Noise Management & Its Control
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Lecture – 40
Noise Source: Sound Attenuation

Hello, welcome to noise control and its management. Today is the fourth day of the ongoing week and today we will introduce you to sound absorbing properties of air and why is this important because in our basic problem which we have talked about where we were trying to get an estimate on the overall noise level at a particular location where we are going to place a microphone, due to the presence of several sound sources could be machines or human person or cars or whatever located at a distance away from the microphone.

As sound travels through air some of it will also get absorbed because of the presence of air. So, how much sound does get absorbed as it passes through air that is something we would like to understand and after that we will actually go back to our original problem and try to get a grip of it.

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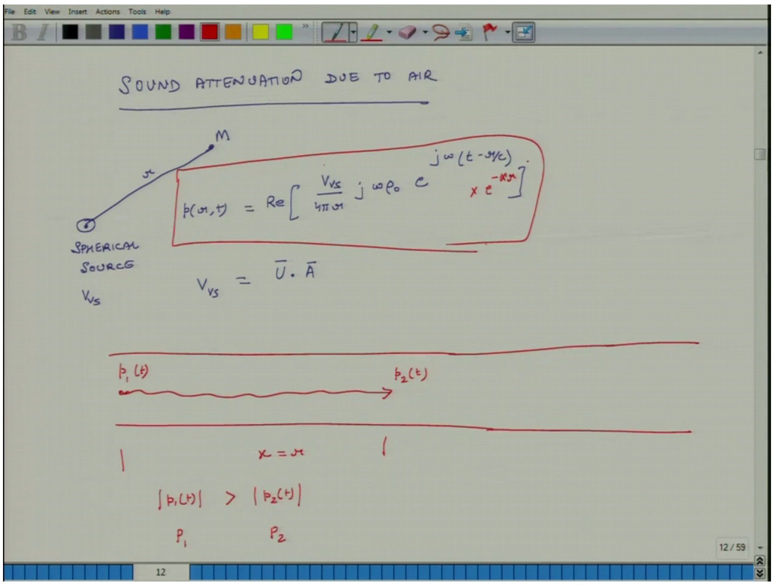

So, the theme right now is sound attenuation due to air sound attenuation due to air. Now suppose, we have a point source or not a point source, but a spherical source and its volume velocities V v s, then we had developed the expression for pressure at a distance r away

So, this is the distance and here we have a microphone m then that is pressure at the location m we had developed an expression for that and that was e is equal to real of V v s divided by 4 pi r j omega rho naught times exponent j omega t minus r by c this is the expression which we had developed couple of several weeks back in time where volume velocity of the source was; what it is the velocity of the outside surface of the sphere outside surface of the sphere because the surface is of the sphere is expanding and contracting uniformly.

So, velocity of that thing as a function of time times the outside surface area. So, that is what volume velocity is and this entire thing. So, this is the expression we have developed the thing which was not accounted for when we were doing this computation was that as sound travels from the source to the microphone it passes through air and air has very less viscosity you know it is very less. So, we had ignored the deceptive effects as sound travels some of the sound gets absorbed because of friction in the air, but we had ignored that effect of friction because we thought that it is very less but now because sound could travel over a large distance.

So, we will incorporate that role also in our relation. So, it turns out based on a lot of experimental data that as sound travels. So, suppose I have a long tube and by long I mean really really maybe 2 kilometers long tube and so, it is in very long tube and as sound and the cross section of this tube is constant as sound is travelling along the length of the tube. Suppose, here the pressure is p 1 as a function of time and after a distance x this is p 2 as a function of time and when you do measurements because of this distance the amplitude p 1 t we will see that it is less than.

So, p 1 amplitude of p 1 is going to be more than amplitude of p 2 t because sound gets absorbed by air.

