Answer on Question #54460, Physics / Molecular Physics | Thermodynamics

Expansion joints are used for materials that easily expand and contract depending upon its temperature. How much expansion can take place for a brass pipe 25.8 m long that experiences temperature changes of 75.2°C?

Solution:

The temperature expansion of pipes depends on the start and final temperature of the pipe and the expansion coefficient of the piping material at the actual temperature. The general expansion formula can be expressed as:

$$\mathrm{dl} = \alpha\, \mathrm{L}_0\, \mathrm{dt}$$

Where

dl = expansion (m, inches)

L_0 = length of pipe (m, inches)

dt = temperature difference (^{0}C, ^{0}F)

α = linear expansion coefficient ($\frac{\mathrm{m}}{\mathrm{m}^0\mathrm{K}}, \frac{\mathrm{in}}{\mathrm{in}^0\mathrm{F}}$)

When an object is heated or cooled, its length changes by an amount proportional to the original length and the change in temperature. Linear thermal expansion of an object can be expressed as:

$$\mathrm{dl} = \mathrm{L}_0\, \alpha\, (\mathrm{t}_1 - \mathrm{t}_0)$$

Where

t_0 = initial temperature (^{0}C, ^{0}F)

t_1 = final temperature (^{0}C, ^{0}F)

First, we indicate the coefficients of linear expansion for brass, which is equal to 0.0000189 (per °C). L_0(Length of the pipe) = 25.8 m, change of the temperature is equal to 75.2°C.

Now, we can apply the formula noted above in order to determine the change in length (m):

$$\text{Difference in length}(\mathrm{dl}) = \alpha\, \mathrm{L}_0\, \mathrm{dt} = 0.0000189\, \frac{\mathrm{m}}{\mathrm{m}^0\mathrm{C}} \cdot\ 25.8\ \mathrm{m} \cdot\ 75.2°\mathrm{C} = 0.03667\ \mathrm{m}$$

Answer: The dimensional change (change of length) for a brass pipe is equal to 0.03667 m.