Noise Management & Its Control
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Lecture – 54
Example Problems Regarding Noise Coming from Compressors

Hello, welcome to noise control and its management today is the last day of the ninth week of this course and over this entire week we have learnt; how to compute sound power level from 3 different types of machines. First one we discussed was noise coming out from an electric motor then we discussed noise coming from pumps and then finally, we discussing right.

Now, noise coming out from compressors and yesterday specifically we discussed; how to compute the sound power level emanating from a compressor also we learnt the term blade pass frequency and how to calculate its value and we also understood that the noise which comes out of a compressor is in general broadband in nature with its maximum energy content revolved you know concentrated around a particular frequency. Let us call at fm and that fm could be computed by these 2 relations which are shown here.

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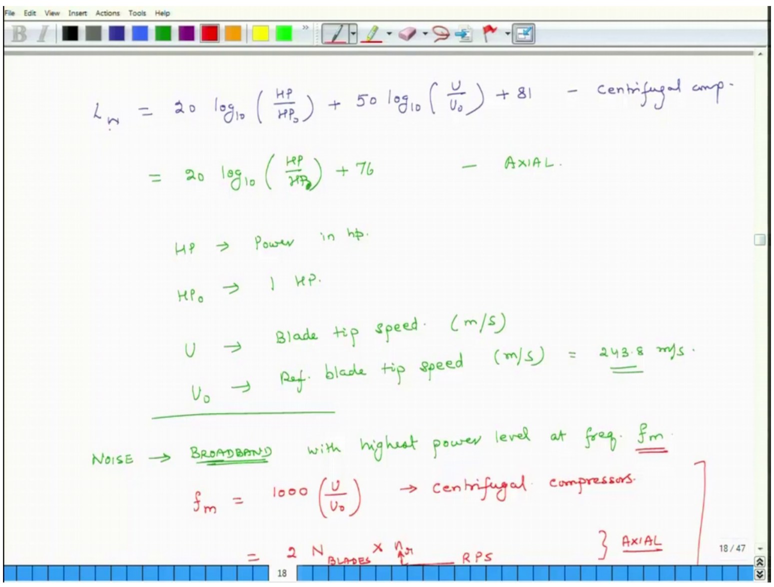

So, the next thing we would do is. So, now, that we know the how to compute Lw you by using this relation or the other relation the second relation is that if we know Lw how do we find out the contribution to this overall sound power level co for different octave bands.

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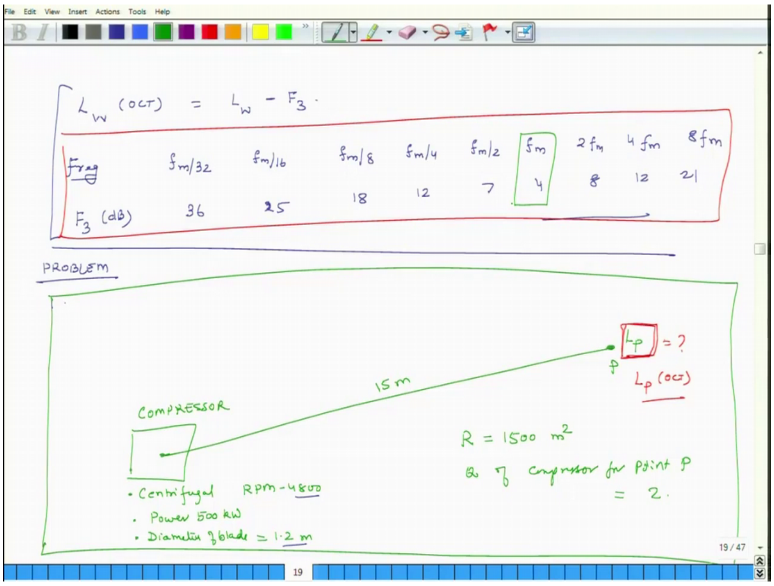

So, let us call that Lw octave for each octave band Lw OCT; Lw and then my minus we have another factor F 3. So, for different machines we have different factors and the value of this factor is computed is determined in a slightly different way compared to what is saw far other machines. So, here we do not have the same tractor for every first standard octave bands rather. So, we look at frequency. So, the first frequency, we look at is fm over 32 fm over 16 and fm we know how to compute fm over 8 fm over 2 fm over 2 fm 2 fm 2 fm and 8 fm. So, first we compute the value of fm then we find out.

So, these are again octave bands, but they are not industry standard octave bands, but we will figure out how to connect the stun industry octave bands with these bands through an example and what is the value of these factors F 3. So, it is 36. So, all these values are in dB 36, 25, 18, 12, 7, 2, 8, 12 and 21. So, by the way all these data which I am sighting is taken from this book industrial.

