Implication of Criterion 1
(**Energy**)

$$\Delta E_{CV} = 0,$$

From Energy Conservation;

$$\frac{dE_{CV}}{dt} = \dot{Q} - \dot{W} + \sum_{in} \dot{m}(h + ke + pe) - \sum_{out} \dot{m}(h + ke + pe)$$

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

Rearrange to get Steady Flow Energy Equation

(SSSF)

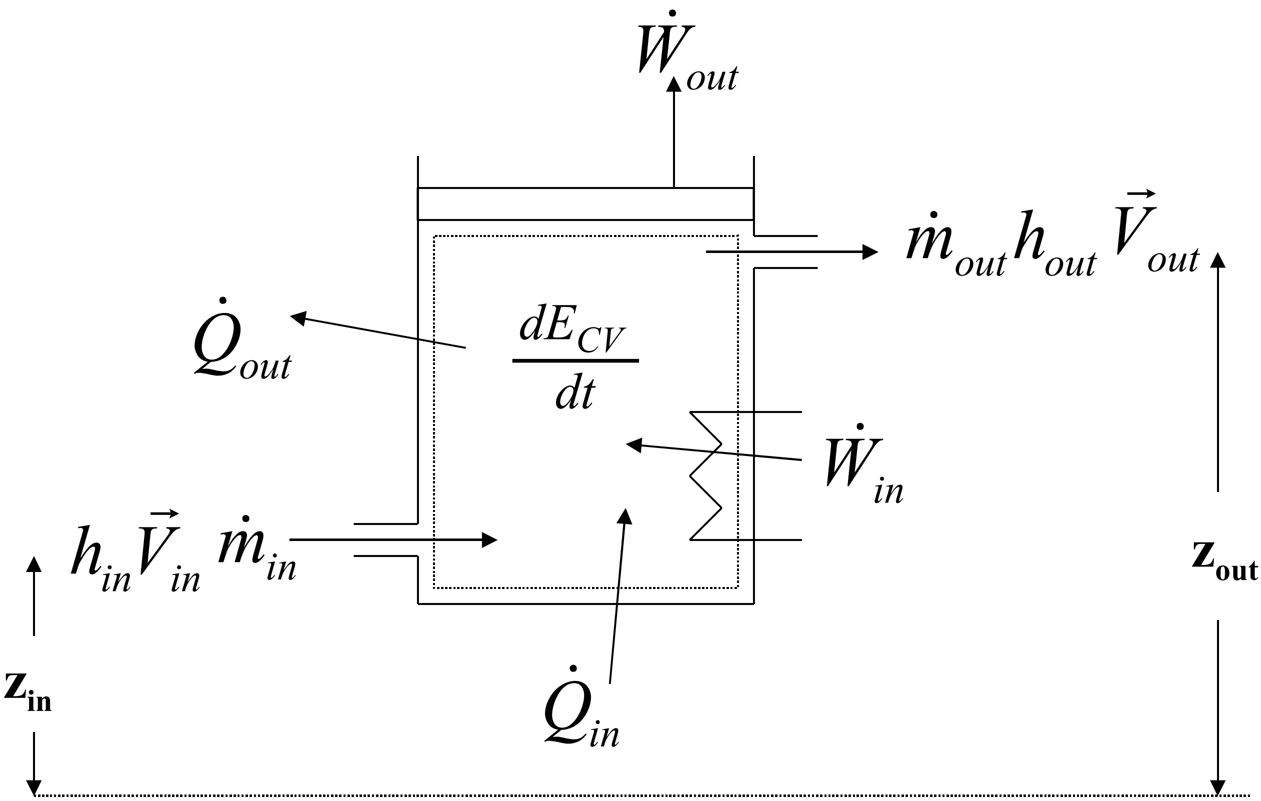
$$\dot{Q} - \dot{W} = \sum_{out} \dot{m}(h + ke + pe) - \sum_{in} \dot{m}(h + ke + pe)$$

SSSF

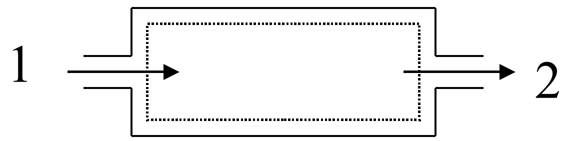
$$\dot{Q} - \dot{W} = \sum_{out} \underbrace{\dot{m}\left(h + \frac{\vec{V}^2}{2} + gz\right)}_{\text{For each exit channel}} - \sum_{in} \underbrace{\dot{m}\left(h + \frac{\vec{V}^2}{2} + gz\right)}_{\text{For each inlet channel}}$$

For each **exit** channel

For each **inlet** channel



SSSF energy equation for 1 inlet / 1 exit



Mass

$$\dot{m}_{in} = \dot{m}_{out} \qquad \text{or} \qquad \dot{m}_1 = \dot{m}_2$$

Energy

$$\dot{Q} - \dot{W} = \dot{m}_2\left(h_2 + \frac{\vec{V}_2^{\,2}}{2} + gz_2\right) - \dot{m}_1\left(h_1 + \frac{\vec{V}_1^{\,2}}{2} + gz_1\right)$$

$$\dot{m}_1 = \dot{m}_2 = \dot{m}$$

$$\dot{Q} - \dot{W} = \dot{m}\left[(h_2 - h_1) + \left(\frac{\vec{V}_2^{\,2} - \vec{V}_1^{\,2}}{2}\right) + g(z_2 - z_1)\right]$$

$$\frac{\dot{Q}}{\dot{m}} - \frac{\dot{W}}{\dot{m}} = (h_2 - h_1) + \left(\frac{\vec{V}_2^{\,2} - \vec{V}_1^{\,2}}{2}\right) + g(z_2 - z_1)$$

$$q - w = \Delta h + \Delta ke + \Delta pe$$

(1 inlet / 1 exit)

(Δ = exit – inlet)

<u>SSSF energy equation for multiple channels but neglecting Δke, Δpe</u>

$$\dot{Q} - \dot{W} = \sum \dot{m}_{out} h_{out} - \sum \dot{m}_{in} h_{in}$$

$$\sum \dot{m}_{in} = \sum \dot{m}_{out}$$