Indian Institute of Technology Kanpur

ESO 201 A: Thermodynamics

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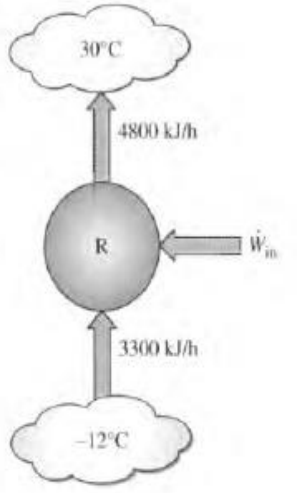
Tutorial- 7

Q.6-28

A coal-burning steam power plant produces a net power of 300 MW with an overall thermal efficiency of 32 percent. The actual gravimetric air-fuel ratio in the furnace is calculated to be 12 kg air/kg fuel. The heating value of the coal is 28,000 kJ/kg. Determine ***(a)*** the amount of coal consumed during a 24-hour period and (***b***) the rate of air flowing through the furnace.

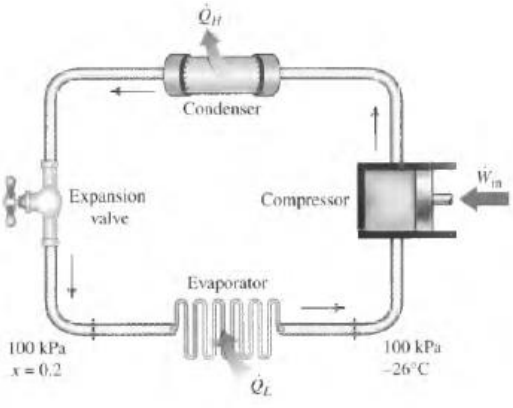
Q.6-42

A food department is kept at -12 ˚C by a refrigerator in an environment at 30 ˚C. The total heat gain to the food department is estimated to be 3300 kJ/h and the heat rejection in the condenser is 4800 kJ/h. Determine the power input to the compressor, in kW and the COP of the refrigerator.



Q.6-57

Refrigerant-134a enters the evaporator coils placed at the back of the freezer section of a household refrigerator at100 kPa with a quality of 20 percent and leaves at 100 kPa and -26 °C. If the compressor consumes 600 W of power and the COP the refrigerator is 1.2, determine (***a***) the mass flow rate of the refrigerant and (***b***) the rate of heat rejected to the kitchen air.



Q.6-101

A refrigerator operating on the reversed Carnot cycle has a measured work input of 200 kW and heat rejection of 2000 kW to a heat reservoir at 27 °C. Determine the cooling load supplied to the refrigerator, in kW, and the temperature of the heat source, in °C.

Q.6-107

A Carnot heat engine receives heat from a reservoir at 900 °C at a rate of 800 kJ/min and rejects the waste heat to the ambient air at 27 °C. The entire work output of the heat engine is used to drive a refrigerator that removes heat from the refrigerated space at -5 °C and transfers it to the same ambient air at 27 °C. Determine (a) the maximum rate of heat removal from the refrigerated space and (b) the total rate of heat rejection to the ambient air.

Additional Homework Problems

Q 6-22

An automobile engine consumes fuel at a rate of 22 L/h and delivers 55 kW of power to the wheels. If the fuel has a heating value of 44,000 kJ/kg and a density of 0.8 g/cm^3, determine the efficiency of this engine.

Q 6-40

An air conditioner produces a 2-kW cooling effect while rejecting 2.5 kW of heat. What is its COP?

Q 6-41

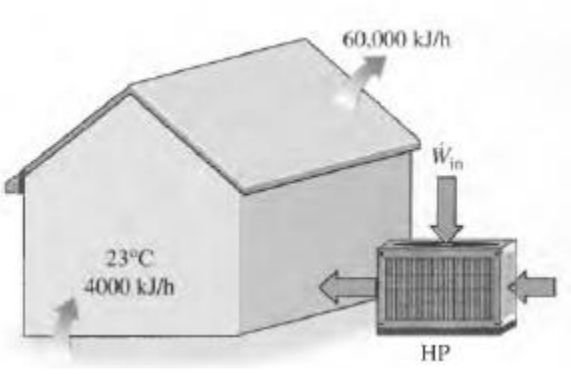
A refrigerator used to cool a computer requires 3 kW of electrical power and has a COP of 1.4. Calculate the cooling effect of this refrigerator, in kW.

Q 6-46

A household refrigerator that has a power input of 450 W and a COP of 2.5 is to cool five large watermelons, 10 kg each, to 8 °C. If the watermelons are initially at 20 °C, determine how long it will take for the refrigerator to cool them. The watermelons can be treated as water whose specific heat is 4.2 kJ/kg °C. Is your answer realistic or optimistic? Explain.

Q 6-51

A heat pump is used to maintain a house at a constant temperature of 23 °C. The house is losing heat to the outside air through the walls and the windows at a rate of 60,000 kJ/h while the energy generated within the house from people, lights, and appliances amounts to 4000 kJ/h. For a COP of 2.5, determine the required power input to the heat pump.



Q 6-95

A heat pump operates on a Carnot heat pump cycle with a COP of 8.7. It keeps a space at 26 °C by consuming 4.25 kW of power. Determine the temperature of the reservoir from which the heat is absorbed and the heating load provided by the heat pump.

Q 6-96

A refrigerator is to remove heat from the cooled space at a rate of 300 kJ/min to maintain its temperature at -8 °C. If the air surrounding the refrigerator is at 25 °C, determine the minimum power input required for this refrigerator.