**Noise Management & Its Control**
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**Lecture – 33**
**Noise Sources & Introduction to Microphones**

Hello, welcome to noise control and its management. Today is the third day of the 6th week of this course and starting from today and the remaining part of the week what we shall be doing is we will be discussing different types of microphones and we learn all about microphones. So, that at the end of this week, hopefully, we should be comfortable in terms of understanding; how microphones work and which type of microphone is the most suitable microphone for my particular necessity which may vary from person to person. So, that is the agenda for remaining part of this week and before we start discussing microphones quickly we will talk about 3 types of noise sources.

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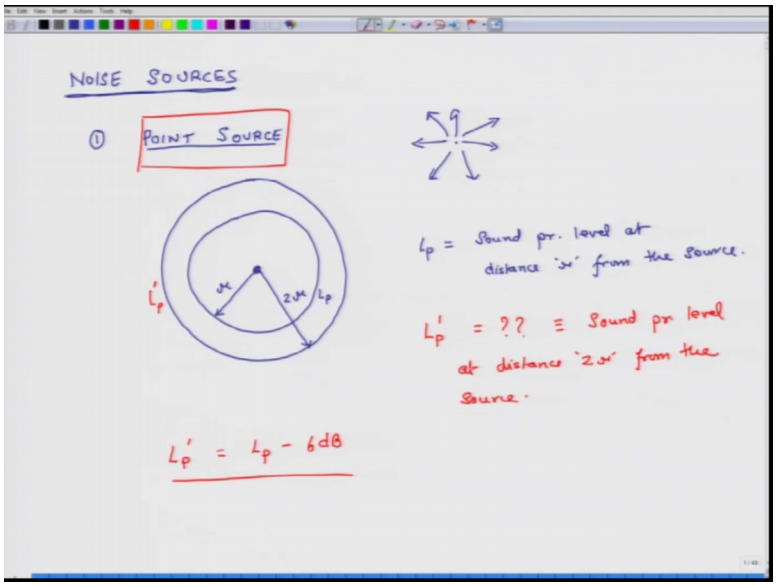


So, there are several types of noise sources, but a lot of times we encounter some special types of noise sources. So, the first type we have already discussed is a point source a point source. So, what do we have here we have a point which acts as a monopole and it emits sound in all directions and when I say all directions it is in all the 3 directions and

if it is a perfect point source then this type of a noise source will emit noise uniformly in all the directions. So, if I have a point source. So, what is special about a point source? So, based on the mathematics of point sources or monopoles which we have already done we know that suppose there are 2 concentric circles and the point source is located at the centre of these 2 circles or sphere in this case.

Let us say this distance is r and I know that this is not the right scale, but let us say that this is 2 r. So, let us say that I am measuring noise level at a distance r away from the centre where the point source or the monopole is located let us say the pressure is L p sound pressure level is L P. So, L p is sound pressure level at distance r from the source then the question is what would be this L p prime. So, the question is; what is L p prime where L p prime is corresponds to sound pressure level at distance 2 r from the source.

And based on the mathematics which we have already discussed in last several lectures, we can say because it is a spherically symmetric source essentially there will be a loss of 6 decibels. So, L p prime will be L p minus 6 decibels. So, each time for a point source you double the distance your sound pressure level falls by 6 decibels. So, if I make it 4 r, then it will be L p minus 12 decibels if I make it 6 r, it will be L p minus 18 decibels and so on and so forth. So, this is a characteristic about point sources which are ideal point sources.

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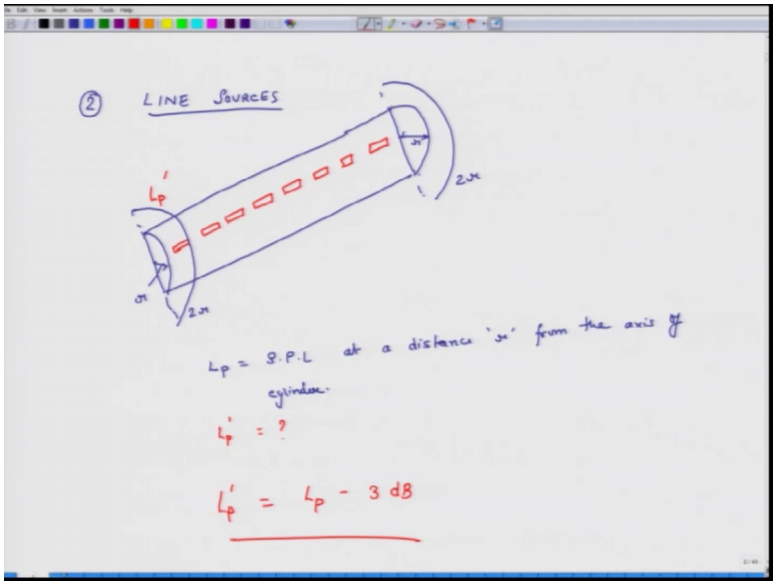


