Formula Sheet – Thermodynamics II

$$\left(\frac{T_2}{T_1}\right)=\left(\frac{V_1}{V_2}\right)^{K-1};\left(\frac{T_2}{T_1}\right)=\left(\frac{P_2}{P_1}\right)^{\frac{K-1}{K}};\left(\frac{P_2}{P_1}\right)=\left(\frac{V_1}{V_2}\right)^{K}$$; where K= $\frac{C_P}{C_V}$; $\eta_P=\frac{W_s}{W_a};\eta_T=\frac{W_a}{W_s}$;

Mole number: $N_i=\frac{m_i}{M_i}$; Mole fraction: $y_i=\frac{N_i}{N_m}$; Average molar mass $M_m=\frac{m_m}{N_m}=\sum y_i M_i$; gas constant:

$$R_m=\frac{R_u}{M_m}\left[R_u=8.314KJ/(Kmol.K)\right];\ PV=ZNR_uT\ ;(Z_m=\sum y_i Z_i);\ \frac{P_i}{P_m}=\frac{V_i}{V_m}=\frac{N_i}{N_m}=y_i;$$

Dalton's law: $P_m=\sum P_i(T_m.V_m)$; Amagat's law: $V_m=\sum V_i(T_m.P_m)$;

$U_m=\sum mf_i U_i$, $U_m=\sum y_i\ U_i$ (same for h and s); $C_{v,m}=\sum mf_i C_{v,i}$; $\overline{C}_{v,m}=\sum y_i\overline{C}_{v,i}$, same for C_{pm}

Real gasses: $\Delta h=(h_2-h_1)_{ideal}-R_uT_{cr}(Z_{h2}-Z_{h1})$; $\Delta u=(h_2-h_1)-R_u(Z_2T_2-Z_1T_1)$;

$$\Delta s=(s_2-s_1)_{ideal}-R(Z_{s_2}-Z_{s_1});$$

Air conditioning energy balance: $\dot{Q}_{in}+\dot{W}_{in}+\sum\dot{m}_i h_i=\dot{Q}_{out}+\dot{W}_{out}+\sum\dot{m}_e h_e$, $\dot{m}_\omega=\dot{m}_a\Delta\omega$

Air fuel ratio: $AF=\frac{\dot{m}_{air}}{\dot{m}_{fuel}}$; m=NM ; $\frac{P_{v_i}}{P_{total}}=\frac{N_i}{N_{total}}$; Percentage of theoretical air: $\frac{\dot{m}_{air,act}}{\dot{m}_{air,th}}$ or $\frac{\dot{N}_{air,act}}{\dot{N}_{air,th}}$

Enthalpy of combustion : $hc=H_{prod}-H_{react}$; $HHV=LHV+(mh_{fg})_{H_2O}$;

First law analysis of reacting systems:

Open system:

$$Q_{in}+W_{in}+\underbrace{\sum N_r\left(\bar{h}_f^0+\left(\bar{h}-\bar{h}^0\right)\right)_r}_{H_r}=Q_{out}+W_{out}+\underbrace{\sum N_p\left(\bar{h}_f^0+\left(\bar{h}-\bar{h}^0\right)\right)_p}_{H_p}$$

Closed system and constant volume

$$Q_{in}+W_{in}+\underbrace{\sum N_r\left(\bar{h}_f^0+\left(\bar{h}-\bar{h}^0-P\bar{v}\right)\right)_r}_{H_r}=Q_{out}+W_{out}+\underbrace{\sum N_p\left(\bar{h}_f^0+\left(\bar{h}-\bar{h}^0-P\bar{v}\right)\right)_p}_{H_p}$$

with $P\bar{v}=R_uT$