

Course : Applied Thermal Engineering (UMT303)

Batch: B.E. Mechatronics (2nd yr.)

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Tutorial No. 02

Topic: Properties of Pure Substance

Q1. A mass of 200 g of saturated liquid water is completely vaporized at a constant pressure of 100 kPa. Determine (a) the volume change and (b) the amount of energy transferred to the water.
[Ans. 0.3386 m^3 , 451.5kJ]

Q2. An 80-L vessel contains 4 kg of refrigerant-134a at a pressure of 160 kPa. Determine (a) the temperature, (b) the quality, (c) the enthalpy of the refrigerant, and (d) the volume occupied by the vapor phase.
[Ans. -15.6°C ; 0.157; 64.2kJ/kg; 0.0775 m^3]

Q3. Determine the specific volume of refrigerant-134a at 1 MPa and 50°C , using (a) the ideal-gas equation of state and (b) the generalized compressibility chart. Compare the values obtained to the actual value of $0.021796 \text{ m}^3/\text{kg}$ and determine the error involved in each case.

[Ans. $0.026325 \text{ m}^3/\text{kg}$; 20.8%, $0.022113 \text{ m}^3/\text{kg}$, 2%]

Q4. Predict the pressure of nitrogen gas at $T = 175 \text{ K}$ and $v = 0.00375 \text{ m}^3/\text{kg}$ on the basis of (a) the ideal-gas equation of state, (b) the van der Waals equation of state, (c) the Beattie-Bridgeman equation of state, and (d) the Benedict-Webb-Rubin equation of state. Compare the values obtained to the experimentally determined value of 10,000 kPa

[Ans. 13851kPa, 9471kPa; 10110kPa; 10009kPa]

Q5. Water contained in a piston–cylinder assembly undergoes two processes in series from an initial state where the pressure is 10 bar and the temperature is 400°C . Process 1–2: The water is cooled as it is compressed at a constant pressure of 10 bar to the saturated vapor state. Process 2–3: The water is cooled at constant volume to 150°C . (a) Sketch both processes on T–s and p–v diagrams. (b) For the overall process determine the work, in kJ/kg. and heat transfer, in kJ/kg.
[Ans. -112.2kJ/kg, -1485.5kJ/kg]

Q6. Two tanks are connected by a valve. One tank contains 2 kg of carbon monoxide gas at 778°C and 0.7 bar. The other tank holds 8 kg of the same gas at 27°C and 1.2 bar. The valve is opened and the gases are allowed to mix while receiving energy by heat transfer from the surroundings. The final equilibrium temperature is 42°C . Using the ideal gas model with constant c, determine (a) the final equilibrium pressure, in bar, (b) the heat transfer for the process, in kJ.
[Ans. 1.05bar, 37.25kJ/kg]