

$$t_1 := \text{time}(0)$$

$$\mu\text{rad} \equiv 10^{-6} \cdot \text{rad}$$

$$\text{mrad} \equiv 10^{-3} \cdot \text{rad}$$

$$\mu\text{m} \equiv 10^{-6} \text{ m}$$

$$\text{nm} := 10^{-9} \text{ m}$$

$$\text{ms} \equiv 10^{-3} \cdot \text{s}$$

$$\mu\text{s} \equiv 10^{-6} \text{ s}$$

$$\text{ns} \equiv 10^{-9} \cdot \text{s}$$

$$\text{kt} \equiv 1852 \frac{\text{m}}{\text{hr}}$$

$$\text{nmi} := 1852 \cdot \text{m}$$

$$^{\circ}\text{C} \equiv \text{K}$$

$$c \equiv 2.99792458 \cdot 10^8 \frac{\text{m}}{\text{s}}$$

$$h \equiv 6.62606876 \cdot 10^{-34} \text{ J} \cdot \text{s}$$

$$r_e \equiv 6378140 \cdot \text{m}$$

$$\sigma \equiv 5.670400 \cdot 10^{-8} \cdot \frac{\text{watt}}{\text{m}^2 \cdot \text{K}^4}$$

$$\text{mJ} \equiv 10^{-3} \text{ J}$$

$$\text{MW} \equiv 10^6 \text{ W}$$

$$\text{nW} \equiv 10^{-9} \text{ W}$$

$$\mu\text{W} \equiv 10^{-6} \text{ W}$$

$$\text{mW} \equiv 10^{-3} \text{ W}$$

$$\text{time}(0) - t_1 = 0.1050$$

$$\text{flow} := 5 \frac{\text{L}}{\text{min}}$$

$$\text{len} := 12\text{ft}$$

$$\text{ID} := \frac{3}{16} \cdot \text{in}$$

$$\text{OD} := \frac{1}{4} \text{ in}$$

$$\text{area} := \left( \frac{\text{ID}}{2} \right)^2 \pi$$

$$\text{area} = 1.7814 \times 10^{-5} \text{ m}^2$$

$$\text{vel} := \frac{\text{flow}}{\text{area}}$$

$$\text{vel} = 4.6780 \frac{\text{m}}{\text{s}}$$

$$\frac{\text{len}}{\text{vel}} = 0.7819 \text{ s}$$

$$\text{surf} := \text{len} \cdot \text{OD} \cdot \pi$$

$$\text{surf} = 0.0730 \text{ m}^2$$

$$7 \frac{\text{W}}{\text{m}^2 \cdot \text{K}} \cdot \frac{\text{surf}}{12} \cdot 770\text{K} = 32.7738 \text{ W}$$

RT Convective transfer, so should be higher

$$\frac{\text{surf}}{12} \cdot .4 \cdot \sigma \cdot \left[ (1083\text{K})^4 - (303\text{K})^4 \right] = 188.5632 \text{ W}$$

Radiative swag

$$\sigma_h := 14310 \cdot \frac{\text{J}}{\text{kg} \cdot \text{K}}$$

$$\text{dens} := 0.07 \cdot 1.22 \frac{\text{kg}}{\text{m}^3} \cdot \frac{303}{1073}$$

RT values, mostly

$$\sigma_h \cdot \text{dens} \cdot \text{flow} \cdot 770\text{K} = 22.1437 \text{ W}$$

Swag thermal mass flow