Ecuaciones: Entropía - Exergía

Entropía

$$\Delta S = \int \frac{\delta Q_R}{T}$$

Gases ideales:

$$s_2 - s_1 = c_v \ln\frac{T_2}{T_1} + R\ln\frac{v_2}{v_1} \quad ; \quad s_2 - s_1 = c_P \ln\frac{T_2}{T_1} - R\ln\frac{P_2}{P_1} \quad ; \quad s_2 - s_1 = c_v \ln\frac{P_2}{P_1} + c_P \ln\frac{v_2}{v_1}$$

$$\left(\frac{T_2}{T_1}\right) = \left(\frac{v_1}{v_2}\right)^{k-1} \quad ; \quad \left(\frac{T_2}{T_1}\right) = \left(\frac{P_2}{P_1}\right)^{\frac{k-1}{k}} \quad ; \quad \frac{P_2}{P_1} = \left(\frac{v_1}{v_2}\right)^k$$

Sistemas incompresibles: $s_2 - s_1 = c\ln\frac{T_2}{T_1}$

Balances de Entropía

Estado estacionario

SC: $s_2 - s_1 = \sum \frac{Q_i}{T_{f_i}} + \sigma$

$$\frac{dS}{dt} = \sum \frac{\dot{Q}_i}{T_{f_i}} + \dot{\sigma} \qquad \rightarrow \qquad \dot{\sigma} = -\sum \frac{Q_i}{T_{f_i}}$$

SA:

$$\frac{dS_{VC}}{dt} = \sum \dot{m}_e s_e - \sum \dot{m}_s s_s + \sum \frac{\dot{Q}_i}{T_{f_i}} + \dot{\sigma}_{VC} \qquad \rightarrow \qquad \dot{\sigma}_{vc} = \sum \dot{m}_s s_s - \sum \dot{m}_e s_e - \sum \frac{\dot{Q}_i}{T_{f_i}}$$

Exergía

$$ex = (u - u_0) - T_0 (s - s_0) + P_0(v - v_0) + C^2/2 + gz$$

$$b = (h - h_0) - T_0(s - s_0) + \frac{C^2}{2} + gz$$

Balances de Exergía

SC:

$$\Delta Ex = Ex_Q - Ex_w - I$$

$$\Delta Ex = \int_1^2 \left(1 - T_0/T_f\right)\delta Q - \left(W - P_0\Delta V\right) - T_0\sigma \qquad I = T_0\sigma$$

Estado estacionario

$$\frac{dEx}{dt} = \left(1 - T_0/T_f\right)\dot{Q} - \left(\dot{W} - P_0\frac{dV}{dt}\right) - \dot{I} \quad \rightarrow \qquad \dot{I} = \left(1 - T_0/T_f\right)\dot{Q} - \dot{W}$$

SA :

$$\dot{I} = \left(1 - \frac{T_0}{T_f}\right)\dot{Q} - \dot{W}_{vc} + \sum \dot{m}_e b_e - \sum \dot{m}_s b_s$$