended solids from their mother liquor by centrifuging, and drying the wet cake. A closed- loop system (see figure E3,19a) for centrifuge unloading, drying conveying, and solvent recovery is comprised of equipment especially designed for handling materials requiring sterile and contamination-free conditions.

Given the experimental measurements on the pilot plant equipment outlined in figure E19A, what is the lb/hr of the recycle stream R?

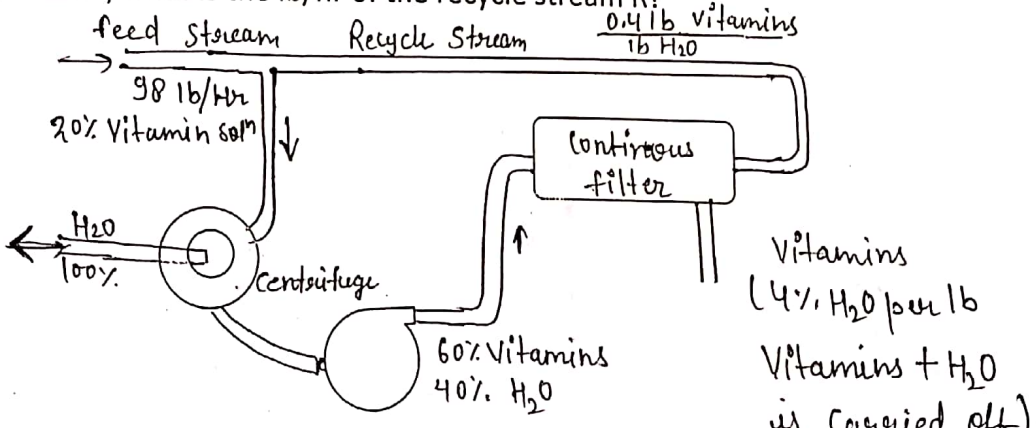
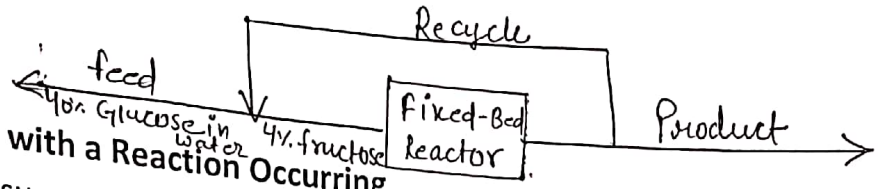


Figure E 3.19a

Ex 3.20 Recycle With a Reaction Occuring

Immobilized glucose isomerase is used as a catalyst in producing fructose from glucose in a fixed bed reactor (water is the solvent). For the system shown in figure E3.20a, what percent conversion of glucose results an one pass though the reactor when the ratio of the recycle stream in mass units is equal to 8.33?

The reaction is

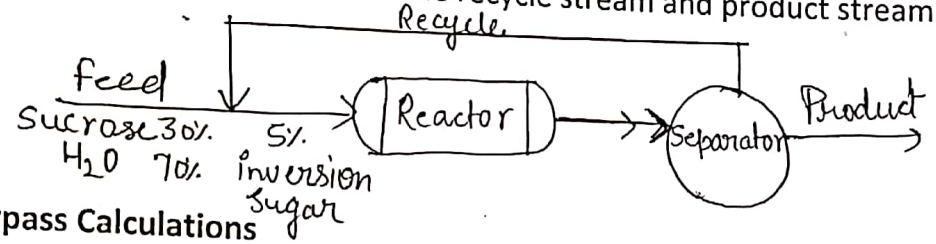


Ex 3.21 Recycle with a Reaction Occurring

Refined sugar (sucrose) can be converted to glucose and fructose by the inversion process

