Tutorial- 11

Q.9-35

Someone has suggested that the air-standard Otto cycle is more accurate if the two isentropic processes are replaced with polytropic processes with a polytropic exponent $n = 1.3$. Consider such a cycle when the compression ratio is 8, $P_1 = 95$ kPa, $T_1 = 15\ °C$, and the maximum cycle temperature is 1200 $°C$. Determine the heat transferred to and rejected from this cycle, as well as the cycle's thermal efficiency. Use constant specific heats at room temperature.

Q.9-129

Consider an ideal gas-turbine cycle with two stages of compression and two stages of expansion. The pressure ratio across each stage of the compressor and turbine is 3. The air enters each stage of the compressor at 300 K and each stage of the turbine at 1200 K. Determine the back work ratio and the thermal efficiency of the cycle, assuming *(a)* no regenerator is used and *(b)* a regenerator with 75 percent effectiveness is used. Use variable specific heats.

Q.10-23

A simple Rankine cycle uses water as the working fluid. The boiler operates at 6000 kPa and the condenser at 50 kPa. At the entrance to the turbine, the temperature is 450 °C. The isentropic efficiency of the turbine is 94 percent, pressure and pump losses are negligible, and the water leaving the condenser is subcooled by 6.3 °C. The boiler is sized for a mass flow rate of 20 kg/s. Determine the rate at which heat is added in the boiler, the power required to operate the pumps, the net power produced by the cycle, and the thermal efficiency.

Q.11-21

Refrigerant-134a enters the compressor of a refrigerator at 100 kPa and -20°C at a rate of 0.5 m³/min and leaves at 0.8 MPa. The isentropic efficiency of the compressor is 78 percent. The refrigerant enters the throttling valve at 0.75 MPa and 26 °C and leaves the evaporator as saturated vapor at -26 °C. Show the cycle on a *T-s* diagram with respect to saturation lines, and determine (a) the power input to the compressor, (b) the rate of heat removal from the refrigerated space, and (c) the pressure drop and rate of heat gain in the line between the evaporator and the compressor.

Q. 11-80

A gas refrigeration system using air as the working fluid has a pressure ratio of 5. Air enters the compressor at 0 °C. The high-pressure air is cooled to 35 °C by rejecting heat to the surroundings. The refrigerant leaves the turbine at -80 °C and then it absorbs heat from the refrigerated space before entering the regenerator. The mass flow rate of air is 0.4 kg/s. Assuming isentropic efficiencies of 80 percent for the compressor and 85 percent for the turbine and using constant specific heats at room temperature, determine *(a)* the effectiveness of the regenerator, (b) the rate of heat removal from the refrigerated space, and (c) the COP of the cycle. Also, determine *(d)* the refrigeration load and the COP if this system operated on the simple gas refrigeration cycle. Use the same compressor inlet temperature as given, the same turbine inlet temperature as calculated, and the same compressor and turbine efficiencies.

Homework-11

Q 9-39

The compression ratio of an air-standard Otto cycle is 9.5. Prior to the isentropic compression process, the air is at 100 kPa, 35 °C, and 600 cm³. The temperature at the end of the isentropic expansion process is 800 K. Using specific heat values at room temperature, determine *(a)* the highest temperature and pressure in the cycle *(b)* the amount of heat transferred in, in kJ *(c)* the thermal efficiency and *(d)* the mean effective pressure.

Q 9-57

An ideal diesel engine has a compression ratio of 20 and uses air as the working fluid. The state of air at the beginning of the compression process is 95 kPa and 20 °C. If the maximum temperature in the cycle is not to exceed 2200 K, determine *(a)* the thermal efficiency and *(b)* the mean effective pressure. Assume constant specific heats for air at room temperature.

Q 10-21

Consider a steam power plant that operates on a simple ideal Rankine cycle and has a net power output of 45 MW. Steam enters the turbine at 7 MPa and 500 °C and is cooled in the condenser at a pressure of 10 kPa by running cooling water from a lake through the tubes of the condenser at a rate of 2000 kg/s. Show the cycle on a *T-s* diagram with respect to saturation lines, and determine *(a)* the thermal efficiency of the cycle, *(b)* the mass flow rate of the steam, and(c) the temperature rise of the cooling water.

Q 10-39 Consider a steam power plant that operates on the ideal reheat Rankine cycle. The plant maintains the boiler at 7000 kPa, the reheat section at 800 kPa, and the condenser at 10 kPa. The mixture quality at the exit of both turbines is 93 percent. Determine the temperature at the inlet of each turbine and the cycle's thermal efficiency.