Noise pollution

Subject code-CHM1002

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Contents

Noise

Introduction

- It is an unpleasant and disturbing sound, which is found to be responsible for several auditory and no-auditory adverse effects on human health and well-being, ranging from simple annoyance to hearing loss.
- The rapid growth of urbanization, industrialization, construction works, increased number of vehicles and deforestation is the major cause of air and noise pollution.
- According to WHO, Noise is considered as a major concerned environmental factor for an unhealthy society (WHO, 2011)
- Noise is a perpetual, significant contributor to occupational diseases in numerous working environments.
- Noise health effects depend on the combination of intensity, frequency and duration of exposure to noise.

Sources of Noise Pollution

- Industries
- Rail and air traffic
- Road Traffic
- Construction
- Indoor Sources
- Loud Speakers
- Fire Crackers

Impact on health due to noise pollution

Pathological Effects	Physiological Effects	Psychological Effects
Hearing loss, reduction of speech intelligibility, acoustic traumas, auditory fatigue, etc.	Changes in blood pressure, pulse rate, constriction of blood vessels, dilation of the pupil of eye and changes in blood cholesterol content, etc.	Feelings of discomfort, sleep interference, reduced intellectual performance, fatigue, vexation, irritation, distress, mental or neurological disorders, antisocial behaviour, etc.

Noise above 60dB has a negative effect on increased use of psychotropic medication

Properties of Sound

- Physically, Sound is a mechanical disturbance propagated as a wave motion in air and other elastic and mechanical media such as water or, steel.
- Physiologically, Sound is an auditory sensation evoked by this physical phenomenon.(not all sound wave evoke an auditory sensation, e.g., the frequency of ultrasound is too high to excite the sensation of hearing)
- Sound waves involve a succession of compressions and rarefactions of an elastic medium such as air.
- These waves are characterized by the amplitude of pressure changes, their frequency and the velocity of propagation.

Wavelength=speed of Sound/ frequency.

Speed of sound in air(20°C)=344 m/s.
Sound travels much faster in solids than in air.
(wood=3,962 m/s, Steel=5,029 m/s)

frequency

Number of compressions and rarefactions per unit time (sec)

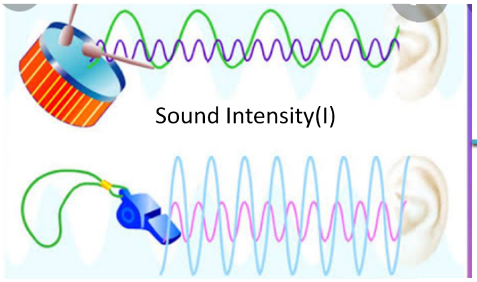
unit=hertz(Hz)

Sound Power

Rate at which energy is transmitted by a sound wave

Represented in terms of watt. Watt=Joules/Sec

Frequency range (20-20,000 Hz)



Average sound power per unit area in the direction of propagation of sound wave.

$I=W/A$ $(watt/m^2)$

For a Vibrating Sphere, $I=W/4\pi r^2$

When Noise is far away from the source,

$I=P^2/\ell e$

P=Sound Pressure

ℓ=Density of the medium i.e., air=1.185

e=speed of Sound i.e.,340m/sec.

