國立中央大學八十五學年度碩士班研究生入學試題卷

所別：機械工程研究所　丙組　科目：熱力學　共 2 頁 第 1 頁

1. A worker pressurizes a rigid pipe (30 mm inside diameter, 20 m long) with dry air to check for leaks. The temperature and absolute pressure of the air in the pipe are 35 ℃ and 205 kpa. The worker returns 24 hours later and the absolute pressure has dropped to 183 kpa, while the air temperature inside the pipe has decreased to 21 ℃.
   (a) Would we conclude that the pipe has leak merely because the pressure decreases from 205 to 183 kpa,why?
   (b) If the pipe has leaked, calculate the mass of air that has leaked form the pipe. (note: Universal gas constnat is 287 $pa \cdot m^3 / kg \cdot K$) (15%)

2. Suppose that a closed, frictionless piston-cylinder that contains water executes a Carnot cycle. The water is initially at 250 ℃ and has a quality of 80 percent. The water is expanded isothermally until its pressure reaches 2 Mpa. The process is followed by an adiabatic expansion to a temperature of 175 ℃. The T-s diagram is shown below for your concenience. (a) Draw the corresponding p-v diagram, (b) calculate the thermal efficiency of the cycle, (c) calculate the heat transferred during the isothermal expansion, (d) claculate the work associated with the adiabatic expansion, (e) calculate the heat transferred during the isothermal compression. (15%)

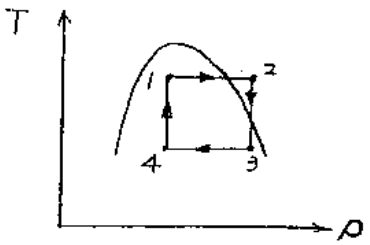
Supplementary date ：

Saturated table for water ：

T, ℃	p_{sat}, Mpa	s_f, kJ/$kg \cdot K$	s_g, kJ/$kg \cdot K$	u_f, kJ/kg	u_g, kJ/kg
170	0.7917	2.0419	6.663	718.33	2576.5
180	1.002	2.1396	6.5857	762.09	2583.7
250	3.973	2.7927	6.0730	1080.4	2602.4

Superheated table for water-vapor at 2 Mpa ：

T,℃	v, cm^3/g	u, kJ/kg	h, kJ/kg	s, kJ/$kg \cdot K$
240	108.5	2659.6	2876.5	6.4952
280	120.0	2736.4	2976.4	6.6828



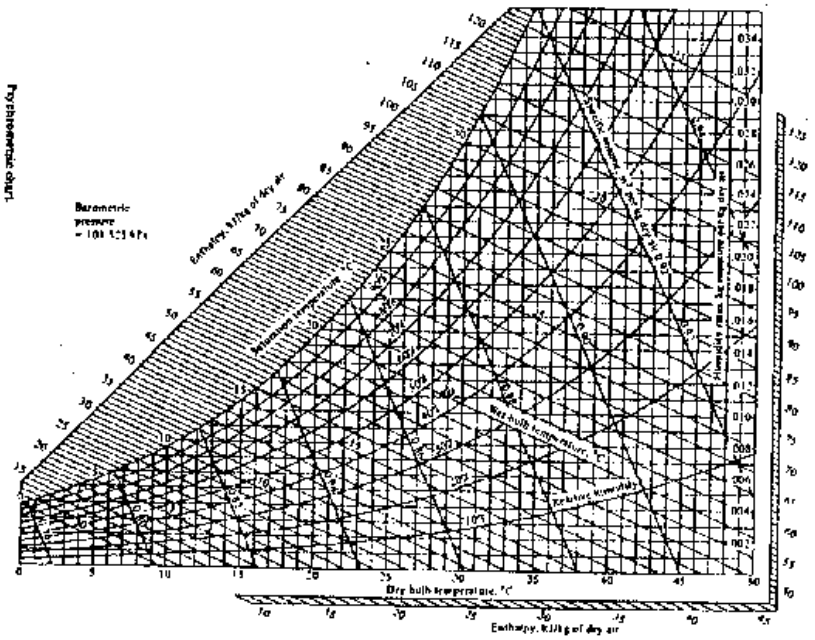
3. The exposed surface ($x = 0$) of a plane wall of thermal conductivity k is subjected to microwave radiation that causes volumetric heating to vary as

$$\dot{q}(x) = \dot{q}_0\left(1 - \frac{x^2}{L^2}\right)$$

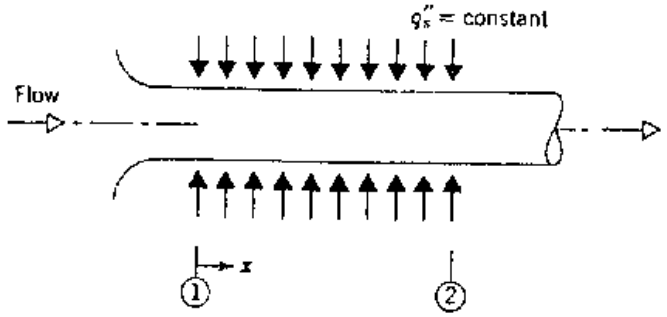
where $\dot{q}_0$ (W/m^3) is a constant. The boundary at $x = L$ is perfectly insulated, while the exposed surface is maintained at a constant temperature T_0. Determine the temperature distribution $T(x)$. (15%)

參考用

4. One hundred kilograms of saturated moist air at 101.325 kPa, 10°C is in a piston/cylinder arrangement. If it is heated to 45°C in an isobaric process, find the heat into the system and the final relative humidity. If it is compressed from the initial state to 200 kPa in an isothermal process, find the mass of water condensing. Note that the water saturated pressure 10°C is 1.227 kPa. (20 %)



5. Consider the flow in a circular tube as shown. within the test section length (between 1 and 2) a constant heat flux q_s'' is maintained. In case A, the flow becomes hydrodynamically and thermally fully developed within the test section. In case B, the flow is still developing when it flows out the test section.
(a) For the two cases, sketch, qualitatively, the surface temperature $T_s(x)$ and the fluid mean temperature $T_m(x)$ as a function of distance along the the test section x.
(b)Assuming that the surface flux q_s'' and the inlet mean temperature $T_{m,1}$ are identical for both cases, will the exit mean temperature $T_{m,2}$ for case A be greater than, equal to, or less than $T_{m,2}$ for case B? Briefly explain why. (20%)



參考用

6. The surface of a satellite receives solar radiation at a rate of 400 Btu/h-ft^2. The surface has an absorptivity of = 0.8 for solar radiation and an emissivity of = 0.9. Assuming no heat losses into the satellite and a heat dissipation by thermal radiation into the space at absolute zero, calculate the equilibrium temperature of the surface. (15%)