Noise Management & Its Control

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Lecture – 49
Weighting

Hello, welcome to noise control and management. This is the ninth week of this course. And over this particular week, we will continue our discussion on how to predict noise in open spaces as well as in close rooms, where we think that in future we will be putting some specific noise generating machinery. So, last time we had discussed the level of noise generated by a fan. And what we will do over this week is we will again cover couple of other machines such as motors, pumps, compressors and things like that.

But before we actually discuss how to predict noise generated by a fan or pumps and these are the machines, I would like you to understand one concept and that is known as weighting. And the reason this concept is important is because a lot of times data related to noise related in stuff as produced by different machines is expressed in not in decibels, but in units known as dba or decibel a weighted a weighted decibels. And to understand what exactly is meant by a weighted decibel level, we have to understand this concept of weighting. So, this is what I wanted to talk in the beginning today and then starting tomorrow a maybe later part of today itself, we will start discussing noise produced by motors then a pumps and compressors.

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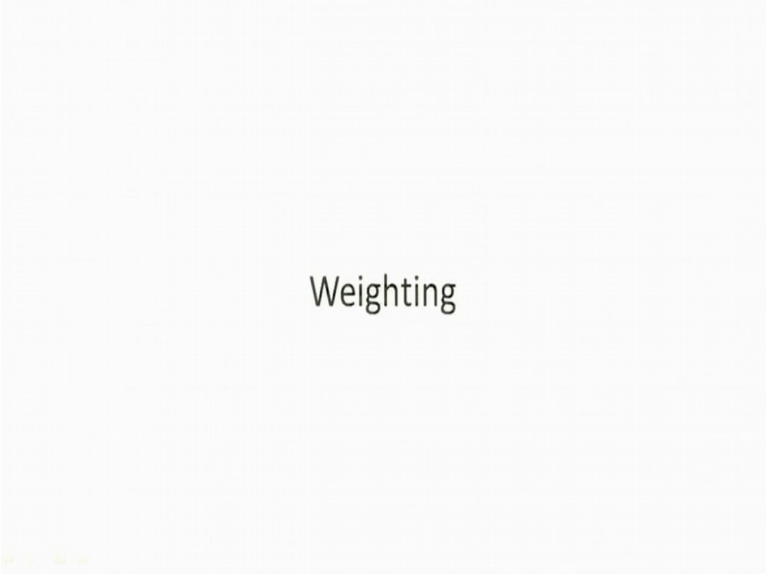

So, what we will discuss today at least for starters for starters is weighting. Now, so what do we implied by weighting. So, consider this fact that let us say I am producing some sound I am talking; and maybe 1 meter away from me I place a microphone and you measure my sound pressure level. And let us say my sound pressure level based on the definition 20 log of rns pressure divided by reference pressure it comes to let us say 90 decibels. So, that is what; that means, is that the sound pressure level 1 meter away from me in a particular direction is 90 decibels.

And then you do an experiment. So, suppose I produce some sound at 1000 hertz and let us say a microphone records it at 1 meter away and it the data from microphone tells me that the sound pressure level 1 meter away at 1000 hertz is 90 decibels. Then I do another experiment I change the sound produced by my throat; and I do it in such a way that instead of 1000 hertz, I produce some sound which is a pear tone and I produce it I had let say 500 hertz. So, one (Refer Time: 03:34) down. And then again 1 metre away and I produce it at the same disable levels. So, I produce it at 1000 hertz and at 500 hertz; and in both the cases at a distance of 1 meter away the microphone records 90 decibels of sound pressure level, so that is what our scientific measurements are telling us that in both the cases the sound pressure level one meter away is 90 decibel.

But if you ask person a man or a women or a child that which sound where is the both these sounds of equal loudness to you, did you perceive them to be of equal loudness. In 99 percent of the cases people will say that no, the 1000 hertz sound which was which we recorded at 90 decibels was perceived by human beings to be at a higher sound pressure level compared to or at a higher loudness level compared to the 500 hertz tone which was also produced at 90 decibels. So, what that means, is that if we produce sounds at specific frequencies at the same sound pressure level, human beings the perception of human beings varies from one frequency to frequency to other frequencies. We tend to hear certain frequencies at a higher level and we tend to hear some other frequencies at a lower level. Even if our engineering measurement or scientific measurement of the sound pressure level maybe the same but our perceptions or sounds are different.

