Assignment: 01

Course: ME304, Engineering Thermodynamics Submission Due Date: 19.09.2022
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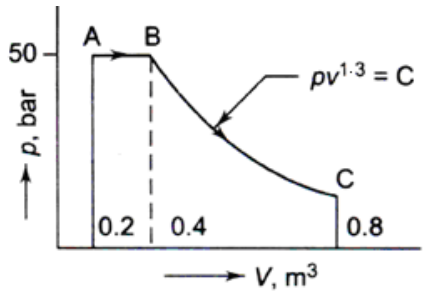
Topic covered: Thermodynamics System and Processes, Zeroth law of thermodynamics, First law of thermodynamics, Heat, Work and Energy.

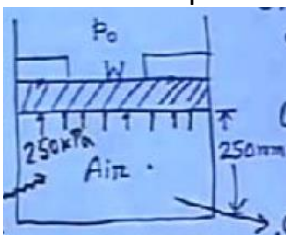
1. How many independent intensive properties are required to fix the state of a system of following types: (i) single component single phase system
(ii) single component two phase system
(iii) single component three phase system
2. What is dead state of a system?
3. What thermodynamic property of a system is defined by the first law?
4. What is quasi-static process? What is its characteristic feature?
5. What is Zeroth law of thermodynamics?
6. What are the different forms of work transfer between a system and its surroundings?
7. Is paddle wheel work is a reversible work of irreversible work? Explain.
8. How do you define enthalpy? Is enthalpy an extensive or intensive property? What is the physical significance of enthalpy?
9. What do you mean by steady flow energy equation?
10. What is PMM1? Why it is impossible?
11. A fluid, contained in a horizontal cylinder fitted with a frictionless leak-proof piston, is continuously agitated by means of a stirrer passing through the cylinder cover. The cylinder diameter is 0.40 m. During the stirring process lasting 10 minutes, the piston slowly moves out a distance of 0.485 m against the atmosphere. The net work done by the fluid during the process is 2 kJ. The speed of the electric motor driving the stirrer is 840 rpm. Determine the torque in the shaft and the power output of the motor.

12. Determine the total work done by a gas system following an expansion process as shown in Figure.



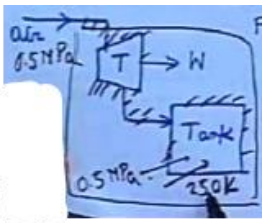
13. The flow energy of 0.124 m3/min of a fluid crossing a boundary to a system is 18 kW. Find the pressure at this point.
14. A gas of mass 1.5 kg undergoes a quasi-static expansion which follows a relationship p = a+bv, where a and b are constants. The initial and final pressure are 1000 kPa and 200 kPa, respectively and the corresponding volumes are 0.2 m^3 and 1.2 m^3. The specific internal energy of the gas is given by u = 1.5 pv – 85 kJ/kg, where p is in kPa and v in m^3/kg. Calculate the net heat transfer and the maximum internal energy of the gas during expansion.

15. A piston cylinder arrangement as shown in figure, contains air at 250 kPa, 300^{o} c. The 50 kg piston has a diameter of 0.1 m and initially pushes against the stops. The atmospheric pressure is 100 kPa and the temperature is 20^{o} c. The cylinder cools as heat is transferred to the ambient. (a) At what temperature does the piston begin to move down?
(b) How far has the piston dropped when the temperature reaches ambient (20^{o} c).



16. (i) An evacuated bottle is fitted with a valve through which air from the atmosphere (1 bar, 25º c) is allowed to flow slowly to fill the bottle. If no heat is transferred to or from the air in the bottle, what will its temperature be when the pressure in the bottle reaches 1 bar?
(ii) If the bottle initially contains 0.03 m^3 of air at 400 mm of Hg and 25º c, what will the temperature be when pressure reaches 760 mm of Hg (atmospheric pressure)?
The property relation for air: u = 0.718 (t+273), where u is in kJ/kg, t in ºc, pv = 0.287 (t+273), where p is in kPa and v in m^3/kg.

17. An air line 300K and 0.5 Mpa as shown is connected to a turbine that exhausts to a closed initially empty tank of 50 m^3. The turbine operates to a tank pressure of 0.5 MPa, at which point the temperature is 250K. Assuming the entire process to be adiabatic, determine the turbine work. The property relation for air: u = 0.718 (t+273), h = 1.005 (t +273) where u is in kJ/kg, t in ^{o}c.



18. Steam at an initial enthalpy of 100 kJ/kg and inlet velocity of 100 m/s, enters an insulated horizontal nozzle. It leaves the nozzle at 200 m/s. The exit enthalpy (in kJ/kg) is?

19. Steam enters a turbine at 30 bar, 300°C (*u* = 2750 kJ/kg, *h* = 2993 kJ/kg) and exits the turbine as saturated liquid at 15 kPa (*u* = 225 kJ/kg, *h* = 226 kJ/kg). Heat loss to the surrounding is 50 kJ/kg of steam flowing through the turbine. Neglecting changes in kinetic energy and potential energy, the work output of the turbine (in kJ/kg of steam) is?

20. Work is done on an adiabatic system due to which its velocity changes from 10 m/s to 20 m/s, elevation increases by 20 m and temperature increases by 1 K. The mass of the system is 10 kg. c_v = 100 J/(kgK) and gravitational acceleration is 10 m/s^2. If there is no change in any other component of the energy of the system, the magnitude of total work done (in kJ) on the system is?