國立臺灣大學 104 學年度碩士班招生考試試題

1. When a sample of liquid is converted to vapor at its boiling point, whether each of the thermodynamics quantities ΔG, ΔH, and ΔS of the system increase, decrease or do not change. Explain your answers briefly. (6%)

2. Consider the reaction of methane gas and O_2 gas at room temperature in a closed container and state whether each of the thermodynamics quantities q, w, ΔU, and ΔH is greater than, equal to, or less than zero. Explain your answers briefly. (8%)

3. The reversible work inputs to a compressor from T_1, P_1 to T_2, P_2 can be done via an isentropic, polytropic or isothermal ($T_1 = T_2$) process. Please list the work input from maximum to minimum and draw the P-v diagram for each process schematically. (6%)

4. An average male (1.8-m^2 body surface area) with basal metabolic rate of 84 W is at rest in a room at temperature 20 °C. Assume his skin temperature is 34°C, the convection heat transfer coefficient is $6\ W/m^2 \cdot °C$, the emissivity of the human skin is 0.97 and the heat of vaporization at the normal skin temperature is 580 calories/g. The average amount of perspiration is assumed to be 600 grams per day. Estimate how much heat is dissipated through radiation, convection and perspiration, respectively and determine how many calories will be consumed for a day? (1 cal=4.186 J, Boltzmann's constant $\sigma = 5.67 \times 10^{-8}\ W/m^2\text{-}K^4$) (15%)

5. The equation of state for a gas contained in a piston-cylinder is

$$P\left(v - a + \frac{b}{T}\right) = RT.$$

If the gas is compressed irreversibly and isothermally from P_1 to P_2. Show that

(a) $\Delta H = \left(a - \frac{2b}{T}\right)(P_2 - P_1)$. (5%)

(b) $\Delta U = -bR\left(\frac{1}{v_2 - a + \frac{b}{T}} - \frac{1}{v_1 - a + \frac{b}{T}}\right)$ (5%)

(c) What is the entropy change for this compression process? (5%)

6. Answer the following questions with suitable assumptions, and use charts on the next page.

(a) An air-conditioner for a space of RH=80% and dry bulb temperature= 20 °C was turned off. For a while, the space became RH= 100% and dry bulb temperature= 26°C. Calculate the increment of absolute humidity. (4%)

(b) When a chiller is purchased to decrease the nutrient fluid temperature from 26°C to 20°C with a flow rate of 10 L/min, assign the cooling capacity (W) of the chiller. (Specific heat of water, C_P= 4.2 kJ/kg K) (6%)

(c) An ideal vapor-compression dehumidifier using R-134a operates its condenser at 40 °C. Please calculate the ratio of dehumidification capacities (kg/s) when the system's evaporator works at 0 °C or 10 °C. Assume that the dehumidifier system is ideal, so the outlets of condenser and evaporator are just on the saturated liquid line and saturated vapor line, respectively. Also, assume the air flow rate passing the evaporator is constant, and the air temperature leaving the evaporator is just the evaporator temperature. The test environment is kept at RH= 60% and dry bulb temperature= 27°C (12%)

(d) For the two operating conditions in (c), calculate the ratio of power consumption. (20%)

(e) For the two operating conditions in (c), calculate the ratio of dehumidification efficiency (kg/kJ). Assume

