BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI
Second Semester (2023-2024)
APPLIED THERMODYNAMICS (ME F217)
Mid-Semester Examination – Regular - (Closed Book)

Tuesday, October 10, 2023

Max Marks = 50 **Maximum Duration 90 Mins**

Instructions

- Carry only thermodynamic/refrigeration property tables

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1. A refrigeration plant works between temperature limits of -5^{o}C and 25^{o}C. The working fluid ammonia has a dryness fraction (quality) of 0.62 at entry to compressor (take compressor entry at State 2). If the machine has a relative efficiency of 55%, draw T-s plot and calculate theoretical C.O.P, actual C.O.P and the amount of ice formed during a period of 24 hours. The ice is to be formed at 0^{o}C from water at 15^{o}C and 6.4 kg of ammonia is circulated per minute. Specific heat of water is 4.817 kJ/kg and latent heat of ice is 335 kJ/kg. **[15]**

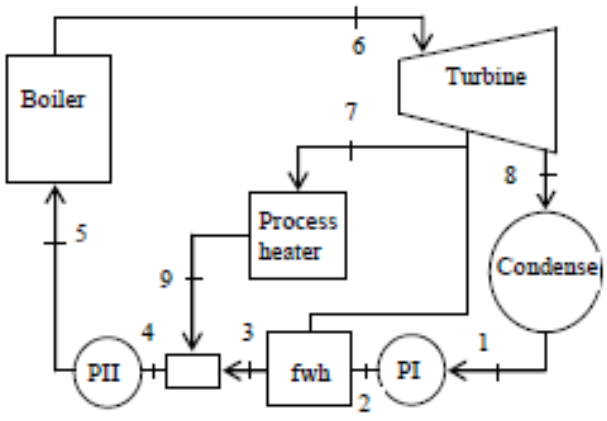
   Use the below properties of NH_3

Temperature (^{o}C)	Liquid heat (kJ/kg)	Latent heat (kJ/kg)	Entropy of liquid (kJ/kg K)
25	298.9	1167.1	1.124
-5	158.2	1280.8	0.630

2. Refrigerant 134a is the working fluid in an ideal vapor-compression refrigeration cycle that communicates thermally with a cold region at 0^{o}C and a warm region at 26^{o}C. Saturated vapour enters the compressor at 0^{o}C and saturated liquid leaves the condenser at 26^{o}C. The mass flow rate of the refrigerant is 0.08 kg/s. Determine (a) the compressor power, in kW, (b) the refrigeration capacity, in tons, (c) the coefficient of performance, and (d) the coefficient of performance of Carnot refrigeration cycle operating between warm and cold region at 26^{o}C and 0^{o}C, respectively. **[8]**

3. Consider an ideal reheat–regenerative Rankine cycle with one open feedwater heater. The boiler pressure is 10 MPa, the condenser pressure is 15 kPa, the reheater pressure is 1 MPa, and the feedwater pressure is 0.6 MPa. Steam enters both the high pressure turbine (at state 5) and low-pressure turbines (at state 7) at 500°C. Draw schematic diagram and show the cycle on a T-s diagram with respect to saturation lines, and determine (a) the fraction of steam extracted for regeneration and (b) the thermal efficiency of the cycle. **[12]**

4. Consider a cogeneration power plant modified with regeneration. Steam enters the turbine at 9 MPa and 400°C and expands to a pressure of 1.6 MPa. At this pressure, 35 percent of the steam is extracted from the turbine, and the remainder expands to 10 kPa. Part of the extracted steam is used to heat the feedwater in an open feedwater heater. The rest of the extracted steam is used for process heating and leaves the process heater as a saturated liquid at 1.6 MPa. It is subsequently mixed with the feedwater leaving the feedwater heater, and the mixture is pumped to the boiler pressure. Assuming the turbines and the pumps to be isentropic, show the cycle on a T-s diagram with respect to saturation lines, and determine the mass flow rate of steam through the boiler for a net power output of 25 MW. **[15]**



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