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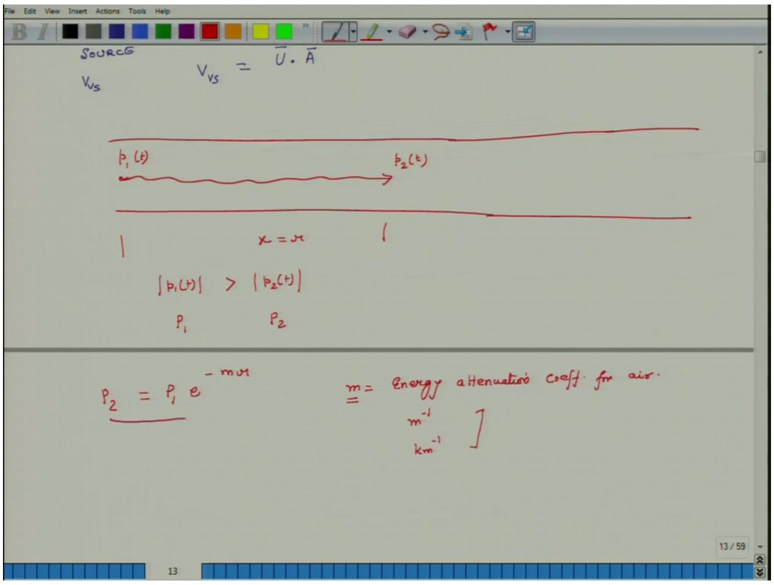

So, let us say these amplitudes are p 1 and this amplitude is p 2 and based on a lot of experimental data people have found that p 2 equals p 1 e to the power of minus m r and what is m? M is the; so, let us say this distance is equal to r x is equal to r. So, m is energy attenuation coefficient for air. So, for a straight tube with a uniform cross section the amplitude just keeps on decaying and it decays in an exponential way, but you would think that this is exponential way. So, it will go down very fast, but does not because for especially for low frequencies the value of m is extremely small.

What is the unit of m? So, m the unit of m is typically inverse of meter or in a lot of times in technical literature it can also be inverse of kilometers because this attenuation number is very small. So, you have to really travel long distances; so, either inverse of meter or inverse of kilometers. So, with this understanding the pressure here is not this entire thing because sound has travelled over a distance of hour meters this thing should also be multiplied by e to the power of minus m r and that will take care of the dissipative effect of the air as sound travels through it

So, there is a small mistake I will call this alpha; it is not m and we will see that difference in a while and I will again call this term alpha and instead of energy attenuation what is really happening is that the pressure is going down.

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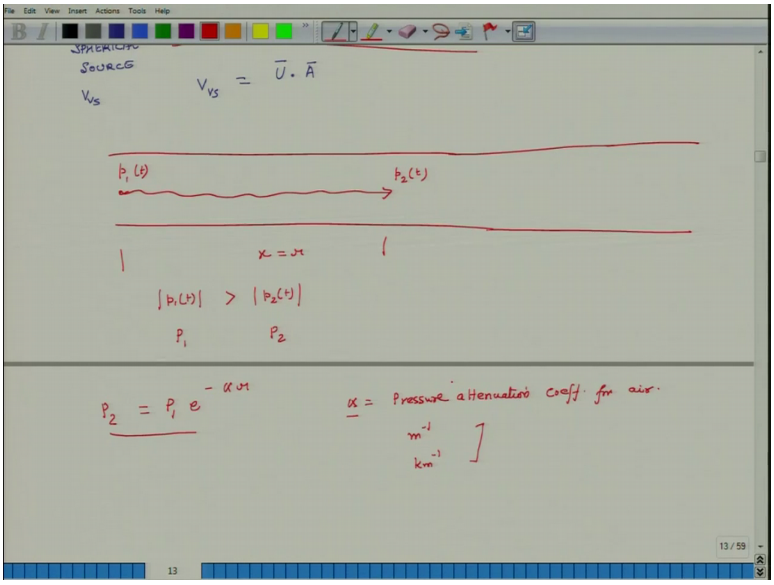

So, I called it pressure attenuation pressure attenuation coefficient and I will modify this relation as e to the power of minus alpha r.

