# Problem 2.17

We have

$P_L = 1.0133 \times 10^5$ Pa

$T_L = 298$

$\sigma = 0.071$ N/m

$\rho_L \approx 1000$ kg/m$^3$

$\gamma = C_{pG} / C_{vG} = 1.4$

$\rho_G = 1.18$ kg/m$^3$

The volumetric and second mode oscillation frequencies are found from

$$f_0 = \frac{\omega_0}{2\pi} = \frac{1}{2\pi}\sqrt{\frac{3\gamma P_L}{\rho_L R_0^2}}$$

$$f_2 = \frac{\omega_2}{2\pi} = \frac{1}{2\pi}\left\{\frac{24\sigma}{R_0^3\left[3\rho_G + 2\rho_L\right]}\right\}^{1/2}$$

The results are as follows

| $R_0$ (m) | $f_0$ (Hz) | $f_2$ (Hz) |
|---|---|---|
| $1.0 \times 10^{-5}$ | $3.28 \times 10^5$ | $1.47 \times 10^5$ |
| $1.0 \times 10^{-4}$ | $3.28 \times 10^4$ | 4,641 |
| $5 \times 10^{-4}$ | 6,567 | 415 |

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{P 2.17}
R_01=10.e-6
R_02=100.e-6
R_03=500.e-6
gamma=1.4
P_L=101330.
T_L=298.
rho_L=1000.
sigma=0.071
omega_01=sqrt(3.*gamma*P_L/(rho_L*R_01^2))
f_01=omega_01/(2.*pi)
omega_02=sqrt(3.*gamma*P_L/(rho_L*R_02^2))
f_02=omega_02/(2.*pi)
omega_03=sqrt(3.*gamma*P_L/(rho_L*R_03^2))
f_03=omega_03/(2.*pi)
rho_a=density(air, P=P_L, T=T_L)
omega_21=sqrt((24.*sigma)/(R_01^3*(3.*rho_a+2.*rho_L)))
omega_22=sqrt((24.*sigma)/(R_02^3*(3.*rho_a+2.*rho_L)))
omega_23=sqrt((24.*sigma)/(R_03^3*(3.*rho_a+2.*rho_L)))
f_21=omega_21/(2.*pi)
f_22=omega_22/(2.*pi)
f_23=omega_23/(2.*pi)
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$R_{01} = 0.00001$

$R_{02} = 0.0001$

$R_{03} = 0.0005$

$\gamma = 1.4$

$P_L = 101330$

$T_L = 298$

$\rho_L = 1000$

$\sigma = 0.071$

$$\omega_{01} = \sqrt{3 \cdot \gamma \cdot \frac{P_L}{\rho_L \cdot R_{01}^{\,2}}}$$

$$f_{01} = \frac{\omega_{01}}{2 \cdot \pi}$$

$$\omega_{02} = \sqrt{3 \cdot \gamma \cdot \frac{P_L}{\rho_L \cdot R_{02}^{\,2}}}$$

$$f_{02} = \frac{\omega_{02}}{2 \cdot \pi}$$

$$\omega_{03} = \sqrt{3 \cdot \gamma \cdot \frac{P_L}{\rho_L \cdot R_{03}^{\,2}}}$$

$$f_{03} = \frac{\omega_{03}}{2 \cdot \pi}$$

$$\rho_a = \rho['Air', P = P_L, T = T_L]$$

$$\omega_{21} = \sqrt{\frac{24 \cdot \sigma}{R_{01}^{\,3} \cdot [3 \cdot \rho_a + 2 \cdot \rho_L]}}$$

$$\omega_{22} = \sqrt{\frac{24 \cdot \sigma}{R_{02}^{\,3} \cdot [3 \cdot \rho_a + 2 \cdot \rho_L]}}$$

$$\omega_{23} = \sqrt{\frac{24 \cdot \sigma}{R_{03}^{\,3} \cdot [3 \cdot \rho_a + 2 \cdot \rho_L]}}$$

$$f_{21} = \frac{\omega_{21}}{2 \cdot \pi}$$

$$f_{22} = \frac{\omega_{22}}{2 \cdot \pi}$$

$$f_{23} = \frac{\omega_{23}}{2 \cdot \pi}$$

SOLUTION

Unit Settings: [J]/[K]/[Pa]/[kg]/[degrees]

| | | |
|---|---|---|
| $f_{01} = 328332$ | $f_{02} = 32833$ | $f_{03} = 6567$ |
| $f_{21} = 146776$ | $f_{22} = 4641$ | $f_{23} = 415.1$ |
| $\gamma = 1.4$ | $\omega_{01} = 2.063E+06$ | $\omega_{02} = 206297$ |
| $\omega_{03} = 41259$ | $\omega_{21} = 922219$ | $\omega_{22} = 29163$ |
| $\omega_{23} = 2608$ | $P_L = 101330$ | $\rho_a = 1.185$ |
| $\rho_L = 1000$ | $R_{01} = 0.00001$ | $R_{02} = 0.0001$ |
| $R_{03} = 0.0005$ | $\sigma = 0.071$ | $T_L = 298$ |

1 potential unit problem was detected.