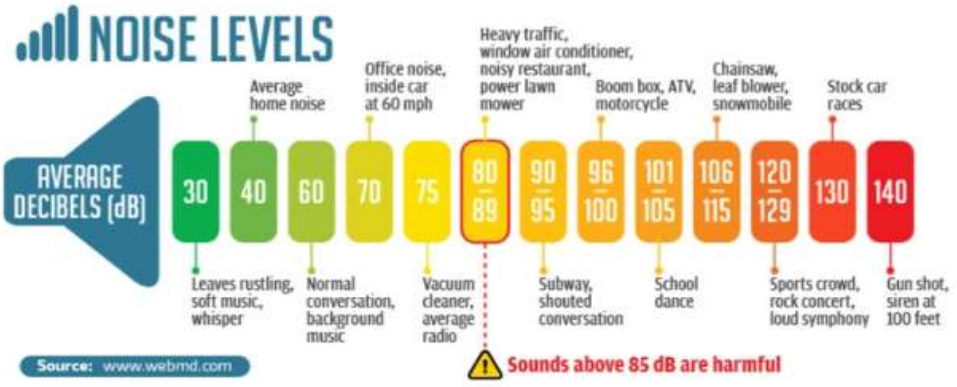
Decibel

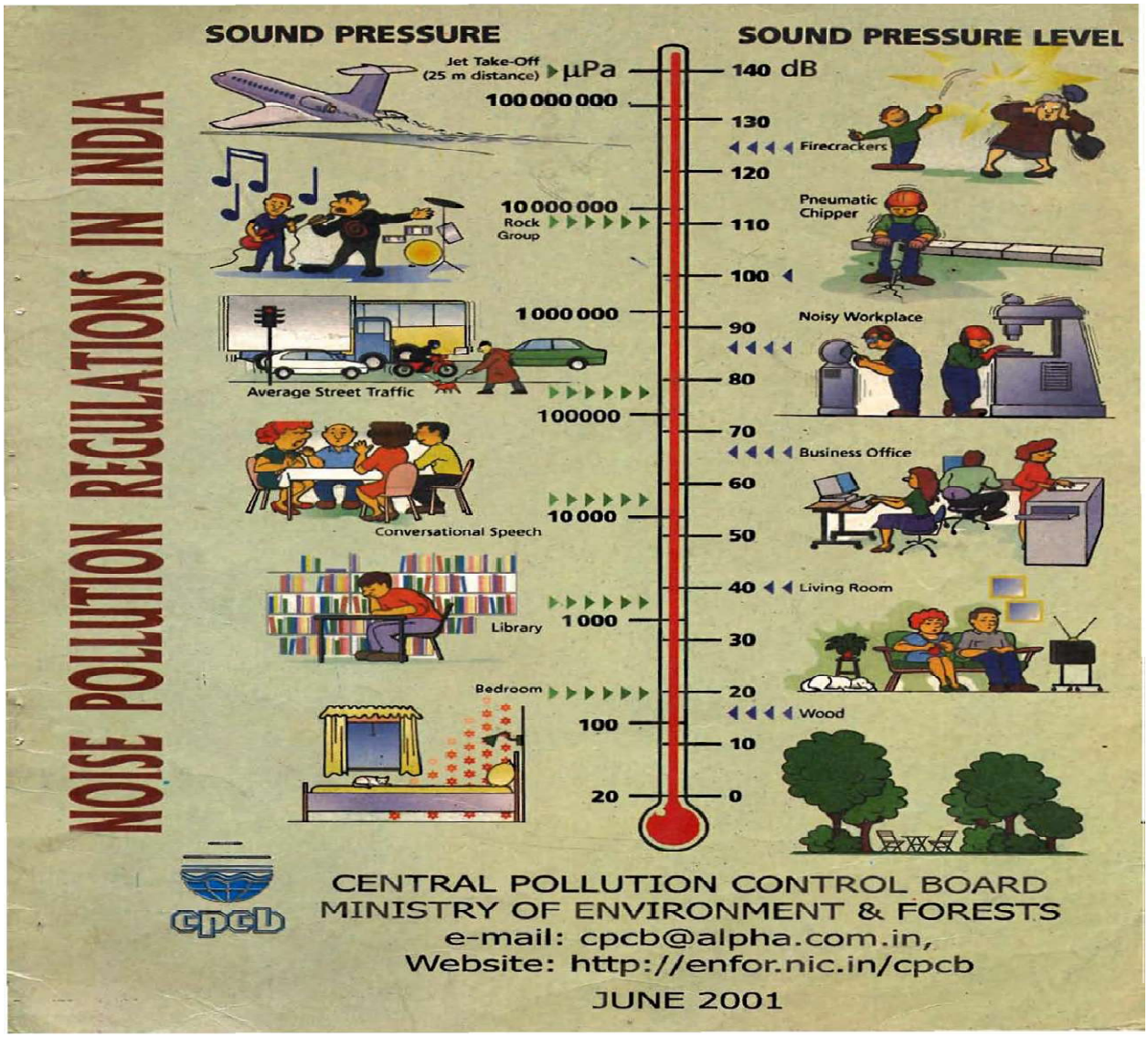
- A scale ten times the logarithm of the ratio of a measured quantity to specified reference quantity.
- It represents sound level.

Sound power level, $Lw=10\log_{10}(W/W_o)$

W=measured Sound power

W_o=Reference sound power($10^{-12}W$)





Problems

1. The sound power generated from a moving tractor is 0.001 watt. What is the Sound Power Level?

Ans-

As we know, Lw=10log10 (w/w0)

$=10\log(0.001/10^{-12})$

$=90$ dB

2. If a sound source has a pressure of 2000µp at 10m distance. Configure the sound pressure level in dB?

- Sound Intensity in watt/m².

