School of Industrial Engineering

Politecnico di Milano, Campus Piacenza

Exercises of "Fundamentals of Chemical Processes for Energy and Environment"

Exercise 1

Consider the gas mixture reported below. Given the molar composition of the mixture, compute the mass fraction of each component.

Specie	x [-]
CH_4	0.30
C_3H_6	0.20
CO	0.10
CH_3CH_2OH	0.40

Consider the gas mixture reported below. Given the mass composition of the mixture, compute the molar fraction of each component.

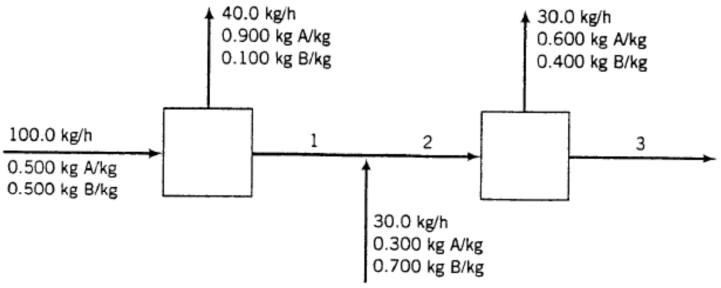
Specie	w [-]
NH_3	0.20
H_2	0.05
H_2S	0.40
N_2O	0.35

Exercise 2

The waste acid from a nitrating process contains 23% HNO_3, 57% H_2SO_4 and 20% H_2O by weight. This waste acid is to be concentrated to contain 27% HNO_3 and 60% H_2SO_4, by the addition of concentrated sulfuric acid containing 97% H_2SO_4 (H_2O to balance) and concentrated nitric acid containing 90% HNO_3 (H_2O to balance). Calculate the weight of waste and concentrated acids that must be combined to obtain 500 kg of the desired mixture.

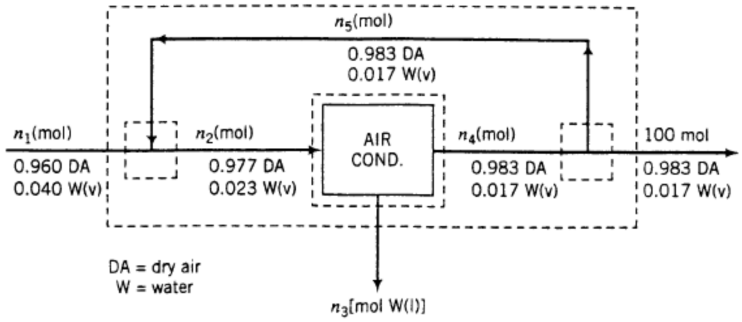
Exercise 3

A labeled flowchart of a continuous, steady-state, two-unit process is shown below. Each stream contains two components, A and B, in different proportions. Three streams whose flow rates and/or compositions are not known are labeled 1, 2 and 3. Calculate the unknown flow rates and compositions of streams 1, 2 and 3.



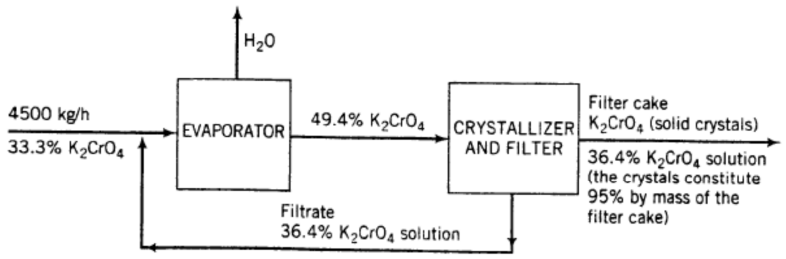
Exercise 4

Fresh air containing 4.00 mole % water vapor is to be cooled and dehumidified to a water content of 1.70 mole % H_2O. A stream of fresh air is combined with a recycle stream of previously dehumidified air and passed through the cooler. The blended stream entering the unit contains 2.30 mole % H_2O. In the air conditioner, some of the water is condensed and removed as liquid. A fraction of the dehumidified air leaving the cooler is recycled and the remainder is delivered to a room. Calculate the moles of fresh feed, moles of water condensed and moles of humidified air recycled.



Exercise 5

The flowchart of a steady state process to recover crystalline potassium chromate (K_2CrO_4) from an aqueous solution of the salt is shown below.



4500 kilograms per hour of a K_2CrO_4 solution that is one third by mass is joined by a recycle stream consisting 36.4% mass K_2CrO_4, and the combined stream is fed into an evaporator. The concentrated stream leaving the evaporator contains 49.4% K_2CrO_4: this stream is fed into a crystallized in which it is cooled (causing crystals od K_2CrO_4 to come out of solution) and then filtered. The filter cake consists of K_2CrO_4 crystals and a solution that contains 36.4% K_2CrO_4 by mass. The crystals account of 95% of the total mass of the filter cake (solid + solution). The solution that passes through the filter, also 36.4% , is the recycled stream.

Calculate the rate of evaporation, the rate of production of crystalline K_2CrO_4, the feed rates that the evaporator and the crystallizer must be designed to handle, and the recycle ratio (mass of recycle)/(mass of fresh feed).