# ACOUSTICS

## LECTURE 1

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# Addition and Subtraction of Decibels

For the addition of sound pressure levels $L_1$, $L_2$, $L_3$, the following formula can be used:

$$L_{total} = 10 \log_{10} \{10^{L1/10} + 10^{L2/10} + 10^{L3/10}\}$$

The previous formula can be extended for the addition of any number of sound pressure levels.

For identical machines, the formula becomes as follows:

$$L_{total} = L_{\text{for one machine}} + 10 \log_{10} n$$

Where n is the total number of machines

Similarity, subtraction of decibels is achieved using the following equation:

$$L_1 = 10 \log_{10} \{10^{L\text{total}/10} - 10^{L2/10}\}$$

**Example 1.1:**

Two sound sources operating together produce 81 dB at a particular point. One source is switched off and the sound level falls to 80 dB. What would be the sound level if the other source was switched off instead?

## Solution:

$$L_2 = 10 \log_{10} \{10^{81/10} - 10^{80/10}\} = 74.1 \text{ dB}$$

**Example 1.2:**

The noise level from a factory with 10 identical machines, measured near some residential property was found to be 54 dB. The maximum permitted noise level at night is 50 dB. How many machines could be used during the night?

Solution:

$$54 = L_{\text{for one machine}} + 10 \log_{10} 10$$

$$L_{\text{for one machine}} = 44 \text{ dB}$$

$$50 = 44 + 10 \log_{10} n$$

$$n = 3.9$$

We can use 3 machines

IMPORTANT NOTE

**1) From the previous, calculate the following:**

The total noise level for 2 identical machines each one produces 42 dB?

The total noise level for 2 identical machines each one produces 48 dB?

The total noise level for 2 identical machines each one produces 53 dB?

**2) After calculation, what you will observe?**

**3) Give another method of solution of the previous example**

**CONCLUSION**

**For prediction the total noise level for 2 identical machines, it becomes a noise level for one machines + 3 dB.**

# Sound Pressure Level as a Function of Distance

The sound pressure level $L_{r2}$ at a distance $r_2$ can be calculated in terms of sound pressure $L_{r1}$ at a distance $r_1$ by the following equations:

- Point source:

$$L_{r2} = L_{r1} - 10\log_{10} \{r_2/r_1\}^2 \text{ dB}$$

- Line source:

$$L_{r2} = L_{r1} - 10\log_{10} \{r_2/r_1\} \text{ dB}$$

**Example 1.3:**

The sound pressure level at a distance of 20 m from a factory is 72 dB. Calculate the sound pressure level at a distance of 40 m.

If the permissible noise level outside building is 60 dB, find the minimum distance between the factory and the building.

Solution:

$L_{r1} = 72$ dB $\quad r_1 = 20$ m $\quad r_2 = 40$ m $\quad L_{r2} = ???$

The source is a factory (point source)

$L_{r2} = 72 - 10 \log_{10} \{40/20\}^2 = 66$ dB ----------request one

Max. noise level $L_{r2} = 60$ dB $\quad r_2 = ???$ $\quad r_1 = 20$ m $\quad L_{r1} = 72$ dB

$60 = 72 - 10 \log_{10} \{ r_2/20\}^2 = 79.6$ dB ----------request two

IMPORTANT NOTE

**1) From the previous, calculate the following:**

a) $Lr_2$ for a compressor machine at a distance of 20m if $Lr_1$ = 44 dB at distance of 10 m?
$Lr_2$ for a compressor machine at a distance of 50m if $Lr_1$ = 60 dB at distance of 25 m?

b) Lr2 for a traffic road at a distance of 20m if Lr1 = 44 dB at distance of 10 m?
Lr2 for a traffic road at a distance of 50m if Lr1 = 60 dB at distance of 25 m?

**2) After calculation, what you will observe?**

**3) Give another method of solution of the first request from the previous example**

**CONCLUSION**

**For point sources, the noise level decreases by 6 dB when the distance is duplicated.**

**For line sources, the noise level decreases by 3 dB when the distance is duplicated.**

**تمت بحمد الله**