So, this is so to figure out the difference between what is perceived and what is actually measured by the instrument, we have to weight the engineering measurement or the scientific measurement of sound by some factor or by some number, so that we get a perceived sound level. So, this is called weighting. So, we will discuss more about this.

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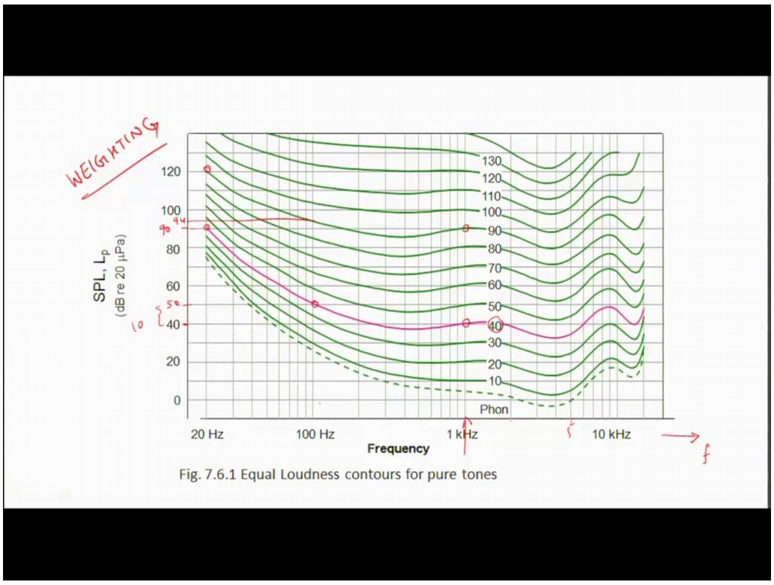

So, to understand this, let us look at this curve. So, on this curve, what we have on the x-axis is frequency in hertz. And just let us look at, so what you see and on the y-axis what we are seeing is the SPL, L P sound pressure level. Now, you have the several curves. So, the several curves are in green and then there is one particular curve in pink colour. So, first we will just look at the pink colour curve. Now, what this tells us is that suppose you are producing, so this is our reference with reference is 1000 hertz. And then this is a logarithmic scales, so you have on the x-axis, 1000 hertz then the next big unit is 10,000 hertz on the left side it is 100 hertz and so on and so forth.

So, let us look at this point on the pink curve. Now, what this 40, this number 40 is that it indicates the perceived sound level. So, it is an equal loudness contour for perceived sound level equal to 40 decibels. So, what that means, is that as long if you are on this curve anywhere, the sound pressure level which you will perceive it will be 40 decibels the actual sound pressure level maybe different the measured sound level, but the perceived sound level will be 40.

Now, let us look at 1000 hertz. So, at 1000 hertz the measured sound level is forty decibels based on whatever is the y-axis. The measured sound level is 40 decibel because this pink curve cuts this access at 40-decibel line, and also the perceived sound level is 40 decibel because we are on the pink curve. Now, let us go to 100 hertz. So, 100 hertz the pink curve cuts the y-axis the this line at 50 decibel line. So, what this tells is that if I produce a 1000 hertz tone at 50 decibels because this is 50 decibels then I will perceive it at forty decibel level. So, there you have, you have a difference of 10 decibel between perception and between perception and engineering measurement of noise. Let us look at some other point. So, let us look at 20 hertz . So, 20 hertz if I go up and I see that the pink line cuts and it corresponds to 90 decibels. So, what that means, is that if I generate 90 decibel tone at 20 hertz, it will be perceived at 40 decibels because the pink curve corresponds to 40 decibel perception curve.

