國立臺灣大學99學年度碩士班招生考試試題

1. A refrigerant at 0°C and 10% quality enters the evaporator of a refrigerating system and leaves at 10 °C. The pressure drop of the refrigerant in the evaporator is negligible. Schematically draw a temperature-entropy (T-s) diagram for the process and calculate the energy absorbed by a kilogram of the refrigerant. Assume constant specific heats of C_p=0.571 kJ/kg・K and C_v=0.551 kJ/kg・K. The properties of the refrigerant at 0 °C are u_f=51.63 kJ/kg, u_g=230.16 kJ/kg, h_f=51.86 kJ/kg and h_g=250.45 kJ/kg. (20%)
2. A quantity of air, 0.1m^3, is compressed from 1 atm to 10 atm by a reciprocating compressor. The compression is adiabatic and reversible. Assume the air is an ideal gas with C_p=1.005 kJ/kg・K and R=0.287 kJ/kg・K, calculate the final volume of the air. (15%)
3. A saturated liquid-vapor mixture of water at 100 °C is contained in a piston-cylinder device. During a constant-pressure process, 500 kJ of heat is transfer to the surrounding air at 30 °C. Assume the dead state is 25 °C and 1atm, determine the entropy generation and exergy destruction (or availability destruction) induced by the process. (15%)
4. The heat transfer coefficient $\bar{h}$, resulting from a forced flow over a flat plate depends on the fluid velocity V, viscosity μ, density ρ, specific heat c_P, and thermal conductivity k, as well as the length of the plate L. Develop the dimensionless functional equation for the heat transfer coefficient. (10%)
5. Please answer the following questions: (15%)
   (a) What is the *effectiveness* of a heat exchanger? What is the *number of transfer units*?
   (b) What is the *mixed convection*? How can one determine if the mixed convection effects should be considered in a heat transfer analysis?
   (c) What is boiling? What mechanisms are responsible for the very high heat transfer coefficients in nucleate boiling?
6. A thermocouple junction, which may be approximated as a sphere, is to be used for temperature measurement in a gas stream. The convection coefficient between the junction surface and the gas is h=210 W/m^2・K, and the junction thermal physical properties are k=35 W/m・K, c=320 J/kg・K, and ρ=8500 kg/m^3. Determine the junction diameter needed for the thermocouple to have a time constant of 1 s. If the junction is at 20°C and is placed in a gas stream that is at 100°C, how long will it take for the junction to reach 99 °C? (25%)

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