Next we will look at line sources. So, the second type of sources we are going to discuss are line sources now you may wonder what kind of a source of noise is there when I talk about line sources consider a straight road and there are lots of cars running on the straight in a line linear fashion. So, this entire thing acts as a line source the sound is being emitted across the length of the line. So, let us make a picture. So, this is the road and I have all the sources these red rectangles you can think of them as cars and theoretically they should be at zero distance away from each other.

So, these gaps should not exist and each the intensity of sound coming from each car should be the same. So, if all these things were to be true, then if I draw a cylinder and let us say the radius of this cylinder is r. So, its same thing here and I can draw another cylinder with a larger radius. So, let us say this is 2 r, then I will ask again the same question that if L P; if L p is the sound pressure level in decibels at a distance r from the axis of the cylinder from the axis of the cylinder then the question is what is L p prime that L p prime is corresponds to cylindrical surface which is 2 r distance away from its axis its radius with respect to its axis is 2 r.

So, in a spherical system you know that it falls by 6 decibels in this case and it will be important that if you use principles of energy basically the energy which is being which

is being flowing across spherical surface cylindrical surface of r will be same as that which flows across a cylindrical surface which is 2 r in radius. So, if you use that notion that energy flowing across both these cylinders is same you will find out that L p prime equals L p minus 3 decibels. So, for line sources each time you double; double the distance your sound pressure level will falls by 3 decibels and finally, we have a planar source.

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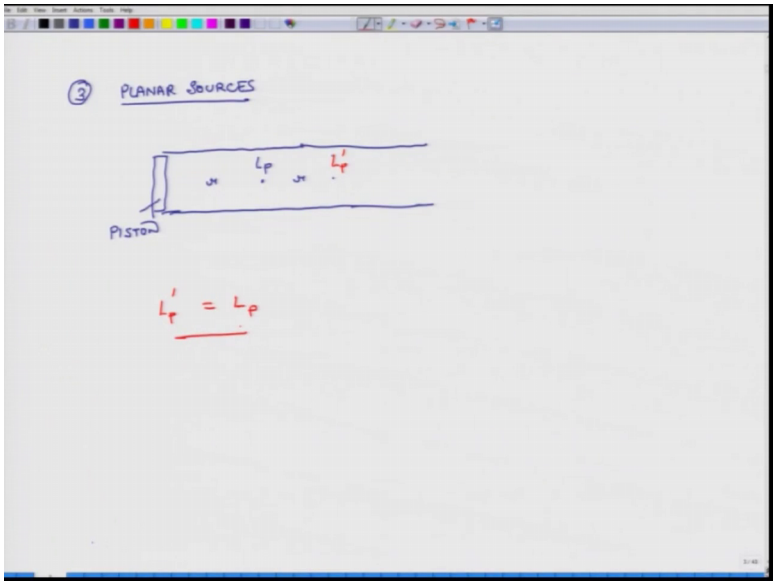


So, we have a point source. So, these are 3 special cases of sounds sound sources a point source a line source and a planar source. So, we will talk about planar sources. So, what is a planar source here a sound is being emitted by a plane and it moves in a direction normal to the plane. So, an example would be you have a long tube now this tube could have a circular cross section or rectangular cross section or whatever, but at one end of the tube you have a piston and let us say there are no reflections happening in this case.

So, this a planar source the piston is a surface and the sound which is being produced is by being produced by that whole surface right. So, it is a planar source and let us say at a distance r. So, this distance is r and this distance is another r. So, here the sound pressure level is L p then if the sound pressure level here the question is; what is L p prime. So, based on what we have understood earlier and because there is no energy loss and the

cross sectional area does not with respect to r L p prime equals L P.

