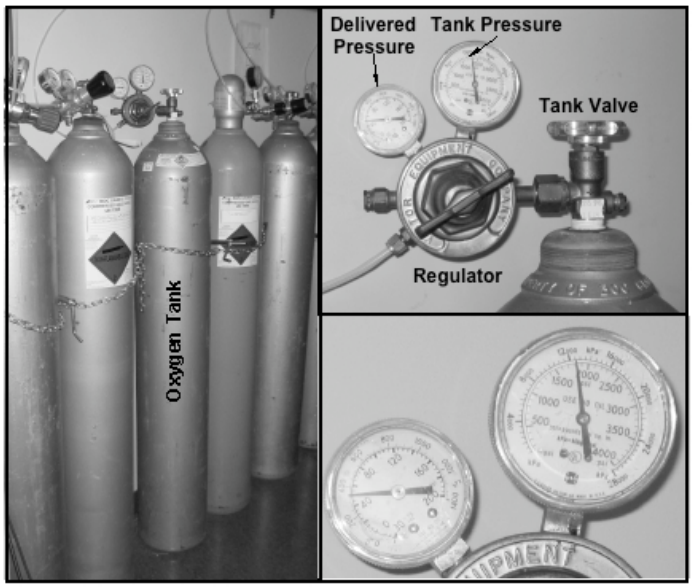
PROBLEM 5.62

An oxygen tank with a volume of 2.5 ft^3 is kept in a room at 50°F. An engineer has used the ideal gas equation of state to determine that if the tank is first evacuated and then charged with 35.3 lb_m of pure oxygen, its rated maximum allowable working pressure (MAWP) will be attained. Operation at pressures above this value is considered unsafe.

Background Information

A photo of an oxygen tank is shown below. When full, the pressure inside the tank is about 2500 psig. The pressure in the tank shown is about 1800 psig so some of the oxygen has been used. A ***pressure regulator*** is used to step down the internal pressure to the desired use pressure, in this case, 200 psig or less. The regulator has two gauges; one to measure the internal pressure and one to measure the delivery pressure. The delivery pressure for the tank in the photo has been set to about 50 psig. Gas tanks such as these are usually rented—one pays for the gas plus a monthly tank rental fee and trades empty tanks for tanks that have been refilled by the gas supplier. The tanks are expensive so the gas suppliers continue to reuse them as long as possible.



(a) What is the maximum allowable working pressure (psig) of the tank?

(b) You suspect that at the conditions of the fully charged tank, ideal gas behavior may not be a good assumption. Use the SRK equation of state to obtain a better estimate of the maximum mass of oxygen that may be charged into the tank. Did the ideal gas assumption lead to a conservative estimate (on the safe side) or a nonconservative estimate of the amount of oxygen that could be charged?

(c) Suppose the tank is charged and ruptures before the amount of oxygen calculated in part (b) enters it. (It should have been able to withstand pressures up to four times the MAWP.) Think of at least five possible explanations for the failure of the tank below its rated pressure limit.