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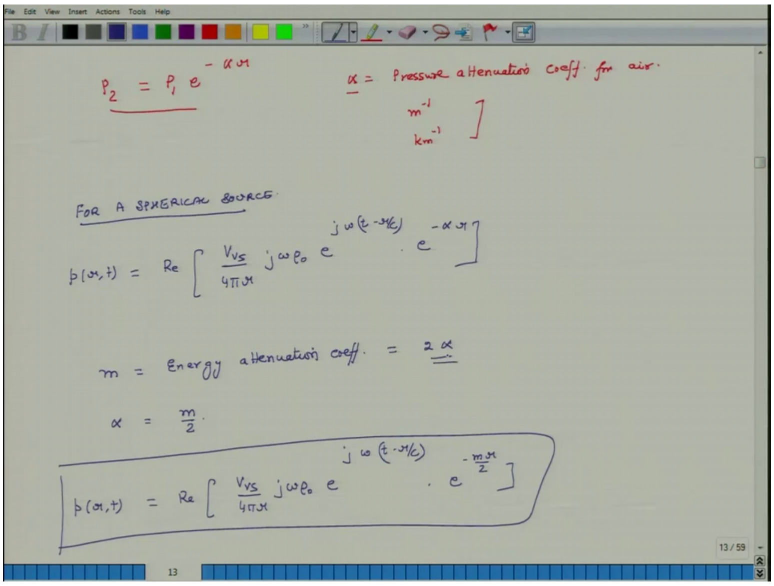

So, I will write down this expression again. So, for a spherical source for a spherical source p r t is what it is equal to real of V v s divided by 4 pi r j omega rho naught e j omega t minus r by c times e to the power of minus alpha r.

A lot of times we also define a parameter m. So, m is called energy attenuation coefficient energy attenuation and mathematically energy efficient attenuation coefficient is nothing, but twice of alpha you can find out you can express this verify this relation mathematically. So, because of this alpha is equal to m over 2 and if I do this then I can again express pressure due to spherical waves produced due to a spherical source and that is equal to real of V v s divided by 4 pi r j omega rho naught e j omega t minus r over c times e to the power of minus m r over 2.

So, with this understanding we will proceed to the next topic, but before I do, I just wanted to give you some insight as to why m equals twice of alpha.

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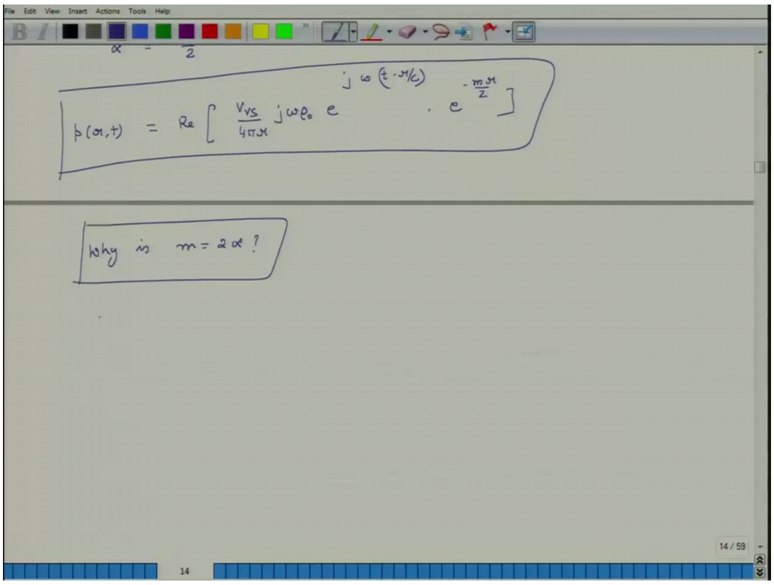

So, why is m equals twice of alpha; you will be wondering. So, for purposes of analogy suppose you have a body moving with a velocity v then what is its kinetic energy its proportional to v square, right, it is proportional to v square in electrical system suppose you have current passing through a resistor what is the heat being dissipated its I square r. So, again its proportional to I square springs suppose you have a spring and I pull it or I compress it and the deflection and the spring is let us say delta then what is the energy stored in the spring it is its stiffness k times delta square divided by 2.

So, in kinetic energy you have v square term in electrical heat dissipated you have I square term in spring you have displacement square term similarly when we are trying to figure out what is the energy being transmitted or flowing intensity. So, how much power is flowing through a cross a cross section due to propagation of sound it is proportional to the square of pressure. So, if it is square of pressure then the energy attenuation will be square of will be related to the square of pressure

So, this minus m r over 2 gets multiplied by 2 because it has to be squared and that is why 2 alpha equals m. So, that is the basic physical understanding which you should have that pressure decays by a factor of m over 2 while energy decays by a factor of m e to the power of minus m r pressure decays by a factor of e to the power of m r e to the power of minus m r over 2. So, that concludes our discussion for today and tomorrow onwards, we will go back to our original problem and start discussing it. So, till then have a great day and I look forward to seeing you tomorrow, bye.