Procedure for Single Unit Material Balances

1. Choose a basis for the Calculation
   Mass, Mole, Mass/time, Mole/time
   Start with what you are given to minimize conversions!
2. Draw a flow Chart and fill in all the known values on the chart!
   Label all unknown streams
   use $n_i$ for molar flow and $m_i$ for mass flow
   $y_i$, $x_i$ for mole and mass fractions of streams.
   Use dots above for rates.
   Fill in what you know or can easily calculate.
   Do you know all but one of the mass(mole) fractions?
   Are relationships specified (e.g., air, multiplying factors)..<br>
   $n_i/n_j = \alpha$ or $m_i/m_j = \beta$ or meaning one real variable.
   Use Mass and Mole, convert volumes to these.
3. Convert all to a consistent basis (mass or moles).
4. Express the problem requested answers in terms of the labeled variables.

5. Do the degree of freedom analysis!
6. If the number of unknowns equals the equations relating them, write down in an efficient order and circle the variables for which you will solve.
   Start from lowest number of unknown variables, then higher….
7. Solve the Equations
8. Calculate the quantities requested in the problem (4) if not already calculated.
9. Scale the answer to that basis for the problem compared to that in the solution.
   multiply by $n_r/n_s$. 

Degree of Freedom Analyses

\[ \text{n degrees of freedom} = \text{n unknowns} - \text{n independent equations} \]

\[ \text{n degrees of freedom} < 0 \]
overspecified

\[ \text{n degrees of freedom} = 0 \]
solvable

\[ \text{n degrees of freedom} > 0 \]
underspecified

solvable as a function of \( n_{\text{dof}} \) Variables

Material Balance in General:

accumulation = input + generation - output - consumption

Material Balances for each species + overall mass balances. This can introduce some redundancy. Use to check the answer!

Recall that N-1 mole or mass fractions are needed !!!

How to handle Batch Processes?

number of degrees of freedom?

What happens if reaction occurs?

What is a species?

How to express (yield, conversion, selectivity, stoichiometry, inerts, ..)