ECHE 260: Additional Problems, Units 1-5

Translating Word Problems into Process Flow Diagrams

For additional practice read the problem statements and do the following:

(1) Fully label the PFD with all known and unknown values
(2) Identify what terms you are asked to calculate and label them according to the variables on your PFD
(3) Translate additional information from the problem statement into equations

Problem 1

Ethanol is produced commercially by the hydration of ethylene:

$$C_2H_4 + H_2O \rightarrow C_2H_5OH$$
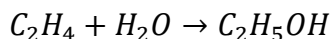
Some of the product is converted to diethyl ether in the side reaction:

$$2C_2H_5OH \rightarrow (C_2H_5)_2OH + H_2O$$
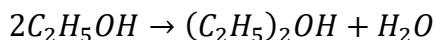
The feed to the reactor contains ethylene, steam and inert gas. A sample of the reactor effluent is analyzed and is found to contain 43.3mol% ethylene, 2.5mol% ethanol, 9.3% inerts, 0.14mol% diethyl ether and the balance water. Calculate the molar composition of the reactor feed, the fractional conversion of ethylene, the fraction yield of ethanol and the selectivity of ethanol production relative to diethyl ether production.

Problem 2

Ammonia is produced through the Haber process in which nitrogen reacts with hydrogen to form ammonia. The fresh feed to an ammonia process contains nitrogen and hydrogen in stoichiometric proportion, along with inert gas (I). The feed is combined with a recycle stream containing the same three species, and the combined stream is fed to a reactor in which a low single-pass conversion of nitrogen is achieved. The reactor effluent flows to a condenser. A liquid stream containing essentially all of the ammonia formed in the reactor and a gas stream containing all the inerts and the unreacted nitrogen and hydrogen leave the condenser. The gas stream is split into two fractions : one is removed from the process as a purge stream and the other stream is recycled to the reactor. *In every stream containing nitrogen and hydrogen, the two species are in stoichiometric proportion.*

Calculate the total moles fed to the reactor, moles of ammonia produced and overall nitrogen conversion.