Question # 75147

A compressed air storage cylinder has a volume of 1 m3 and contains air at an absolute pressure of 2 MPa and temperature 25°C. A quantity of the air is released during which the temperature of the remaining air falls to 15°C and the pressure to 1 MPa. The characteristic gas constant for air is 287 Jkg−1K−1.

Calculate the mass of the air released.

Answer:

The general gas equation is given by

$$PV = MRT, \tag{1}$$

where P is the pressure of the gas,

V is the volume of the gas,

M is the mass of the gas,

R is the characteristic gas constant,

T is the absolute temperature of the gas.

Equation (1) gives the relation between the initial and final parameters of the air, which mass remains constant:

$$\frac{P_0 V_0}{T_0} = \frac{P_1 V_1}{T_1},$$

So, the final volume of the air to reach 15°C at 1 MPa should be:

$$V_1 = V_0 \frac{P_0 T_1}{P_1 T_0} = 1 \cdot \frac{2 \cdot (15 + 273)}{1 \cdot (25 + 273)} = 1.93 \text{ m}^3.$$

Since the volume of the storage air cylinder remains constant, then (1.93 – 1)m^3 = 0.93m^3 of air at final parameters should be released. From (1) the mass of the released air equals to:

$$M = \frac{PV}{RT} = \frac{10^6 \cdot 0.93}{287 \cdot (15 + 273)} = 11.3 \text{ kg}.$$