Sound Intensity and Sound Power

The energy flow through the medium per unit area per unit time is defined as the sound intensity, I.

The units for sound intensity are watts/m^2.

Since energy per unit time equals the sound power W, we relate the intensity and power as follows:

Intensity = POWER/AREA

Both Sound intensity and power are rms quantities.

Sound Intensity and Sound Power

For the case of a point source, we assume that a spherical wave is propagated.

At a distance r from the point source, the surface area of the spherical wave front equals $4\pi r^2$, so that the sound intensity at this distance from the source is

$$I = W/ 4\pi r^2$$

We observe that the intensity decreases inversely as the square of the distance from the sound source, which generates a fixed amount of sound power.

Sound Intensity

This effect is called the Inverse square law for the sound intensity.

Relationship of sound intensity with the rms pressure experienced by the air molecules as the sound wave propagates through the medium:

$I = p^2 / \rho c$

Sound Intensity

$I = p^2 / \rho c$

p = rms sound pressure in pascals

ρ = air density in kg/cum

c = speed of propagation in m/s

ρc = *specific acoustic impedance* of the medium in kg per square meter-sec

This equation is true for both plane and spherical waves.

Reverse engineering approach for determining sound power

$I = p^2/ \rho c$

If we have a means of measuring the root-mean-square pressure, then the sound intensity is known from the above equation.
Having the sound intensity, the distance from the source, and assuming freely propagating spherical waves from the source, we can calculate the sound power.
This is one established procedure for determination of sound power of industrial equipment.

Sample problems

Q1. A body oscillates in simple harmonic motion at 500Hz. If the air temperature is 10 deg Celsius, find the wave length of the sound wave propagated by the vibrating body.

Q2. Find the root-mean-square pressure of a spherical wave whose intensity equals to 2 W/m^2 at room temperature (22 deg c).

Q3. At 3 m from a sound source the root-mean-square pressure is measured as 0.632 Pa. Assuming a point source, room temp and atmospheric pressure, calculate the sound power.

Sample problems

Q4. If the sound intensity level increases from 80 dB to 83 dB, what is the percentage change in sound intensity ?