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熱力學

1. Prove 1st TdS eqn. TdS = dU+PdV and 2nd TdS eqn. TdS = dH + VdP (10%)

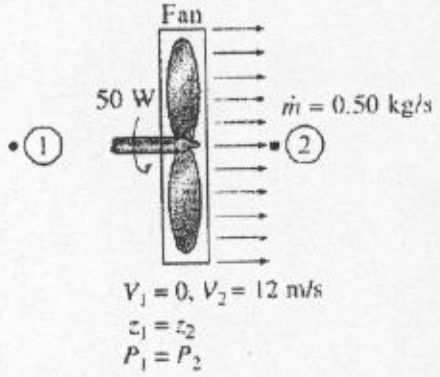
2. For a closed system, prove its exergy (X) equals to

$$X = Wc = (U - U_o) + p_o(V - V_o) - T_o(S - S_o) + KE + PE \quad (10\%)$$

Where **U,V, S KE** and **PE** denote internal energy, volume, entropy, kinetic energy, and potential energy of the system at a specified state. U_0,V_0 and S_0 denote internal energy, volume, and entropy of the system at the dead state.

3. During the isothermal heat rejection process of a Carnot cycle, the working fluid experiences an entropy change （ΔS） of -0.8 kJ/K. If the heat sink is 95℃, determine (a) the amount of heat transfer, (b) entropy change of the sink, (c) the total entropy change for this process. (15%，@5%)

4. Determine the mechanical efficiency of a fan ($\eta_{mech,\,fan}$) shown below. (15%)



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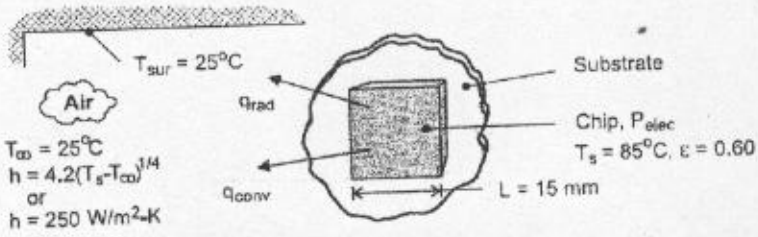
5. (15%) (a). Please describe the physical mechanisms of conduction, convection and radiation, **and write their rate equations.** (10%)
(b). What is the difference between natural convection and force convection ? (5%)

6. (20%) Chips of which L=15mm on a side are mounted to a substrate that is installed in an enclosure whose walls and air are maintained at a temperature of T_{sur}=T∞ =25C. The chip have an emissivity of ε =0.60 and a maximum allowable temperature of T_S= 85C.
(a). If heat is rejected from the chips by radiation an natural convection, what is the maximum operating power of each chip? The convection coefficient depends on the chip-to-air temperature difference and may be approximated as h= C (T_S-T_∞) where C=4.2 W/m^{2}K$^{5/4}$. (10%)
(b) If a fan is used to maintain air flow through the enclosure and heat transfer is by forced convection, with h=250W/m^{2}K, what is the maximum operating power? (10%)



7. (15 %) A thin walled copper tubes of radius r_i is used to transport a low temperature refrigerant and is at a temperature T_i that is less than that of the ambient air at T_∞ around the tube. Is there an optimum thickness associated with application of insulation to the tube. Please construct the thermal circuit of heat flow resistance. And prove the optimal insulation radius is r_{cr}= k/h.

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