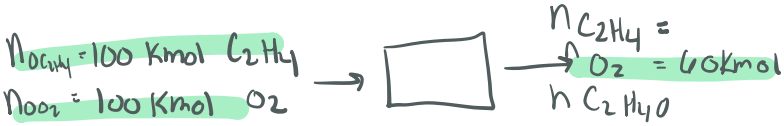
Conceptual Questions

1. Fractional Conversion

$$2\,C_2H_4 + O_2 \rightarrow 2\,C_2H_4O$$



b. $f_{O_2} < f_{C_2H_4}$

$$f_{O_2} = \frac{n_{0,O_2} - n_{O_2}}{n_{O_2}} = \frac{100-60}{100} = 0.40$$

$$f_{C_2H_4} = \frac{n_{0,C_2H_4} - n_{C_2H_4}}{n_{0,C_2H_4}} = \frac{100-20}{100} = 0.80$$

O_2 : $n_{O_2} = n_{0,O_2} - \xi$

C_2H_4 : $n_{C_2H_4} = n_{0,C_2H_4} - 2\xi$

C_2H_4O : $n_{C_2H_4O} = 2\xi$

1. Calc. $\xi = 40$ from O_2 balance
2. calc $n_{C_2H_4}$ from C_2H_4 balance which is $100 - 2(40) = 20$

2. Mol conservation

b. NO

moles are not a conserved quantity! especially problematic for chemical rxns

3. Material balances

c. 3

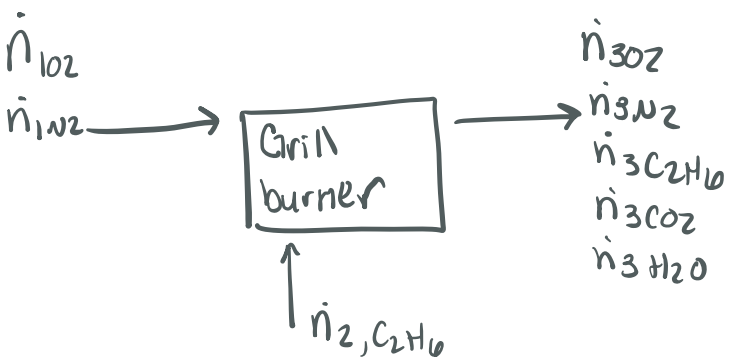
4. **d. NO and NO**

We never write material balances using volumes because they can change with T, P (think about ideal gases)

5. Propane

A) $C_2H_6 + \frac{7}{2}O_2 \rightarrow 2CO_2 + 3H_2O$

B)



Want to know: $\dot{n}_{3CO_2}$

add. equations: $f_{C_2H_6} = \frac{\dot{n}_{2\,C_2H_6} - \dot{n}_{3\,C_2H_6}}{\dot{n}_{2C_2H_6}} = 0.90$ (*)

(**) $P\dot{V} = nRT$ so $P_{C_2H_6}\dot{V}_{C_2H_6} = \dot{n}_{2C_2H_6} R \cdot T_{outside}$

Where $P_{C_2H_6} = 103$ mmHg

$\dot{V}_{C_2H_6} = 14$ L/min

$T_{outside} = 22°C$

Composition of air:

$$\frac{\dot{n}_{1O2}}{\dot{n}_{1N2} + \dot{n}_{1O2}} = 0.20$$

c) DOF

8 unknowns ($\dot{n}_{1O_2}$ $\dot{n}_{1N_2}$ $\dot{n}_{3O_2}$ $\dot{n}_{3N_2}$ $\dot{n}_{3C_2H_6}$ $\dot{n}_{3CO_2}$ $\dot{n}_{3H_2O}$ $\dot{n}_{2,C_2H_6}$)

- 5 material balances (b/c 5 species)
+ 1 chemical rxn (ξ)
- 3 additional equation (** cmd air composition)

1 DOF - cannot solve ☹

D) Material balances

$C_2H_6 + \frac{7}{2}O_2 \rightarrow 2CO_2 + 3H_2O$

O_2: $\dot{n}_{3O_2} = \dot{n}_{1O_2} - \frac{7}{2}\xi$

N_2: $\dot{n}_{3N_2} = \dot{n}_{1N_2}$

C_2H_6: $\dot{n}_{3C_2H_6} = n_{2C_2H_6} - \xi$

CO_2: $\dot{n}_{3CO_2} = 2\xi$

H_2O: $\dot{n}_{3H_2O} = 3\xi$