! Sound values - Sound field quantities and Sound energy quantities Answers

German Version: Schallgrößen - Schallfeldgrößen und Schallenergiegrößen http://www.sengpielaudio.com//Schallgroessen-TUAntworten.pdf

Source: Collection of exercises from the Department of Communication of the TU Berlin

UdK Berlin
Sengpiel
02.2013
F + A

For a progressive plane wave the RMS value of the sound pressure p = 0.05 N/m² or 0.05 Pa is found.

$$Z_0 = \frac{p}{v} = \rho \times c$$

a) What is the particle velocity v? The acoustic impedance $Z_0 = p / v = \rho \times c$ = 413 N·s/m³.

$$v = \frac{p}{Z_0}$$

v = 0.05 N/m² / 413 N·s/m³ = 1.21×10⁻⁴ m/s = 0.121 mm/s

b) What is the particle displacement ξ for the frequencies f = 100 Hz and f = 1000 Hz?

$$\xi = \frac{v}{\omega} = \frac{v}{2\pi \times f}$$

This maximum displacement of the air particles is often expressed by amplitude.

ξ at 100 Hz = 1.21×10⁻⁴/(6.283 × 100) = 1.926×10⁻⁷ = 0,1926 µm

ξ at 1000 Hz = 1.21×10⁻⁴/(6.283 × 1000) = 1.926×10⁻⁸ = 0,01926 µm

c) What is the sound intensity I?

$$I = p \cdot v \qquad \text{W = N·m / s}$$

I = 0.05 N/m² × 1.21×10⁻⁴ m/s = 0,00000605 N·m/ m²·s = 6.05×10⁻⁶ W/m²

d) What is the sound power P, passing through an area of A = 4 m?

$$P = \int I dA$$

$P = I \times A$ = 6.05·10⁻⁶ W/m² × 4 m² = 0.0000242 W = 24.2×10⁻⁶ W

e) What is the sound pressure level L_p?

$$L_p = 20 \times \log_{10}\left(\frac{p}{p_0}\right) \text{ in dB}$$

L_p = 20 × log (5×10⁻² / 2×10⁻⁵) dB = 67.96 dB

f) What is the sound intensity level L_I?

$$L_I = 10 \times \log_{10}\left(\frac{I}{I_0}\right) \text{ in dB}$$

L_I = 10 × log (6.05×10⁻⁶ W/m² / 1×10⁻¹² W/m²) dB = 67.82 dB

g) What is the sound power level L_W for above calculated sound power?

$$L_W = 10 \times \log_{10}\left(\frac{P}{P_0}\right) \text{ in dB}$$

L_W = 10 × log (24.2×10⁻⁶ W / 1×10⁻¹² W) dB = 73.84 dB