R & AC Assignment # 2 [2k9 ME]

1. A machine working on a Carnot cycle operates between 305 K and 260 K. Determine the C.O.P. when it is operated as refrigerating machine, a heat pump, and heat engine.

2. A Carnot refrigeration cycle absorbs heat at 270 K and rejects it at 300 K. (a) Calculate the coefficient of performance of this refrigeration cycle. (b) If the cycle is absorbing 1130 kJ/min at 270 K, how many kJ of work is required per second?

3. A refrigerating plant is required to produce 2.5 tonnes of ice per day at -4° C from water at 20° C. If the temperature range in the compressor is between 25°C and -6°C. Calculate power required to drive the compressor. Latent heat of ice = 335 kJ/kg and specific heat of ice = 2.1 kJ/kg K.

4. A Carnot cycle machine operates between the temperature limits of 4~C and -30°C. Determine the C.O.P. when it operates as (1) a refrigerating machine; (2) a heat pump, and (3) a heat engine.

5. A cold storage plant is required to store 20 tonnes of fish. The fish is supplied at a temperature of 30°C. The specific heat of fish above freezing point is 2.93 kJ/ kg K. The specific heat of fish below freezing point is 1.26 kJ/kg K. The fish is stored in cold storage which is maintained at -8°C. The freezing point of fish is -4°C. The latent heat of fish is 235 kJ/kg. If the plant requires 75 kW to drive it.Find; (a) The capacity of the plant, and (b) Time taken to achieve cooling. Assume actual C.O.P. of the plant as 0.3 of the Carnot C.O.P.

6. A refrigerator working on Bell-Coleman cycle operates between pressure limits of 1 bar and 7.5 bar. Air is drawn from the cold chamber at 10°C. compressed and then it is cooled to 30°C before entering the expansion cylinder. The expansion and compression follows the law $pv^{1.3}$ = constt. Determine the theoretical C.O.P. of the system.

7. The atmospheric air at pressure 1 bar and temperature -5°C is drawn in the cylinder of the compressor of a Bell-Coleman refrigerating machine. It is compressed isentropically to a pressure of 5 bar. In the cooler, the compressed air is cooled to 15° C, pressure remaining the same. It is then expanded to a pressure of 1 bar in an expansion cylinder, from where it is passed to the cold chamber. Find (1) the work done per kg of air, and (2) C.O.P. of the plant.

   [For air assume law of expansion $p\,v^{1.2}$ =constt; law of compression $p\,v^{1.4}$=constt and specific heat of air at constant pressure 1kJ/kg]

8. A dense closed cycle refrigeration system working between 4 bar and 16 bar extracts 126 MJ of heat per hour. The air enters the compressor at 5°C and into the expander at 20°C.Assuming the unit runs at 300 r.p.m., find out: (a) power required to run the unit (b) Bore of compressor and (c) Refrigerating capacity in tonnes of ice at 0°C per day. Consider the following:

   The compressor and expander are double acting and stroke for compressor and expander is 300mm.The mechanical efficiency of compressor is 80%.The mechanical efficiency expander is 85%.Assume the compression and expansion are isentropic.

9. Air refrigeration used for food storage provides 25 tonnes.The temperature of air entering the compressor is 7°C and temperature at exit of cooler is 27°C Find (a) C.O.P. of the cycle and (b) power per tonne of refrigeration required by compressor. The quantity of air circulated in the system is 3000 kg/h.The compression and expansion both follows the law $pv^{1.2}$=constt and take γ=1.4 and c_p=1kJ/kg k for air

10. A dense air refrigeration cycle operates between pressures of 4 bar and 16 bar. The air temperature after heat rejection to surroundings is 37°C and air temperature at exit of refrigerator is 7°C. The isentropic efficiencies of turbine and compressor are 0.85 and 0.8 respectively. Determine compressor and turbine work per tonne; C.O.P.; and power per tonne. Take γ= 1.4 and c_p = 1.005 kJ/ kg K.