Introduction to Thermodynamics and Heat Transfer + EES Software (2nd Edition)

Problem

The pressure in an automobile tire depends on the temperature of the air in the tire. When the air temperature is 25°C, the pressure gage reads 210 kPa. If the volume of the tire is 0.025 m3, determine the pressure rise in the tire when the air temperature in the tire rises to 50°C. Also, determine the amount of air that must be bled off to restore pressure to its original value at this temperature. Assume the atmospheric pressure is 100 kPa.

FIGURE P4-79

Step-by-step solution

Step 1 of 6

Assume that at the given conditions air behaves as an ideal gas.

Calculate the initial absolute pressure in the tire by using the equation:

$$P_1 = P_g + P_{atm}$$

Here, the initial absolute pressure in the tire is P_1, the gauge pressure reading is P_g and the atmospheric pressure is P_{atm}.

Substitute $210\,\text{kPa}$ for P_g and $100\,\text{kPa}$ for P_{atm}.

$$P_1 = 210 + 100$$
$$= 310\,\text{kPa}$$

Comment

Step 2 of 6

Calculate the final pressure in the tire by using the ideal gas equation.

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \quad \text{..... (1)}$$

Here, the volume of air in the tire remains constant and hence $V_1 = V_2 = V$.

…… (2)

Here, the initial and final temperatures are T_1 an

the initial and final volumes are V_1 and V_2 respectively.

Substitute for T_2, $298\,\mathrm{K}$ for T_1 and $310\,\mathrm{kPa}$ for P_1 in equation (2).

$$P_2 = \frac{323}{298} \times 310$$
$$= 336\,\mathrm{kPa}$$

Comment

Step 3 of 6

Calculate the pressure rise in the tire when the air temperature rises to $50\,^\circ\mathrm{C}$.

$$\Delta P = P_2 - P_1$$

Here, the pressure rise in the tire when the air temperature rises to $50\,^\circ\mathrm{C}$ is ΔP.

Substitute for and for .

Comments (2)

Step 4 of 6

Calculate the initial mass of air in the tire.

Here, the initial mass of air in the tire is and the universal gas constant is *R*.

Substitute for , for , for *R* and for .

Comments (2)

Step 5 of 6

Calculate the final mass of air in the tire when the air must bleed off to restore the pressure of air to its initial value.

Here, the final mass of air in the tire when the air must bleed off to restore the pressure of air to its initial value is .

Substitute for , for , for *R* and for .

Comments (7)

Step 6 of 6

Calculate the amount of of air in the tire when the air must bleed off to restore the pressure of air to its initial value.

Here, the amount of of air in the tire when the air must bleed off to restore the pressure of air to its initial value is .

Therefore, the amount of of air in the tire when th
air to its initial value is .

Chapter 4, Problem 79P | Bookmark | Show all steps:

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