Reactant & Product Mixtures

- **Stoichiometry** – Mixture of oxidizer & fuel that contains *just enough* oxidizer for complete combustion of the fuel
- **Lean** – excess of air (more air than needed by fuel)
- **Rich** – excess of fuel (less air than needed by fuel)

Stoichiometric relation

- For hydrocarbon (C_xH_y) in air (21% O_2, 79% N_2)

$$C_x H_y + a(O_2 + 3.76\, N_2) \rightarrow xCO_2 + \frac{y}{2} H_2O + 3.76\, a\, N_2$$

$$a = x + \frac{y}{4}$$

Air-Fuel Ratio

- Stoichiometric A/F ratio

$$\left(\frac{A}{F}\right)_{stoic} = \left(\frac{m_{air}}{m_{fuel}}\right)_{stoic} = \frac{4.76a}{1}\frac{M_{air}}{M_{fuel}}$$

- Equivalence Ratio Φ

$$\Phi = \frac{(A/F)_{stoic}}{(A/F)} = \frac{(F/A)}{(F/A)_{stoic}}$$

$\Phi = 1 \quad stoichiometric$

$\Phi < 1 \quad lean$

$\Phi < 1 \quad rich$

Air-Fuel Ratio

- Relative air-fuel ratio λ

$$\lambda = \phi^{-1}$$

$$\lambda = 1 \quad stoichiometric$$
$$\lambda < 1 \quad rich$$
$$\lambda > 1 \quad lean$$

- Percent stoichiometric air

$$x\,\% = \frac{100\,\%}{\phi}$$

- Percent excess air

$$x\,\%\, excess\, air = \frac{(1-\phi)}{\phi}\,100\,\%$$