So, what we are seeing is that there is a significant difference in decibels, there is a significant different perceived decibels and actual decibels. So, these curves are called equal loudness contours. So, for illustration purposes, we have shown you the contour for 40 decibels, but you have similar curves for 10 decibels, 20 decibels, 30 and so on and so forth up to 31 and so on and so forth. So, we can look at another curve, let us say the 90 decibel curve at 1000 hertz, there is no difference between perception and engineering measurement because on the 90 decibel curve the engineering the perception is 90 decibels and the measured value is also 90 decibels. But if you go to 100 hertz, let us see where it cuts it cuts the green line at something like 94 decibels. So, this is like 94 decibels.

So, what that means, is that I have to produce a 94 decibel a sound 100 stone should be 94 decibels in SPL, if it has to be perceived it 90 decibels. And if you go to 20 hertz, this difference increases further. So, this difference goes to 120. So, once again I have to produce 120 hertz, I mean 120 decibels of sound at 20 hertz, so that it gets perceived at 90 decibel level. So, this is equal loudness contours they give you an understanding of the difference between perception and the engineering measurements of sound. And from these data we can also do this weighting. But to do this weighting from these data it is a little more complicated because you have to go frequency by frequency and read the graph more accurately and things like that.

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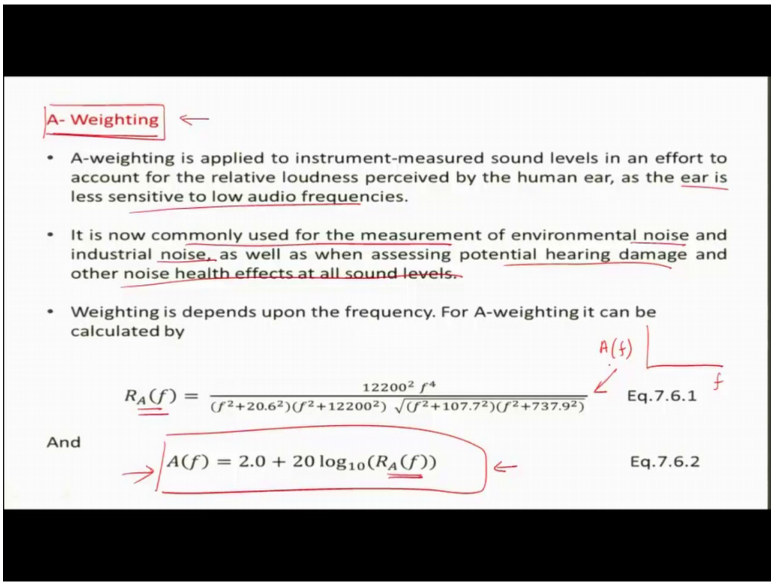

To do a better job for weighting, we can use this curve. So, this particular weighting account for the difference between perception and engineering measurement this is known as A-weighting. So, there are several types of weightings, but at least in this course in context of noise produced by machinery, we are interested in A-weighting curves because we want to account for the difference between the human perception of sound pressure level and the actual measured sound pressure level. So, we are talking to about A-weighting. So, what does they say A-weighting is applied to instrument measured sound levels in an effort to account for the relative loudness perceived by the human ear, as the ear is less sensitive to low audio frequencies. So, this is what we actually saw in this graph also that as the frequencies go low, this curve rapidly climbs up which means that I have to produce more sound to so that it gets heard at the same level, because our ears are less sensitive to low frequencies. They are also their sensitivity increases at higher frequencies, but then maybe after 1, 2, 3, 4, after 5 kilo hertz their sensitivity against starts decrease because the curves start again climbing up again. So, this is what it says.

And the other bullets which says is it is now commonly used it is commonly used it. So, that is why whenever we are in the business of talking about noise a lot of times people will not be interested in finding out what is the actual sound level or the sound level measured by the instrument rather they will be interested in finding out what is the perceived sound level because that is what we are interested in as human beings. So, it is commonly used for measurement of environmental noise and industrial noise as well as and when assessing potential hearing damage and other noise related health effects. And to account for this difference, so the difference between perception and measurement was about 10 decibels at 100 hertz. So, this is what we get from the graph, but this difference can also be calculated by this relation.