So, what we have discussed are these 3 special sources of sound and it is important to talk about those before we start talking about noise measurement and all that because if you have in your situation one of these 3 types of sources then each time you double the mic distance between the microphone and the source either the sound pressure level will fall by 6 decibels or 3 decibels or it may not fall at all.

So, you may want to have this understanding before you start taking a lot of measurement. So, then it may give you some idea whether your measurements makes sense or not. So, now, we will start discussing about microphones.

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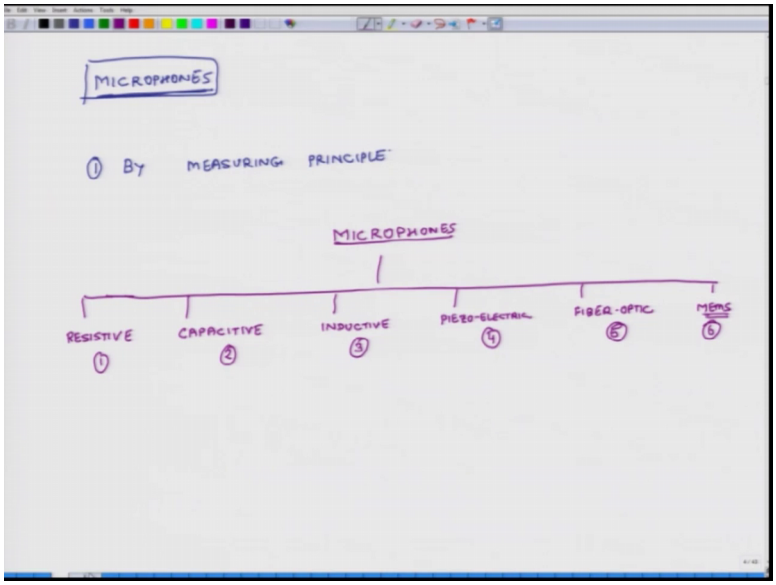


So, we will start discussing about microphones and what we will talk about is first part we will do is we will classify microphones and you can classify microphones in several ways. So, the first classification is by or by measuring principle the measuring principle this is one way to classify microphones and based on how what is the fundamental principle which in microphone uses to measure sound pressure level.

So, if I have to classify microphones according to this by measuring principle I will

make a chart. So, we will say microphones and actually we will describe these different measurement principles broadly speaking; we have 6 categories; we have 6 categories. So, in the first category we use these are resistive microphones; what they do here is they use the principle of resistance where resistance connects voltage and current v equals I r. So, we measure changes and resistance and from that we try to figure out what is the value of pressure due to sound.

So, these are resistive microphones then we have different types of capacitive microphones. So, here what we try to do is measure changes and capacitance and we will describe each of these microphones and theirs different categories, then we have inductive microphones. So, here we are trying to measure changes in inductance through measurement of some other parameters. So, that is inductive microphones and then there are some materials when you apply external pressure on them they generate internal voltage. So, these are known as piezoelectric materials. So, microphones which imply the piezoelectric effect they are known as piezoelectric microphones, then we have fibre optic microphones fibre optic microphones and then finally, we have mems based microphones.

So, in fibre optics we use principles of light and how light interacts with vibrating surfaces and based on that we use these microphones. So, what we will do is we will go one by one especially on the first five types of microphones. So, that you have a good understanding of what kind of microphones are there in the world and which particular microphone is most suitable for your needs. So, it is important to that understanding.

