Attach a coordinate system to the surface of the pressure vessel as shown below, such that the z-axis is normal to the surface.

Figure E4.1
The ratio of radius to thickness, $r/t$, is such that it is reasonable to employ the thinwalled tube assumption, and the resulting stress equations A6-1 to A6-6. Denoting the pressure as $p$, we have

$$
\sigma_x = \frac{pr}{2t} = \frac{(2\text{MPa})(1500\text{mm})}{2(5\text{mm})} = 300\text{MPa}
$$

$$
\sigma_y = \frac{pr}{t} = \frac{(2\text{MPa})(1500\text{mm})}{5\text{mm}} = 600\text{MPa}
$$

The value of $\sigma_z$ varies from $-p$ on the inside wall to zero on the outside, and for a thinwalled tube is everywhere sufficiently small that $\sigma_z \approx 0$ can be used. Substitute these stresses, and the known $E$ and $v$ into Hooke’s Law, Eqs.6-9 and 6-10, which gives
\[ \varepsilon_x = 6.00 \times 10^{-4} \quad \varepsilon_y = 2.55 \times 10^{-3} \quad \varepsilon_z = -1.35 \times 10^{-3} \]

These strains are related to the changes in length \( \Delta L \), circumference \( \Delta (\pi d) \), diameter \( \Delta d \), and thickness \( \Delta t \), as follows:

\[
\varepsilon_x = \frac{\Delta L}{L} \quad \varepsilon_y = \frac{\Delta (\pi d)}{\pi d} = \frac{\Delta d}{d} \quad \varepsilon_z = \frac{\Delta t}{t}
\]

Substituting the strains from above and the known dimensions gives

\[
\Delta L = 6 \text{mm} \quad \Delta d = 7.65 \text{mm} \quad \Delta t = -6.75 \times 10^{-3}
\]

Thus, there are small increases in length and diameter, and a tiny decrease in the wall thickness.