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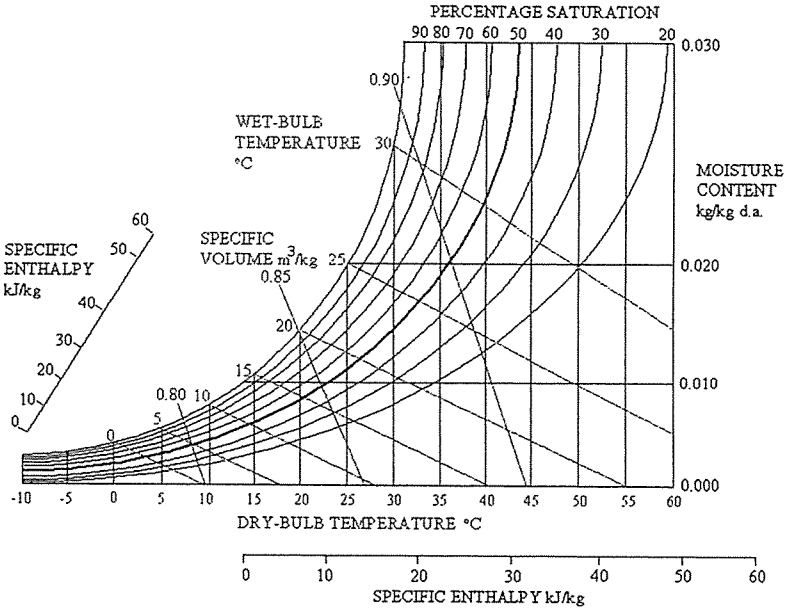
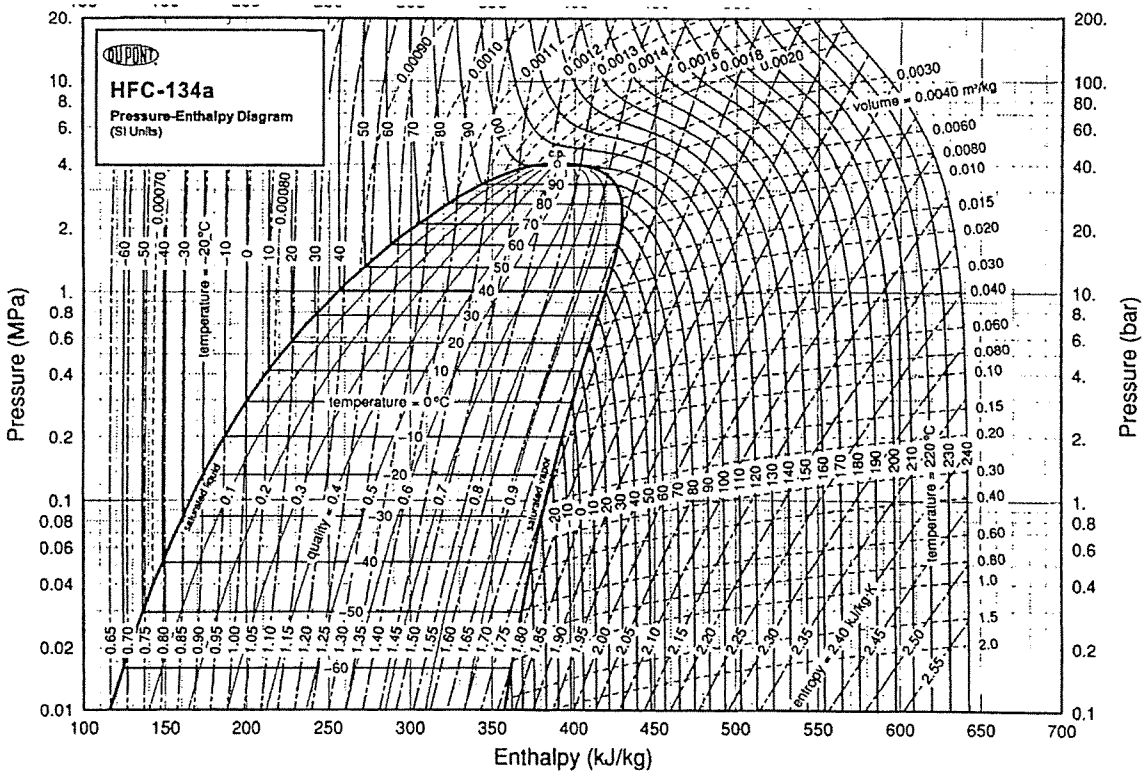
the R134a flow rate is constant. (8%)





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