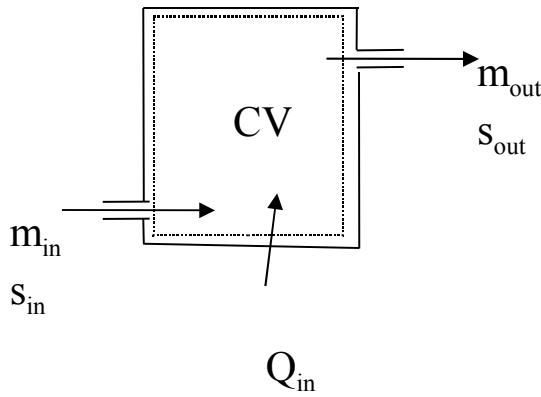


Entropy Generation for Open Systems

Apart from heat, **mass flows** also carry entropy along with them



$$\Delta S_{CV} = \sum_{j=1} \frac{Q_j}{T_j} + \sum S_{in} - \sum S_{out} + S_{gen}$$

$$\Delta S_{CV} = \sum_{j=1} \frac{Q_j}{T_j} + \sum m s_{in} - \sum m s_{out} + S_{gen}$$

$$\frac{dS_{CV}}{dt} = \sum_{j=1} \frac{\dot{Q}_j}{T_j} + \sum \dot{m} s_{in} - \sum \dot{m} s_{out} + \dot{S}_{gen}$$

Rate of
change of
system
entropy

Rate of entropy
transfer

Rate of
entropy
generation

Steady Flow Process

$$\frac{dm_{CV}}{dt} = 0 \rightarrow \boxed{\sum \dot{m}_{in} = \sum \dot{m}_{out}}$$

$$\frac{dS_{CV}}{dt} = 0$$

$$\cancel{\frac{dS_{CV}}{dt}} = \sum_{j=1} \frac{\dot{Q}_j}{T_j} + \sum \dot{m}_i s_i - \sum \dot{m}_o s_o + \dot{S}_{gen}$$

$$\boxed{0 = \sum_{j=1} \frac{\dot{Q}_j}{T_j} + \sum \dot{m}_i s_i - \sum \dot{m}_o s_o + \dot{S}_{gen}}$$

single inlet/outlet;

$$0 = \sum_{j=1} \frac{\dot{Q}_j}{T_j} + \dot{m}(s_i - s_o) + \dot{S}_{gen}$$

$$s_o - s_i = \sum_{j=1} \frac{\cancel{\dot{Q}_j} / \dot{m}}{T_j} + \frac{\dot{S}_{gen}}{\dot{m}}$$

Reversible adiabatic process = isentropic process

Isentropic is not necessarily reversible adiabatic

Reversible process $\rightarrow S_{gen} = 0$

— Produces W_{max}

— Consumes W_{min}