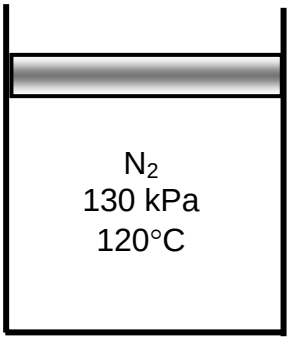
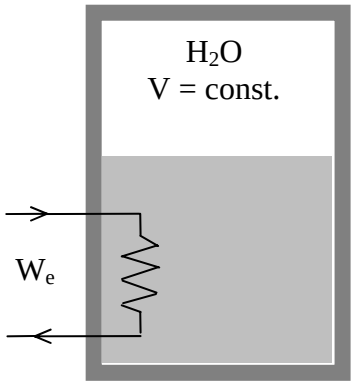
Chapter 4

4-8. A piston–cylinder device initially contains 0.07 m^3 of nitrogen gas at 130 kPa and 120°C. The nitrogen is now expanded polytropically to a state of 100 kPa and 100°C. Determine the boundary work done during this process.



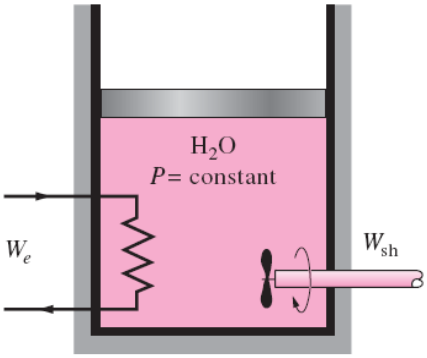
4-15. During an expansion process, the pressure of a gas changes from 100 to 700 kPa according to the relation P = aV + b, where a = 1220 kPa/m^3 and b is a constant. If the initial volume of the gas is 0.2 m^3, calculate the work done during the process. Answer: 197 kJ

4-33. A well-insulated rigid tank contains 5 kg of a saturated liquid–vapor mixture of water at l00 kPa. Initially, three-quarters of the mass is in the liquid phase. An electric resistor placed in the tank is connected to a 110-V source and a current of 8 A flows through the resistor when the switch is turned on. Determine how long it will take to vaporize all the liquid in the tank. Also, show the process on a *T-v* diagram with respect to saturation lines.



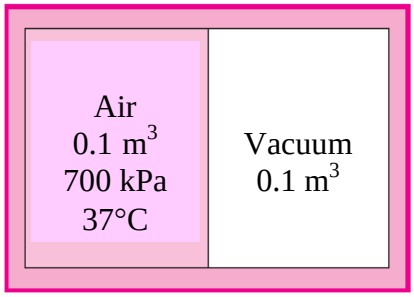
4-37. An insulated piston–cylinder device contains 5 L of saturated liquid water at a constant pressure of 175 kPa. Water is stirred by a paddle wheel while a current of 8 A flows for 45 min through a resistor placed in the water. If one-half of the

liquid is evaporated during this constant pressure process and the paddle-wheel work amounts to 400 kJ, determine the voltage of the source. Also, show the process on a P-v diagram with respect to saturation lines. Answer: 224 V

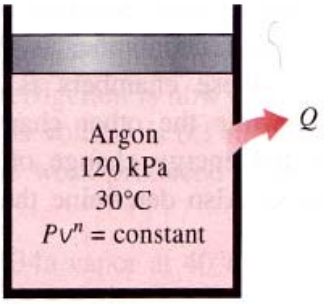


4-62. A rigid tank contains 10 kg of air at 350 kPa and 27 °C. The air is now heated until its pressure doubles. Determine (a) the volume of the tank and (b) the amount of heat transfer. Answer: (a) 2.46 m^3, (b) 2207 kJ

4-65. A 0.1 m3 adiabatic rigid container is devide into two equal volumes by a thin membrane, as shown in fig. P4-65. Initially, one of these chambers is filled with air at 700 kPa and 37 °C while the other chamber is evacuated. Determine the internal energy change of the air when the membrane is ruptured. Also determine the final air pressure in the container.

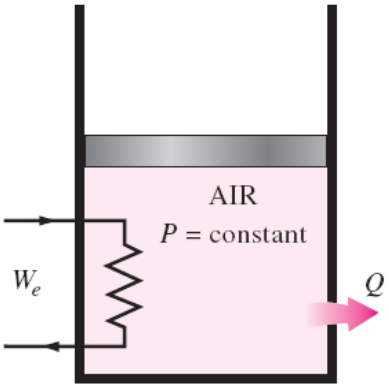


4-70. Argon is compressed in a polytropic process with n = 1.2 from 120 kPa and 30°C to 1200 kPa in a piston – cylinder device. Determine the work produced and heat transferred during this compression process, in kJ/kg.



4-75. A mass of 15 kg of air in a piston–cylinder device is heated from 25 to 77°C by passing current through a resistance heater inside the cylinder. The pressure inside the cylinder is held constant at 300 kPa during the process, and a heat loss of 60 kJ occurs. Determine the electric energy supplied, in kWh.

Answer: 0.235 kWh



4-154. A 3 – m3 rigid tank contains nitrogen gas at 500 kPa and 300 K. Now heat is transfer to the nitrogen in the tank and the pressure of nitrogen rises to 800 kPa. The work done during this process is

(a) 500 kJ (b) 1500 kJ

(c) 0 kJ (d) 900 kJ

(e) 2400 kJ