- Sound Power in watt.

Ans. $Lw_a=10\log_{10}(Wa/W_0)$
$=>Wa = Wo \times 10^{Lwa/10}$
$=>Wa=Wox10^{61/10}$
So, $Wb=Wox10^{54/10}$ $Wc=Wox10^{73/10}$ $Wd=Wox10^{67/10}$ $We=Wox10^{\frac{45}{10}}$
$W=Wa+Wb+Wc+Wd+We$
$=Wo(10^{6.1}+10^{5.4}+10^{7.3}+10^{6.7}+10^{4.5})$
Resultant Sound Power $Lw = 10[logWo(10^{6.1}+10^{5.4}+10^{7.3}+10^{6.7}+10^{4.5})/Wo]$
$=>Lw=74.23dB$

Sound Perception and Measurement

- The magnitude of sound as perceived by human ear is called Loudness.
- Ear is not equally sensitive to all frequencies and amplitudes of sound pressure. For this reason, the sound pressure levels of two different noises may be same. The first may be judged to be louder than the second. If the sound energy of the first is concentrated in a frequency region where the ear is more sensitive.

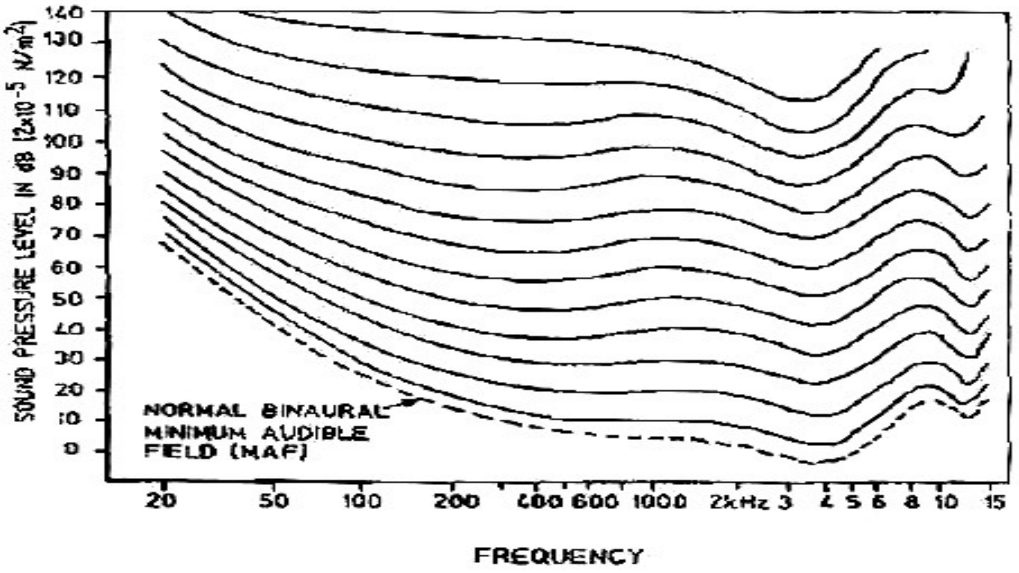


Fig. 1 Equal Loudness Contours for Pure Tones

- The frequency weighting networks are incorporated in sound level meters to obtain sound levels which bear a closer relationship to loudness than the sound pressure levels.
- Generally three types of filters having frequency response curves A,B and C are employed to find out the ear response at low, medium and high loudness
- 'A' filter provides the highest correlation between the physical measurement and subjective evaluations of loudness of noise. So, it is internationally accepted and expressed as dB(A).