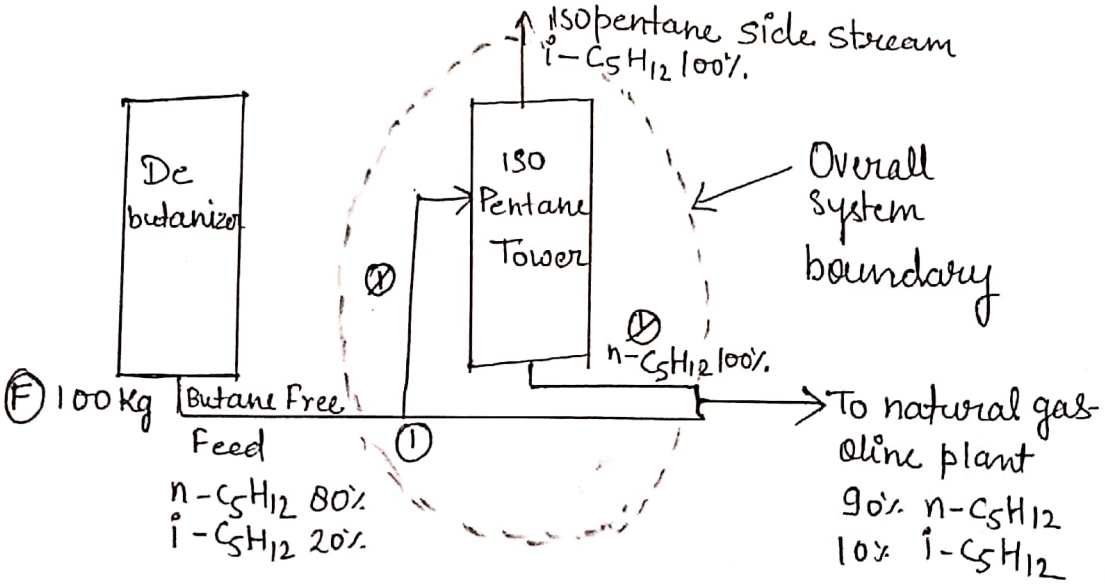
$$C_{12}H_{22}O_{11} + H_2O \longrightarrow C_6H_{12}O_6 + C_6H_{12}O_6$$

The combined quantity glucose plus fructose is called inversion sugar. If 90% conversion of sucrose occurs on one pass though the reactor , what would be the recycle stream flow per 100 lb fresh feed of sucrose solution entering the process shown in figure E3.21a ? what is the concentration of inversion sugar (I) in the recycle stream and in the product stream ? the concentrations of components in the recycle stream and product stream are the same .



Ex3.22 Bypass Calculations

In the feedstock preparation section of a plant manufacturing natural gasoline, isopentane is removed from butane free gasoline. Assume for purposes of simplification that the process and components are as shown in figure E3.22. What fraction of the butane free gasoline is passed through the isopentane tower? Detailed step will not be listed in the analysis and solution of this problem. The process is in the steady state and no reaction occurs.

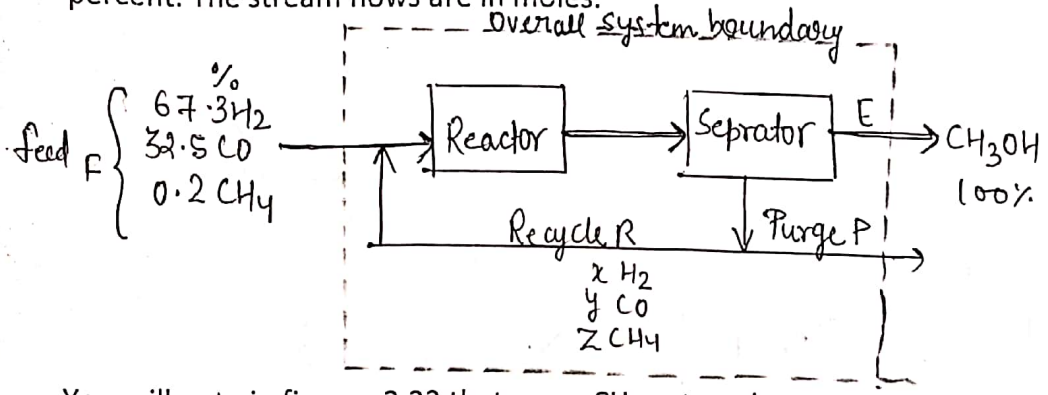


Ex3.23 Purge

Considerable interest exists in the conversion of coal into more convenient liquid products for subsequent production of chemicals. Two of the main gases that can be generated under suitable conditions from insitu coal combustion in the presence of steam (as occurs naturally in the presence of groundwater) are H_2 and CO. After cleanup, these two gases can be combined to yield methanol according to the following equation

$$CO + 2H_2 \longrightarrow CH_3OH$$

Figure E3.23 illustrates a steady- state process. All compositions are in the mole fraction or percent. The stream flows are in moles.



You will note in figure e2.23 that some CH_4 enters the process. but the CH_4 does not participate in the reaction . A purge stream is used to maintain the CH_4 concentration in the exit to the separator at no more than 3.2 mol% . The once through conversion of the CO in the reactor is 18%.

Compute the moles of recycle , CH_3OH , and purge per mole of feed , and also compute the purge gas composition.