ME202 – THERMODYNAMICS

Problem Solving Techniques for Chapter 3 and 4

Section: -

PROBLEMS

Chapter 3

3.59) A piston-cylinder device initially contains 50L of liquid water at 40°C and 200kPa. Heat is transferred to the water at constant pressure until the entire liquid is vaporized.

a) What is the mass of the water? {49.61kg}
b) What is the final temperature? {120.21°C}
c) Determine the total enthalpy change. {125,923kJ}
d) Show the process on a T-ν diagram with respect to saturation lines. {166kJ}

3.66) The pressure gage on a 2.5m³ oxygen tank reads 500kPa. Determine the amount of oxygen in the tank if the temperature is 28°C and the atmospheric pressure is 97kPa.

3.67) A spherical balloon with a diameter of 9m is filled with helium at 27°C and 200kPa. Determine the mole number and the mass of the helium in the balloon. {30.6kmol, 123kg}

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Chapter 4

4.3) The volume of 1kg of helium in a piston-cylinder device is initially $5m^3$. Now the helium is compressed to $2m^3$ while its pressure is maintained constant at 180kPa. Determine the initial and final temperatures of helium as well as the work required to compress it, in kJ.

4.5) A piston-cylinder device with a set of stops initially contains 0.6kg of steam at 1.0MPa and 400°C. The location of the stops corresponds to 40% of the initial volume. Now the steam is cooled. Determine the compression work if the final state is (a) 1.0MPa and 250°C and (b) 500kPa. (c) Also determine the temperature at the final state in part (b).

4.7) A mass of 5kg of saturated water vapor at 300kPa is heated at constant pressure until the temperature reaches 200°C. Calculate the work done by the steam during this process. {166kJ}

4.27) A $0.5m^3$ rigid tank contains refrigerant 134a initially at 160kPa and 40% quality. Heat is now transferred to the refrigerant until the pressure reaches 700kPa. Determine (a) the mass of the refrigerant in the tank and (b) the amount of heat transferred. Also, show the process on a P-ν diagram with respect to saturation lines.

4.29) A rigid 10L vessel initially contains a mixture of liquid water and vapor at 100°C with 12.3% quality. The mixture is then heated until its temperature is 150°C. Calculate the heat transfer required for this process. {46.9kJ}

4.33) A piston-cylinder device initially contains steam at 200kPa, 200°C and $0.4m^3$. At this state, a linear spring is touching the piston but exerts no force on it. Heat is now slowly transferred to the steam, causing the pressure and the volume to rise to 250kPa and $0.6m^3$, respectively. Show the process on a P-ν diagram with respect to saturation lines and determine (a) the final temperature, (b) the work done by the steam and (c) the total heat transferred. {606°C, 45kJ, 288kJ}

4.55) A $3m^3$ rigid tank contains hydrogen at 250kPa and 550K the gas is now cooled until its temperature drops to 350K. Determine (a) the final pressure in the tank and (b) the amount of heat transfer.