So, this is the difference between perception, so this formula it gives you the difference between perception and the measurement, the scientific measurement of sound. And this is 2 plus 20 log base 10 of a parameter which is frequency dependent called R A. And what is R A, R A you can calculate by this relation which is this complicated relation where f is the frequency of interest. So, it change this value of R A, it changes with frequency, and for a specific frequency you can calculate A f. Now, if you calculate this A f and then on an x-axis and y-axis; so on x-axis I plot f, and on y-axis I plot A f, this is what I get.

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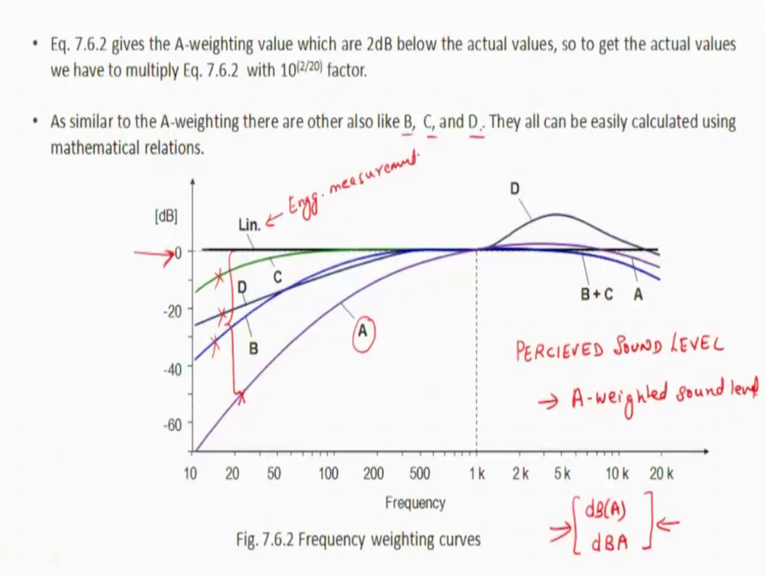

Fig. 7.6.2 Frequency weighting curves

So, this is my A-weighting. So, there are several lines on this graph. We do not worry about B curve or D curve or C curve, we are only interested at least in this course on the in the A-weighting curve. So, this curve is the is actually generated from this relation. So, you can also use this curve to compute the difference between perception and the engineering measurement of sound. So, the engineering measurement of sound is if it is 0 decibels, if the engineering measurement of sound is 0 decibels for all frequencies let say I am producing at all frequencies 0 decibel level of sound then the human perception will be short by so much of delta so much of difference. So, that is the difference between this a curve and this black line which is this thing. So, this Lin is the engineering measurement or scientific measurement.

So, if I know the sound pressure level at any particular frequency and I have to compute what is the perceived sound level basically suppose this is the frequency of interest then I have to deduct so much of decibels from my scientific measurement to get the A-weighted sound level. So, the perceived sound level, it is known as A-weighted sound level; and it is either it is written as either dB A this is one way to express it. So, if I say 18 dBA it means a weighted sound level is 80 decibels, but it is A-weighted or other at other times it is also written as dBA. These are the two ways the perceived sound level which is a weighted is denoted dB and in brackets A or dBA. There are other weightings also as I mentioned B-weighting, C-weighting and D-weighting, but at least in the context of this course we will not worry about those weightings. So, we will just move on with that.

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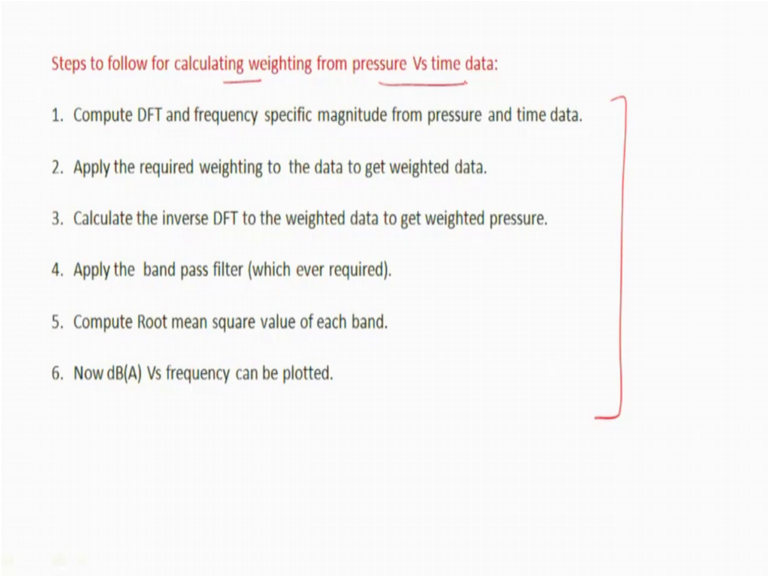

