Indian Institute of Technology Kanpur
ESO 201 A: Thermodynamics
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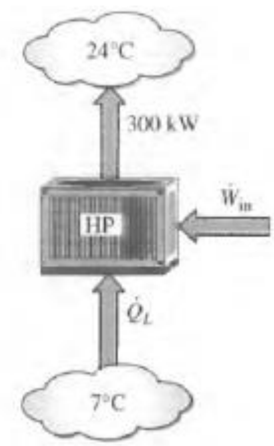
Tutorial- 8

Q 7-27

A completely reversible heat pump produces heat at a rate of 300 kW to warm a house maintained at 24 °C. The exterior air, which is at 7 °C, serves as the source. Calculate the rate of entropy change of the two reservoirs and determine if this heat pump satisfies the second law according to the increase of entropy principle.



Q.7-29

Refrigerant-134a enters the coils of the evaporator of a refrigeration system as a saturated liquid-vapor mixture at a pressure of 160 kPa. The refrigerant absorbs 180 kJ of heat from the cooled space, which is maintained at -5°C, and leaves as saturated vapor at the same pressure. Determine *(a)* the entropy change of the refrigerant, (*b)* the entropy change of the cooled space, and (c) the total entropy change for this process.

Q.7-50

Steam is expanded in an isentropic turbine with a single inlet and outlet. At the inlet, the steam is at 2 MPa and 360°C. The steam pressure at the outlet is 100 kPa. Calculate the work produced by this turbine, in kJ/kg.

Q.7-56

Refrigerant-134a enters a steady-flow adiabatic compressor as a saturated vapor at 320 kPa and is compressed to 1200 kPa. The minimum power supplied to the compressor is found to be 100 kW.

(a) Sketch the T-s diagram with respect to the saturation lines for this process.

(b) Determine the volume flow rate of the refrigerant-134a at the compressor inlet, in m^3/s.

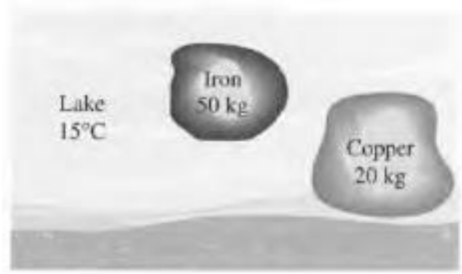
Q.7-66

A 25-kg iron block initially at 350 °C is quenched in an insulated tank that contains 100 kg of water at 18 °C. Assuming the water that vaporizes during the process condenses back in the tank, determine the total entropy change during this process.

Homework-8

Q 7-69

A 50-kg iron block and a 20-kg copper block, both initially at 80 °C, are dropped into a large lake at 15 °C. Thermal equilibrium is established after a while as a result of heat transfer between the blocks and the lake water. Determine the total entropy change for this process.

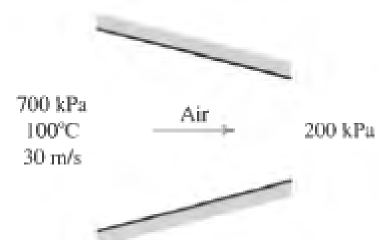


Q 7-89

An insulated rigid tank is divided into two equal parts by a partition. Initially, one part contains 5 kmol of an ideal gas at 250 kPa and 40 °C, and the other side is evacuated. The partition is now removed, and the gas fills the entire tank. Determine the total entropy change during this process.

Q 7-95

Air is expanded in an adiabatic nozzle during a polytropic and 100 °C with a velocity of 30 m/s and exits at a pressure of 200 kPa. Calculate the air temperature and velocity at the nozzle exit.



Q 7-100

A constant-volume tank contains 5 kg of air at 100 kPa and 327 °C. The air is cooled to the surroundings temperature of 27 °C. Assume constant specific heats at 300 K. (*a*) Determine the entropy change of the air in the tank during the process, in kJ/K, *(b)* determine the net entropy change of the universe due to this process, in kJ/K, and (c) sketch the processes for the air in the tank and the surroundings on a single *T-s* diagram. Be sure to label the initial and final states for both processes.

Q 7-110

Calculate the work produced, in kJ/kg, for the reversible isothermal, steady-flow process 1-3 as shown in Fig. P7-110. When the working fluid is an ideal gas.

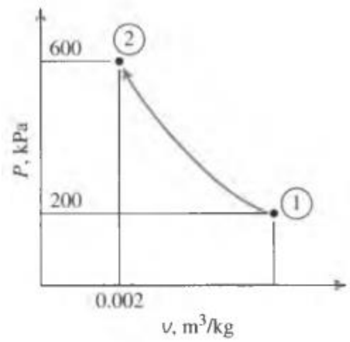
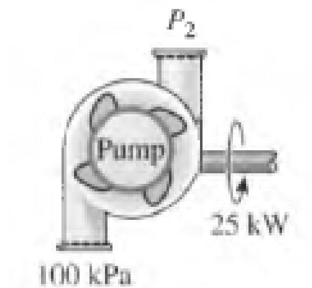


FIGURE P7–110

Q 7-111

Liquid water enters a 25-kW pump at 100-kPa pressure at a rate of 5 kg/s. Determine the highest pressure the liquid water can have at the exit of the pump. Neglect the kinetic and potential energy changes of water, and take the specific volume of water to be 0.001 m^3/kg.



Q 7-146

A well-insulated, shell-and-tube heat exchanger is used to heat water (c_p = 4.18 kJ/kg-°C) in the tubes from 20 to 70°C at a rate of 4.5 kg/s. Heat is supplied by hot oil (c_p =2.30 kJ/kg-°C) that enters the shell side at 170°C at a rate of 10 kg/s. Disregarding any heat loss from the heat exchanger, determine (*a*) the exit temperature of the oil and (*b*) the rate of entropy generation in the heat exchanger.