Answer on Question #51730, Physics, Molecular Physics | Thermodynamics

Poisson's ratio is 0.4, longitudinal strain is $2*10^{-3}$, so what will be the volume percentage?

Solution:

Poisson's Ratio can be expressed as

$$\nu = -\frac{\varepsilon_t}{\varepsilon_l}$$

where

ν = Poisson's ratio

ε_t = transverse strain

ε_l = longitudinal or axial strain

Strain can be expressed as

$$\varepsilon = \frac{\Delta L}{L}$$

where

ΔL = change in length (m, ft)

L = initial length (m, ft)

For a cube stretched in the x-direction with a length increase of ΔL in the x direction, and a length decrease of ΔL' in the y and z directions

$$\nu \approx \frac{\Delta L'}{\Delta L}$$

The relative change of volume ΔV/V of a cube due to the stretch of the material can now be calculated. Using V=L^3 and

$$V + \Delta V = (L + \Delta L)(L - \Delta L')^2$$

$$\frac{\Delta V}{V} = \left(1 + \frac{\Delta L}{L}\right)\left(1 - \frac{\Delta L'}{L}\right)^2 - 1$$

Using the above derived relationship between ΔL and ΔL':

$$\frac{\Delta V}{V} = \left(1 + \frac{\Delta L}{L}\right)^{1-2\nu} - 1$$

and for very small values of ΔL and ΔL', the first-order approximation yields:

$$\frac{\Delta V}{V} \approx (1 - 2\nu)\frac{\Delta L}{L}$$

Hence,

$$\frac{\Delta V}{V} \approx (1 - 2 * 0.4) * 2 * 10^{-3} = 0.0004 \text{ or } 0.04\%$$

Answer: $\frac{\Delta V}{V} = 0.04\ \%$