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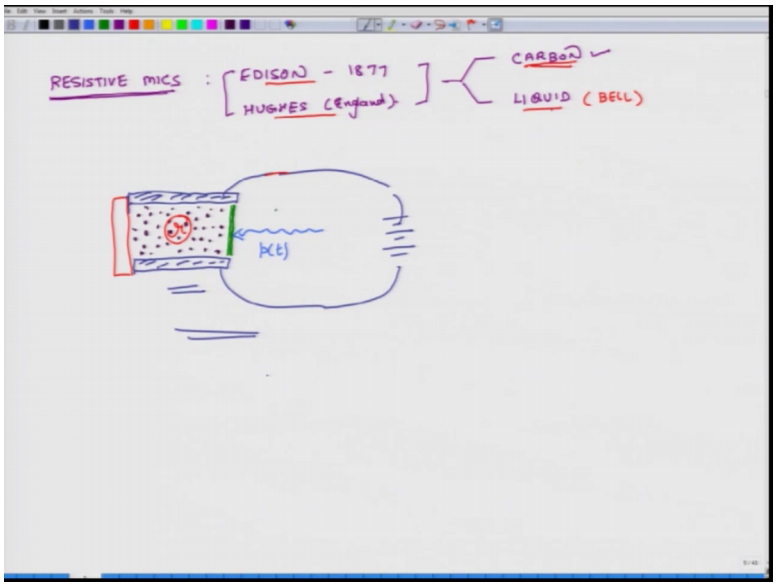


So, this is the first way to classify microphones. So, we will start by discussing resistive microphones resistive MICS. Now these were perhaps the earliest microphones developed by human beings. So, one person who made these microphones was Edison and he developed it in 1877 and in parallel another person by the name Hughes, he was in England, he also developed a similar microphone, but he developed a little latter compared to Edison, but he had no knowledge of Edison that Edison had already developed it. So, these are all independent works.

Now, the way resistive microphone works is. So, so before I talk about how it works there are 2 broad categories of resistive microphone one is known as carbon microphones and the other one is liquid microphone. So, as a name suggests in the first case we use graphite particles to measure changes in resistance and then the other case we use liquids to measure changes in resistance. So, we will discuss this carbon microphone. So, it is it was this carbon microphone which was discovered by or invented by these 2 guys; the liquid microphone was made by another inventor bell Alexander Graham Bell.

So, he made this microphone. So, let us understand how a carbon microphone works. So, what the carbon microphone has is essentially 2 metallic plates or surfaces; if you may and then you have this end is closed and this end, let us say I have a very light diaphragm very light diaphragm. So, it is in green. So, it has it has the flexibility to move in and out

and inside the inside this gap. So, this is a metal plate this is another metal plate and here I can apply some your know I can apply some voltage.

So, this is a very crude demonstration and inside I have loosely packed graphite particles. So, I do not pack them very tightly they are loosely packed. So, graphite is a form of carbon which has the ability to conduct electricity now what happens is that when sound; sound hits this diaphragm, it pushes it inside and. So, because of the sound change in sound changing sound level here which is p which is a function of t this green thing the green diaphragm moves in and out and as the diaphragm moves in the resistance of this graphite material it becomes less because the spacing between the graphite particles becomes less and as the diaphragm moves out it becomes more.

So, as a consequence the resistance here resistance it starts changing with time and that is somewhat proportional to changes in pressure. So, what people do is they try to measure the current and from the current they try to figure out how much r is changing and from that they try to figure out what is the pressure they based on some calibration methods.

So, this is resistive type of microphone and these microphones were actually very popular in earlier days and by earlier I do not mean hundred years back, but even like thirty forty years back thirty years back they were used very extensively in our old type of telephones. So, in old type of telephones you had cradle where you would have a microphone and a speaker the microphone actually worked on the basis of this resistive principle and other place where they are these microphones used to be used where in radio stations where they would have these microphones in front of the speaker and they were used very extensively. So, now, they have given way and we use other types of microphones.

So, they were very popular microphones. So, this is about the carbon the liquid microphone is somewhat similar it is somewhat similar and what you have there is basically cup filled with some water with some sulphuric acid and the purpose of sulphuric acid it makes water conductive and then they would be a needle which would be slightly dipping into the water very small amount it goes in to the water and when sound strikes the surface of water it vibrates the water the top surface of water is curved

because of surface tension and it moves up and down as it moves up and down the depth of the needle which it is into water it changes because of that the overall resistance of the system changes.

So, that is how this liquid microphone used to work. So, that one never became very popular, but carbon microphones were very popular. So, that is all about resistive microphones in the second case we will discuss about capacitive microphones and there are actually several types of capacitive microphones so, but I think we are almost out of time for today and what we will do tomorrow is we will actually discuss these other types of microphones so that you get an overall picture of what kind of technologies are there which are available; so, to ensure that we are able to measure sound pressure levels.

So, that is what we planned to do tomorrow and till then have a great day, bye.