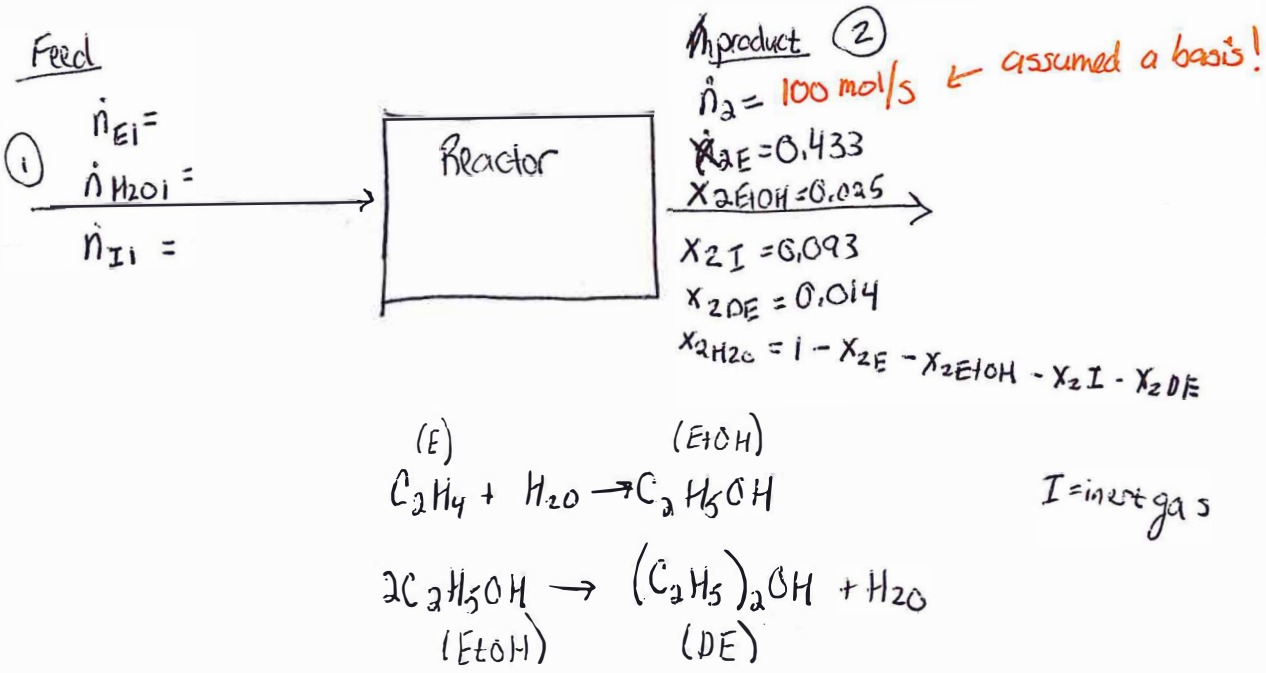
Solutions

Solutions for Unit 1-5 practice problems

Problem 1



(E) (EtOH)

$C_2H_4 + H_2O \rightarrow C_2H_5OH$ I = inert gas

(EtOH) (DE)

$2C_2H_5OH \rightarrow (C_2H_5)_2OH + H_2O$

We want to calculate

Mol fractions or total molar composition of feed. ($\dot{n}_{E1}$ $\dot{n}_{H2O1}$ $\dot{n}_{I1}$)

fractional Conversion of ethylene = $f_E = \frac{\text{moles E reacted}}{\text{moles E fed}} = \frac{\dot{n}_{E1} - \dot{n}_2 X_{2E}}{\dot{n}_{E1}}$

Selectivity to EtOH over diethyl ether $\alpha_{EtOH/DE} = \frac{\text{desired}}{\text{und.}} = \frac{\dot{n}_2 X_{2EtOH}}{\dot{n}_2 X_{2DE}}$