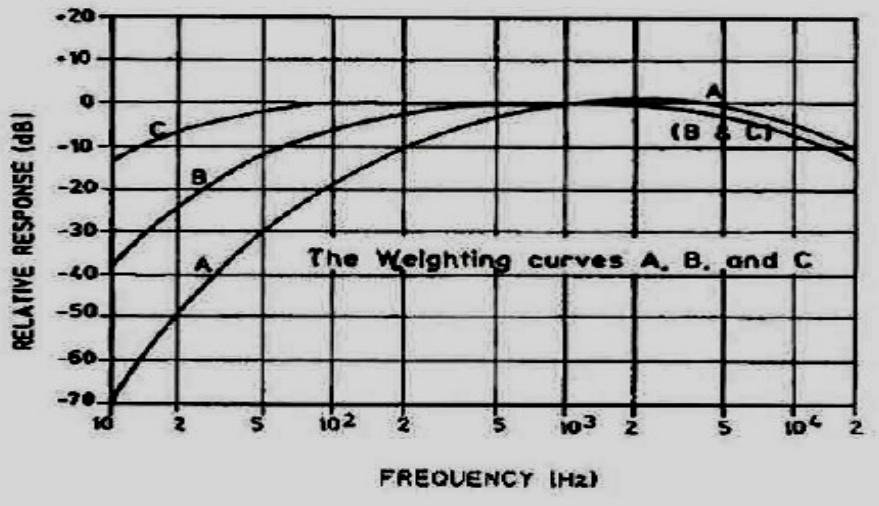


Fig. 2 Frequency- weighting Network for Sound Level Meters

Equivalent Continues Noise Level

Equivalent continues noise level (L_{Aeq}) of that steady sound which over the same interval of time contains the same total energy as the fluctuating sound.

$\mathrm{LAeq} = 10\log_{10}(\frac{1}{\mathrm{T}}\sum_{\mathrm{i}=1}^{\mathrm{n}} 10^{0.1\mathrm{li}} \times \mathrm{t_i})$

Where, T=Total time of operation.

L_i=Noise level of the ith sample.

T_i=Fraction of total time.

N=number of sample.

Sound pressure level (Lp)

Sound is measured with a Sound level meter which is usually a portable self contained instrument incorporating a microphone amplifier, a voltmeter and a attenuator. The whole of which is calibrated to read sound pressure level directly.

Sound pressure level, $Lp(dB)=10\log10\ (P/P_r)^2$.....(i)

P=measured Sound Pressure

P_r =Reference sound Pressure (20µp)

Average sound pressure levels

$\overline{Lp} = 20log\frac{1}{N}\sum_{j=1}^{N} 10^{(\frac{Lj}{20})}$.....(ii)

$\overline{Lp}$=Average Sound Pressure Level

L_j=The jth sound pressure level.

J=1,2,3.....N

Physical conditions for Noise measurement

- Noise measurement should be done at location of maximum noise.
- Maximum wind speed should be 5m/sec

- Humidity up to 90%
- Temp 10-50°C

Problem

1. If an Industrial fan generates a noise level of 65 dB(A) for 10 minutes out of every hour. Compute the LAeq, if the background level is 55dB(A)?

Ans-$L_{Aeq}=10\log_{10}(\frac{1}{T}\sum_{i=1}^{n}10^{0.1li}\times t_i)$

Here, T=60,L1=65 dB(A) and L2=55dB(A) t1=10, t2=50

So, $L_{Aeq}=10log\ [\frac{1}{60}(10^{0.1\times65}\times10)+(10^{0.1\times55}\times50)$

= 59dB(A)

Ambient Air quality standards in respect of Noise

Area Code	Category of Area/Zone	Limits of dB(A) Leq	
		Day Time	**Night Time**
A	**Industrial Area**	75	70
B	**Commercial Area**	65	55
C	**Residential Area**	55	45
D	**Silence Zone**	50	40

- Day time shall mean from 6:00 AM to 10:00 PM.
- Night time shall mean from 10.00 PM to 6:00 AM.
- Silence Zone is an area comprising not less than 100 meters around hospitals, educational institutions, and Courts Religious places or, any other area which is declared as such by the competent authority.

Permissible Noise level standards for house appliances

Home Appliances	Permissible Noise Level
Refrigerator	60dB(A)
Air Conditioner	68dB (A)
Mixer	75dB(A)
Generator	85-90dB(A)

Control of Noise

Noise Reduction at the Source

- The reduction of the exciting forces e.g., reduction of impacts or, impulsive forces, balancing of moving masses, reduction of frictional forces by proper alignment and lubrication etc.
- Reduction of the response of various components of the system of these exciting forces e.g., by application of vibration dumping materials to the radiating surfaces.
- Changes in operating procedure, e.g., a factory, adjacent to the residential areas, suspend or reduce noise generating operations at night.

Noise control of the transmission path

- Sitting e.g., increasing distance between source and the Receiver.
- Path deflection e.g., by use of barrier.
- Properly designed enclosures.
- Absorption e.g., use of sound absorbing material in a room where both the source and the receiver are present in a room.

Protective Measures at the receiver

- Use of personal protective equipment, e.g., use of earplugs, earmuffs, noise helmets etc.
- Education and public relations.
- Exposure Control. e.g., the rotation of personnel so that work assignments in the intense noise area is for a limited period of time only.