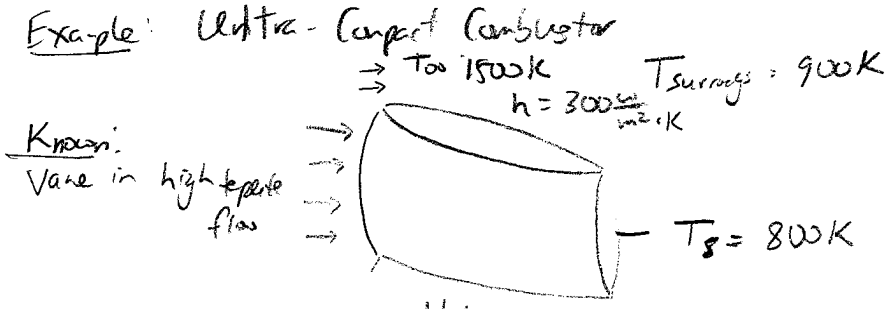
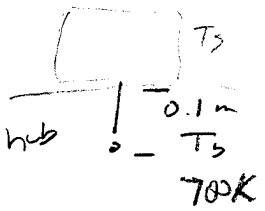
Lecture 1

Example: Ultra-Compact Combustor



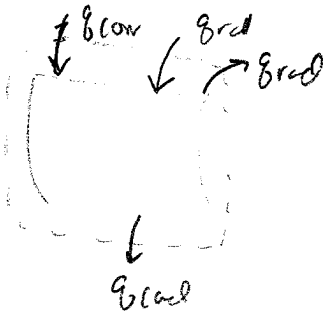
Known: Vane in high temperature flow



Find: A) How much heat is radiated from the vane

B) What is the thermal conductivity through the hub

Schematic:



$$E_{in} + E_{out} + E_{gen} = E_{st}$$

(A_b) Area of the base $0.1 m^2$

(A_s) Surface area $= 0.5 m^2$

Assumption: 1) Assume isothermal
2) Steady state
3) Assume gray

Properties: $\alpha = 0.2$

Solution: A) $E_{in} + E_{out} + E_g = E_{st}^{0}$

$$E_{in} = E_{out}$$

$$q_{convect} + q_{rad,surroundings} = q_{rad,vane} + q_{cond}$$

$$q_{cond} = q_{conv} + q_{rad} - q_{rad,vane}$$

$$q_{cond} = h(A_s)(T_{\infty} - T_s) + A_s \epsilon \sigma (T_{sur}^4 - T_s^4)$$

$$q_{cond} = (0.5)300(1500 - 800) + 0.2(5.67 \times 10^{-8})(900^4 - 800^4)$$

B)

$$q_{cond} = (A_b)(-k)\frac{dT}{dx} = -k\frac{\Delta T}{L}$$

$$-k = \frac{q_{cond} \cdot L}{\Delta T}$$

$$q_{cond} = (0.1)\ -k\frac{(700 - 800)}{0.1}$$