1. Five hundred kilograms per hour of steam drives a turbine. The steam enters the turbine at 44 atm and 450°C at a linear velocity of 60 m/s and leaves at a point 5 m below the turbine inlet at atmospheric pressure and a velocity of 360 m/s. The turbine delivers shaft work at a rate of 70 kW, and the heat loss from the turbine is estimated to be 10^4 kcal/h. Calculate the specific enthalpy change associated with the process.

2. Determine the vapor pressure, specific internal energy, and specific enthalpy of saturated steam at 133.5°C.

3. Show that water at 400°C and 10 bar is superheated steam and determine its specific volume, specific internal energy, and specific enthalpy relative to liquid water at the triple point, and its dew point.

4. Steam at 10 bar absolute with 190°C of superheat is fed to a turbine at a rate m = 2000 kg/h. The turbine operation is adiabatic, and the effluent is saturated steam at 1 bar. Calculate the work output of the turbine in kilowatts, neglecting kinetic and potential energy changes.

5. Two streams of water are mixed to from the feed to a boiler. Process data are as follows:

   Feed stream 1   120 kg/min @ 30°C
   Feed stream 2   175 kg/min @ 65°C
   Boiler pressure   17 bar (absolute)

   The exiting steam emerges from the boiler through a 6cm ID pipe. Calculate the required heat input to the boiler in kilojoules per minute if the emerging steam is saturated at boiler pressure. Neglect the kinetic energies of the liquid inlet stream.

6. A gas stream containing 60.0 wt% ethane and 40.0% n-butane is to be heated from 150 K to 250 K at a pressure of 5 bar. Calculate the required heat input per kilogram of the mixture, mixture, neglecting potential and kinetic energy changes, using tabulated enthalpy data for C_2H_6 and C_4H_{10} and assuming ideal gas behavior.

7. Saturated steam at 1 atm is discharged form a turbine at a rate of 1150 kg/h. Superheated steam at 300 °C and 1 atm is needed as feed to a heat exchanger; to produce it, the turbine discharge stream is mixed with superheated steam available from a second source at 400 °C and 1 atm. The mixing unit operates adiabatically. Calculate the amount of superheated steam at 300 °C produced and the required volumetric flow rate of the 400 °C steam.

1. Ten pounds of CO_2 at room temperature (80 °F) are stored in fire extinguisher having a volume of 4.0 ft^3. How much heat must be removed from the extinguisher so that 40% of the CO_2 becomes liquid?

2. Argon gas in an insulated plasma deposition chamber with a volume of 2 L is to be heated by an electric resistance heater. Initially the gas, which can be treated as an ideal gas, is at 1.5 Pa and 300 K. The 1000-ohm heater draws current at 40 V for 5 minutes (i.e., 480 J of work is done by the surroundings). What is the final gas temperature and pressure at equilibrium? The mass of the heater is 12 g and its heat capacity is 0.35 J/(g)(K). Assume that the heat transfer to the chamber from the gas at this low pressure and in the short time period is negligible.

3. Air is being compressed from 100 kPa and 255 K (where it has enthalpy of 480 kJ/kg) to 1000 kPa and 278 K (where it has an enthalpy of 509 kJ/kg). The exit velocity of the air from the compressor is 60 m/s. What is the power required (in kW) for the compressor if the load is 100 kg/hr of air?

4. Water is being pumped form the bottom of a well 15 ft deep at the rate of 200 gal/hr into a vented storage tank to maintain a level of water in a tank 165 ft above the ground. To prevent freezing in the winter a small heater puts 30,000 Btu/hr into the water during its transfer from the well to the storage tank. Heat is lost from the whole system at the constant rate of 25,000 Btu/hr. What is the temperature of the water as it enters the storage tank, assuming that the well water is at 35 °F? A 2-HP pump is being used to pump the water. About 55% of the rated horsepower goes into the work of pumping the rest is dissipated as heat to the atmosphere.

5. Assuming ideal gas behavior, calculate the heat that must be transferred in each of the following cases.
    1. A stream of nitrogen flowing at a rate of 100 mol/min is heated form 20 °C to 100 °C.
    2. Nitrogen contained in a 5-liter flask at an initial pressure of 3 bar is cooled from 90 °C to 30 °C.