Chapter 14 Problem 37 [†]

Given

$P = 6.2 \times 10^5\ N/m^2$
$\rho = 4.5\ kg/m^3$
$\gamma = 1.61$
$\lambda = 50\ cm = 0.50\ m$

Solution

Find the frequency of the wave under these conditions.

First the velocity of the wave must be found. This depends on the density and pressure by the equation

$$v = \sqrt{\frac{\gamma P}{\rho}} \tag{1}$$

The relationship between velocity and frequency is

$$v = f \cdot \lambda \tag{2}$$

Combining Equations 1 and 2 and solving for frequency gives

$$f = \frac{v}{\lambda} = \frac{1}{\lambda}\sqrt{\frac{\gamma P}{\rho}} = \frac{1}{(0.50\ m)}\sqrt{\frac{(1.61)(6.2 \times 10^5\ N/m^2)}{(4.5\ kg/m^3)}}$$

$$f = 942\ Hz$$

Under normal conditions in air the frequency would be

$$f = \frac{v}{\lambda} = \frac{(343\ m/s)}{(0.5\ m)} = 686\ Hz$$

[†] Problem from Essential University Physics, Wolfson