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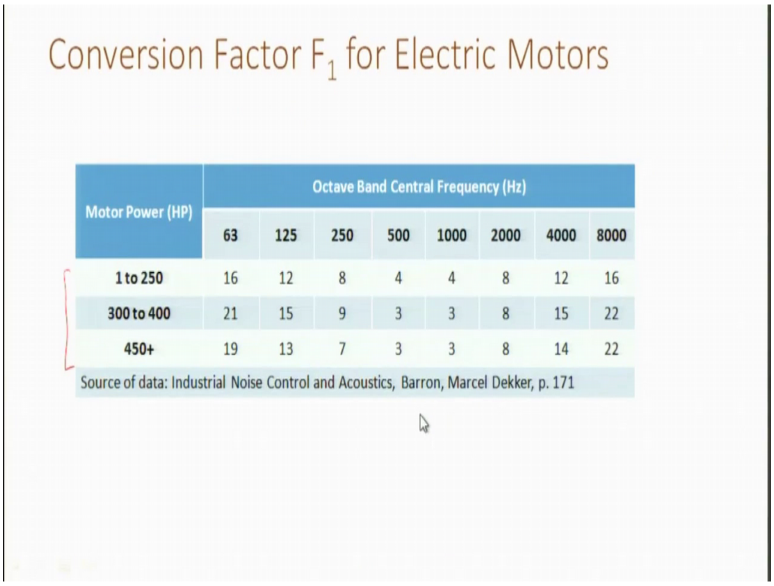

Motor Power (HP)	Octave Band Central Frequency (Hz)							
	63	125	250	500	1000	2000	4000	8000
1 to 250	16	12	8	4	4	8	12	16
300 to 400	21	15	9	3	3	8	15	22
450+	19	13	7	3	3	8	14	22

Source of data: Industrial Noise Control and Acoustics, Barron, Marcel Dekker, p. 171

So, here you have. So, all data which I am talking about and referring to is been taken from this particular book industrial noise control and acoustics the author is Barron is published by Marcel and Dekker and of course, this table is from page 171, but from the same chapter I have; I am sighting all these data.

So, this is important to remember. So, if you run into questions or if you want some more information, then it is worth while checking into this book and getting more information.

So, this is how we compute Lw for each octave band. So, now, let us try to do a question and example. So, that things become clearer. So, here is the problem. So, you have a room and let us say we have a compressor here and I am interested in finding out LP at a distance away from the compressor and let us say this distances 15 meters and let us give let us find out some details about the compressor. So, what kind of a compressor is this; this is centrifugal compressor this is the first information we have then it runs at 4800 RPM, it consumes 50 kilowatts of power actually 500 kilowatts, 500 kilowatts of power the room constant for this room is 1500 square meters; what else the diameter of blade is 1.2 meters and the directivity. So, directivity of point P directivity for point P directivity of compressor for point P is given as 2. So, the question is that with all this information please find out; what is the sound pressure level at this location LP; this is what we have to find out.

So, this is one thing we have to find out and the other thing is please find out also for each octave band; what is the overall sound pressure level for every octave band. So, once again you have a compressor which is centrifugal in nature running at 4800 rpm power is 500 kilowatts; if it is pretty big compressor blade diameter is 1.2 meters sitting in of large room 1500 square meters is the room constant directivity with respect to point P is 2. So, we have to find out sound pressure level overall and sound pressure level for each octave band. So, how do we do it? So, we know that for a room we know how to compute LP if I know Lw. So, in this case I have to find Lw; now this is a centrifugal compressor.

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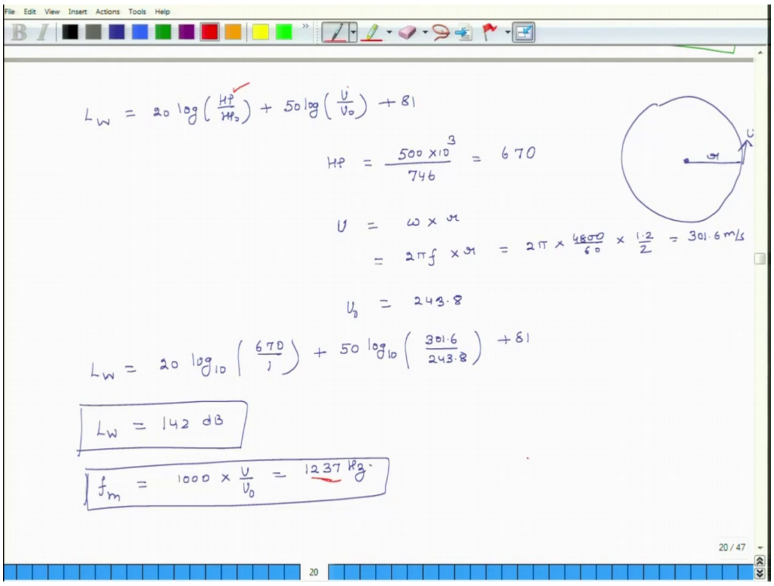

