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06ME43

Fourth Semester B.E. Degree Examination, June 2012
Applied Thermodynamics

Time: 3 hrs. Max. Marks:100

Note: ***1. Answer FIVE full questions, selecting at least TWO questions from each part.***
2. Use of thermodynamics data handbook is permitted.

PART – A

1 a. Define the following :
i) Enthalpy of reaction ii) Heat of formation
iii) Higher calorific value iv) Enthalpy of formation. **(08 Marks)**

b. Find the stoichiometric air for the combustion of gaseous propane (C_3H_8) on mass basis and molar basis. **(04 Marks)**

c. The products of combustion of hydrocarbon fuel of unknown composition have the following composition as measured on dry basis.
CO_2 – 8.0%, CO–0.9%, O_2 – 8.8%, N_2 – 82.3%
Calculate :
i) Air fuel ratio
ii) Composition of fuel on mass basis
iii) The percentage of theoretical air on mass basis. **(08 Marks)**

2 a. With the help of superimposed P–V and T–S diagrams compare, the efficiencies of air standard Otto cycle and diesel cycles for same state of air before compression and same maximum pressure and temperature in both the cycles. **(08 Marks)**

b. The compression ratio for a single cylinder engine operating on dual cycle in 8. The max pressure in the cycle is limited to 55 bar. The pressure and temperature of the air at the beginning of the cycle are 1 bar and 27°C. Heat is added during constant pressure process upto 3% of the stroke. Assuming the diameter as 25 cm and stroke as 30 cm, find the following :
i) The work done per cycle
ii) The air–standard efficiency of the cycle
iii) The power developed if number of working cycles are 200/ min. **(12 Marks)**

3 a. What are the methods used for improvement of thermal efficiency of simple open cycle constant pressure gas turbine plant? Explain any one in detail. **(10 Marks)**

b. In a jet propulsion cycle, air enters the compressor at 1 bar and 15°C. The pressure leaving the compressor is 5 bar and the max. temperature is 900°C. The air expands in the turbine to such a pressure that the turbine work is just equal to the compressor work. On leaving the turbine, the air expands in a reversible adiabatic process in a nozzle to 1 bar. Calculate the velocity of air leaving the nozzle.
Take Cp = 1.0035 and $\gamma = 1.4$ for compressor and expansion processes. **(10 Marks)**

4 a. Sketch the flow diagram and corresponding temperature entropy diagram of the reheat vapor cycle and derive an expression for the reheat cycle efficiency. What are the advantages gained by reheating the steam in between stages? **(10 Marks)**

b. A vapour power plant is working on closed feed water heater regenerative rankine cycle. Boiler pressure = 70 bar and 400°C ; condense pressure = 0.1 bar ; steam is bled from the turbine at 10 bar. Bled stream and feed water leaves the closed feed water heater as saturated liquid. Calculate the thermal efficiency of Rankine cycle. **(10 Marks)**

PART – B

5 a. Derive the condition for minimum work input to a two stage compressor with perfect inter cooling between stages. Also derive an expression for the ideal intermediate pressure for the same. **(10 Marks)**

b. A two stage compressor delivers 2 m^3 free air per minute. The temperature and pressure of air at the suction are 27°C and 1 bar. The pressure at delivery is 50 bar. The clearance is 5% of the stroke in L.P cylinder as well as in H.P cylinder. Assume perfect intercooling between the two stages. Find the minimum power required to run the compressor at 200 rpm. Also find the diameters and strokes assuming the strokes of both cylinders are equal to the diameter of LP cylinder. What is the ratio of cylinder volumes? Law of compression and re–expansion in both cylinders is $PV^{1.35}$ = constant. Also assume that the ambient air condition is same such as suction condition. **(10 Marks)**

6 a. Explain with the aid of T-S diagram and P-H diagram, the effect of superheat and sub cooling on the vapour compression refrigeration cycle. **(06 Marks)**

b. What are the desirable properties of refrigerants? **(04 Marks)**

c. An air refrigerator working on Bell-Colemann cycle takes air from cold chamber at 1 bar and –5°C and compresses to 6 bar following the law $PV^{1.25}$ = C. The compressed air is cooled to 37°C in the cooler before entering into the expander. The expansion in isentropic. Determine,

i) C.O.P. of the cycle.

ii) Mass of air circulated per minute if 500 kg of ice is produced per day at 0°C when water is supplied at 20°C.

iii) Refrigeration capacity of the plant in tons.

Neglect the clearances in compressor and expander. Take $\gamma = 1.4$ and $C_P = 1$ kJ/kg for air Latent heat of ice = 335 kJ/kg , C_p (water) = 4.1868 kJ/kg. **(10 Marks)**

7 a. What do you understand by dry bulb, wet bulb and dew point temperatures? **(06 Marks)**

b. Define the terms:

i) Specific humidity ii) Relative humidity **(04 Marks)**

c. 40 m^3 of air per minute at 31°C DBT and 18.5°C WBT is passed over the cooling coil whose surface temperature is 4.4°C. The coil cooling capacity is 3.56 tonnes of refrigeration under the given condition of air. Determine the DBT of the air leaving the cooling coil and bypass factor. **(10 Marks)**

8 a. What do you understand by heat balance sheet? Enumerate the importance of the same. **(05 Marks)**

b. Describe the principle of conducting Morse test on IC engines. What is the important precaution to be taken while conducting this test? **(05 Marks)**

c. A test on single cylinder, 4 stroke oil engine, having bore 180mm and stroke 360mm gave the following results:

Speed 290 rpm; brake torque 392 Nm; indicated mean effective pressure 7.2 bar; oil consumption 3.5 kg/hour; cooling water flow 270kg/hour; cooling water temperature rise 36°C; air fuel ratio by weight 25; exhaust gas temperature 415°C; barometric pressure 1.013 bar; room temperature 21°C. The fuel has calorific value of 45,200 kJ/kg and contains 15% of hydrogen by weight. Calculate

i) The indicated thermal efficiency ii) The volumetric efficiency based on the atmospheric conditions. Draw a heat balance sheet in terms of kJ/min.

Take R = 0.287 kJ/kg K, C_p for dry exhaust gases = 1.0035 kJ/kg K and C_{Ps} for super heated steam = 2.093 kJ/kg K. **(10 Marks)**

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