And then the question would be that how do you compute or actually we will discuss this later in the course that how to calculate weighting from pressure versus time data. So, this something we will discuss later, but this is what the basic concept of A-weighting is. So, that concludes our discussion on A-weighting. And now we will for the next 5-6 minutes, 10 minutes, we will discuss the noise as it comes out of motors.

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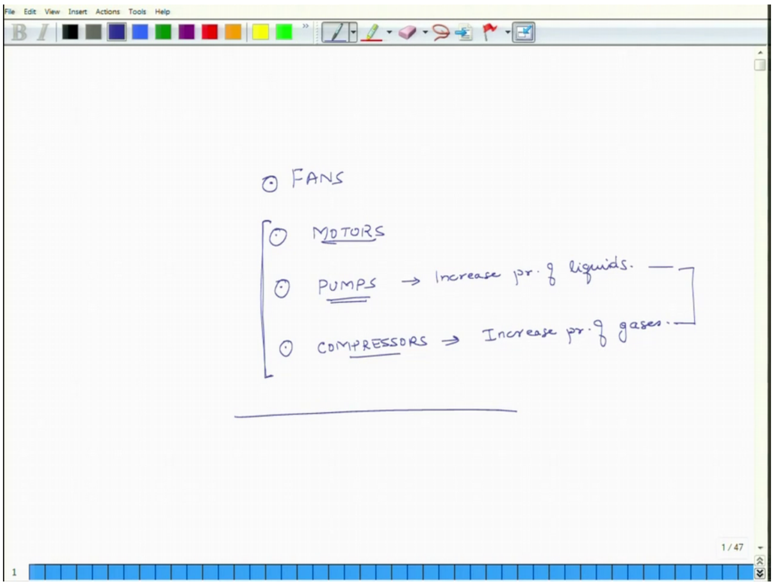

So, over the remaining part of this week we will discuss noise from three important other components. So, last week we had done fans. And by fans we imply industrial fans which are big devices which blow a lot of air, but a lot machines are basically assemblies of different components. And another important components with several machines have are motors. So, virtually any mechanical machine would have a motor. For instance, you have lathe, or a milling machine, or a pump, or a compressor all these machines they have motors. So, it is important to understand that what kind of sound pressures are or sound pressure levels are generated by motors. So, this is another thing we will discuss.

Then there are a lot of machines which have which are pumps. So, what do pumps to pumps basically increase the pressure of liquids. If we have to increase the pressure of a liquid we use pumps. Pumps by themselves they a have they are always invariably attach to a motor if the motor, which drives the pump. So, when we talk about noise for pumps we will not discuss the noise coming from the motor part, but just noise coming from the pump alone, so that is the pump.

And then another thing which we will discuss today is noise from compressors. So, what do compressors do. So, pumps what they do is they increase the pressure of liquids what do compressors do they increase pressure of gases. So, if in your factory or system, you have to you are required to increase the pressure of gas, you go for compressors. Suppose, you want to use some fluid at very high pressure, water or whatever then you use pumps, but in both these cases the drive is coming from the motor. So, these are three important components. And we will hopefully try to complete the discussion on noise from these three important sources. So, this gives us preview of what is going to happen over the next five days. And we will start discussing noise coming from motors starting from tomorrow and then we will also cover noise from pumps and compressors over the remaining part of the week so that concludes our discussion for today, and I look forward to seeing you tomorrow.

Thank you.