

# Rajiv Gandhi institute of Petroleum Technology

Mid Sem. Exam.

Sub: Engg. Thermodynamics

Sem-1

08.02.2021 (2hours)

B.Tech : all branches

43 Marks

Answer all questions

Q1: 90 Kilograms of propane needed to be stored at 140°C in a rigid tank having volume of 0.6 m<sup>3</sup>. Utilizing compressibility chart estimate the pressure to which the tank is to be charged.  $T_C = 369.9\text{K}$  and  $P_C = 42.57\text{ bar}$  (5M)

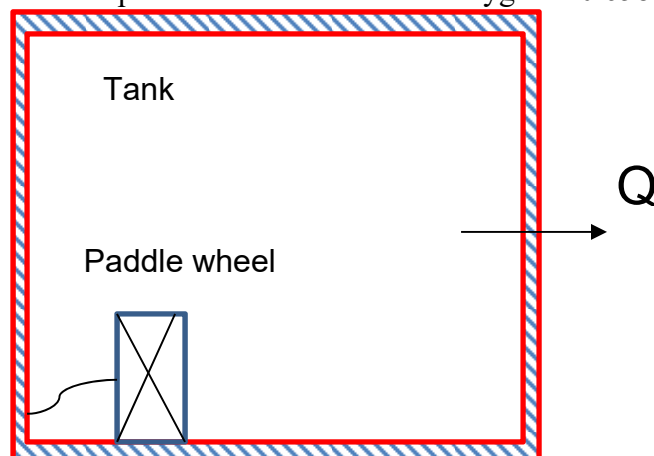
Q2: An ideal gas initially at 600K and 10 bar undergoes a four step mechanically reversible cycle in a closed system. In step 1-2, pressure decreases isothermally to 3 bar; in step 2-3, pressure decreases at constant volume to 2 bar; in step 3-4, volume decreases at constant pressure; and in step 4-1, the gas returns adiabatically to its initial state. Take  $C_p = (7/2)R$  &  $C_v = (5/2)R$ ; (10M)

(a) Sketch a neat PV diagram for the above mentioned cycle

(b) Determine (where unknown) both T and P for states 1,2,3,4

(c) Calculate Q, W,  $\Delta U$  and  $\Delta H$  for each step of cycle.

Q3: Oxygen gas at a pressure of 250 kPa and 27°C is filled in a tank of volume 0.3 m<sup>3</sup>. A paddle wheel within the tank is rotated until the pressure inside rises to 350 kPa. During this process 4 kJ of heat is lost to the surroundings. Neglecting the energy stored in the paddle wheel, determine the work done by paddle-wheel. Explain the result.  $C_v$  of Oxygen = 0.658 kJ/kg K (5M)



Q4: A gas move in to a compressor at conditions  $P_i=100\text{kPa}$  and  $T_i=283\text{K}$  and left at conditions  $P_o= 3.6\text{MPa}$  and  $T_o=363\text{K}$ . The entering gas flows through a 9cm diameter pipe with a velocity of 8m/s and is discharged through a 3cm diameter pipe. The provided power to the compressor is 12kJ/mol. What is the heat transfer rate from the compressor? (8M)

Property values are:

$$H_i= 21.71 \text{ kJ/mol}$$

$$V_i=23.40 \text{ L/mol}$$

$$H_o= 23.78 \text{ kJ/mol}$$

$$V_o=0.7587 \text{ L/mol}$$

Q5: Methane and air both at 25C enter an adiabatic combustion chamber. Assume that complete combustion occurs. Compute the maximum temperature reached due to combustion reaction if air is present in 20% excess. (10M)

Data for methane  $\Delta H_f^\circ = -1,91,760 \text{ cal/g mol}$ .

$\Delta H_{298}^\circ$ : -8,02,860 joules/gmol.

$C_p^\circ$  mean (cal/g mol K): for  $\text{CO}_2$ : 13.1 ; for  $\text{H}_2\text{O}$  : 10.4; for  $\text{O}_2$ : 8.4; for  $\text{N}_2$ : 8.0;

Q6: Water in a closed container maintained at constant P at 800 kPa, quality 90% with a volume of  $0.1 \text{ m}^3$ . A heater is turned on heating the water with 3 kW. What is the rate of mass (kg/s) vaporizing? (5M)