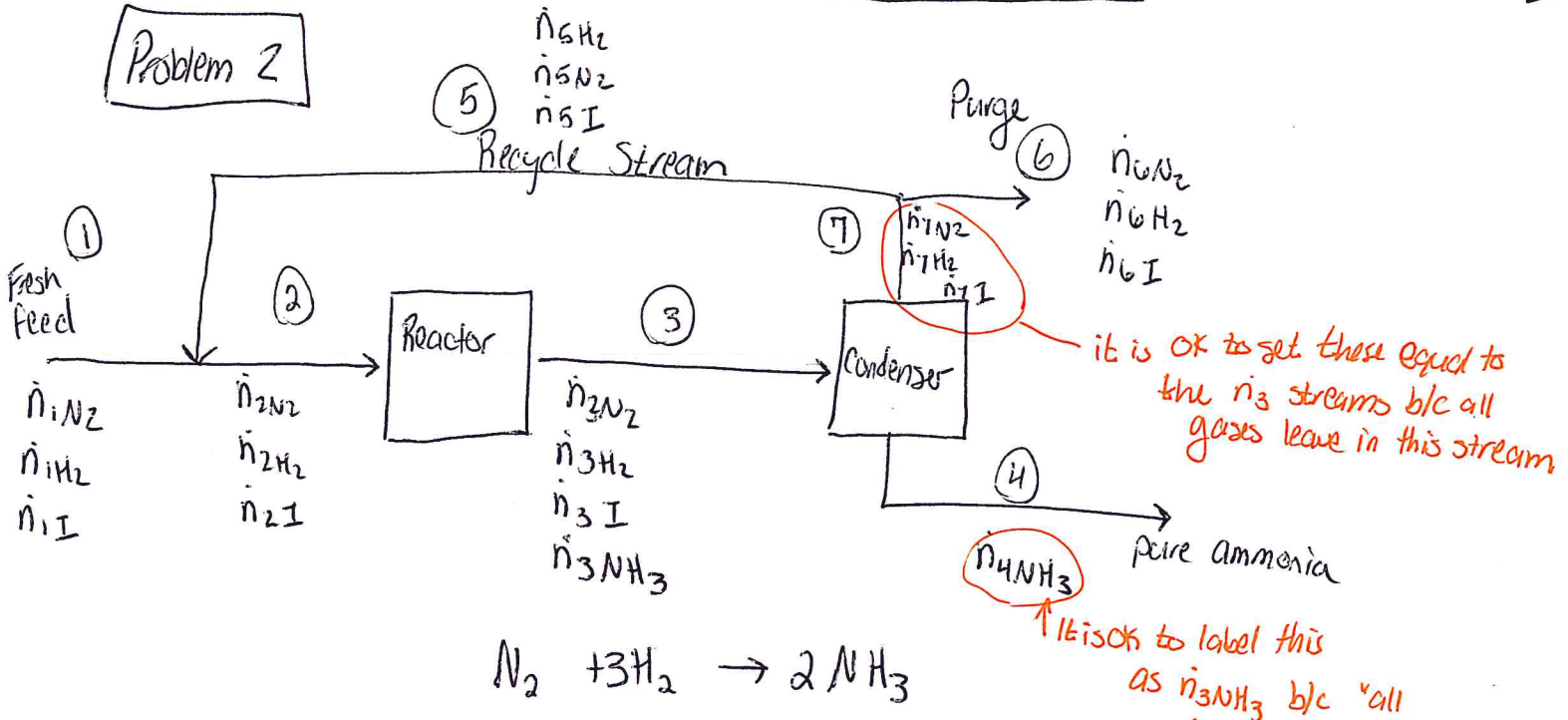
To fully solve the problem we need ($\dot{n}_{E1}$ $\dot{n}_{H2O1}$ $\dot{n}_{I1}$ $\dot{n}_2$ ~~X_{1E}~~ ~~X_{1DE}~~ X_{2E} X_{2DE} X_{2EtOH})

($\dot{n}_{E1}$ $\dot{n}_{H2O1}$ $\dot{n}_{I1}$: unknown; X_{2E} X_{2DE} X_{2EtOH}: given)

We are not given any additional info in problem statement, but we should assume a basis!

$\dot{n}_2 = 100$ mol/s Now we have one less value to calculate to solve the problem!

Problem 2



it is OK to set these equal to the $\dot{n}_3$ streams b/c all gases leave in this stream

It is ok to label this as $\dot{n}_{3NH_3}$ b/c "all ammonia is condensed"

$$N_2 + 3H_2 \rightarrow 2NH_3$$

We want to calculate

Total moles fed to reactor ($\dot{n}_{1N_2}$ $\dot{n}_{1H_2}$)

Total moles of ammonia produced ($\dot{n}_{4NH_3}$)

Overall nitrogen conversion, $f_{N_2} = \frac{\text{moles } N_2 \text{ reacted}}{\text{moles } N_2 \text{ fed}} = \frac{\dot{n}_{1N_2} - \dot{n}_{6N_2}}{\dot{n}_{1N_2}}$

To fully solve we need ($\dot{n}_{1N_2}$ $\dot{n}_{1H_2}$ $\dot{n}_{4NH_3}$ $\dot{n}_{6N_2}$)

Additional information

~~Assume~~. ~~But~~ We should assume a basis because we are only given stoichiometric info. Also, N_2 and H_2 always being in stoichiometric proportion is important.

Basis: 100 mol/s = $\dot{n}_{3N_2} + \dot{n}_{3H_2} + \dot{n}_{3I} + \dot{n}_{3NH_3}$

You could also include this in the PFD labeling

We usually have a lot of info about the reactor, so its a good place to start. We can write all of our 3 reaction equations.

Stoich. proportion in all streams:

$\frac{\dot{n}_{1N_2}}{\dot{n}_{1H_2}} = \frac{1}{3}$; $\frac{\dot{n}_{2N_2}}{\dot{n}_{2H_2}} = \frac{1}{3}$; $\frac{\dot{n}_{3N_2}}{\dot{n}_{3H_2}} = \frac{1}{3}$; $\frac{\dot{n}_{7N_2}}{\dot{n}_{7H_2}} = \frac{1}{3}$; $\frac{\dot{n}_{6N_2}}{\dot{n}_{6H_2}} = \frac{1}{3}$; $\frac{\dot{n}_{5N_2}}{\dot{n}_{5H_2}} = \frac{1}{3}$