So, the ration for a centrifugal compressor is 20 log of HP divided by reference HP plus 50 log of U divided by U naught plus 81; this is for a centrifugal compressor; what is HP this is the horsepower of the machine and a what I know is that the power of the machine is 500 kilowatts. So, it will be 500 times 10 to the power of 3. So, many watts divided by 746. So, that becomes you comes to if you do the calculation it comes to 670 horsepowers. So, we know this now we have to calculate u which is the blade tip frequency blade tip frequency, no, I am sorry blade tip speed. So, blade tip speed is what the blade is rotating at what rpm its rotating 4800 rpm and the diameter of the blade is 1.2 meters. So, what is the; so, if this is radius; this is the velocity we are interested in what is velocity it is angular frequency times radius and angular frequency is what 2 pi f and then times r and what. So, this is equal to 2 pi f is what; 4800 divided by 60 and times r 1.2 divided by 2. So, if you do the math it comes to 301.6 meters per second.

So, the blade of the compressor the tip of the blade is moving at a velocity of 301.6 meters per second and then of course, u naught is what 243.8. So, Lw equals 20 log of 10 670 divided by 1 plus 50 log on base 10; 301.6 divided by 243.8 plus 81. So, you do all the good math and you get Lw for the compressor is 142 decibels. So, as I said compressors generate a lot of noise and 142 decibels is very bad sound level; you do not like that is not a good sound level to be near to. So, this is the power level coming out of the compressor.

Now, we have to find LP and this LP; we can directly find by using the relation which we have discussed earlier, but not only LP, we also have to find LP for each octave band and in context of that we have to know what is fm otherwise we cannot use this table, right because the value of F3 depends on the value of fm.

What we will do is we will find out the value of fm. So, fm is what 1000 for centrifugal compressors the relation 1000 times U by U 0 and that is 1237 hertz. So, this is the second important piece of data. So, what this means is that the sound power level which will be coming out of this compressor will correspond to 142 decibels and it will be maximum at 1237 hertz. Now we have to find now we have to use this table, but what we are really interested in is finding Lw OCT for different industry standard octave bands because if I use 1237 I will get some very bad you know weird numbers, we are not interested because the industry will look at industry standard octave bands.

So, but it is going to peak at 1237 hertz; so, then the question is in which octave band does 1237 hertz lie.

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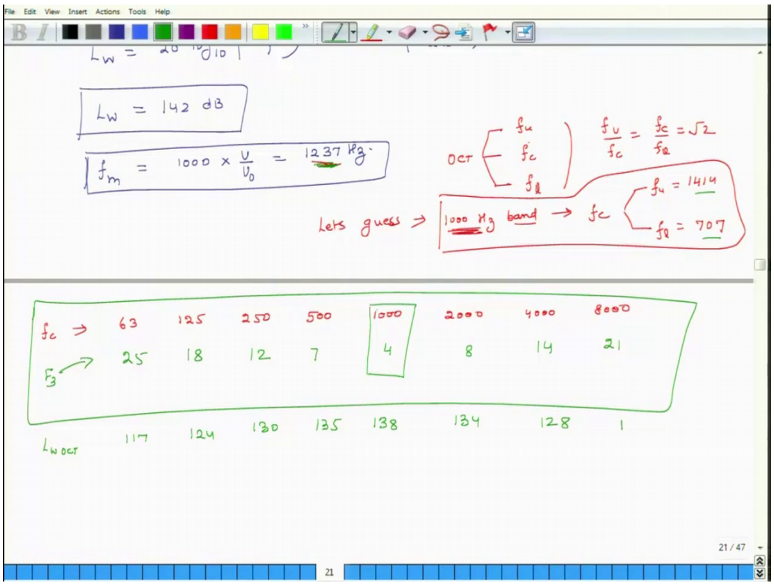

In which octave band does 1237 hertz lie. So, remember an octave band has 3 frequencies what are those a central frequency a lower frequency and an upper frequency and what is the relation between these 3 guys f u over fc is equal to fc over fl is equal to square root of two. So, we have to figure out in which octave band does this 1237 hertz lie. So, how do we do it we have to just try it? So, let us assume let us guess because it is close to 1000, it is close to thousand what are the industry standard octave its 500, 1000, 2000; say its nearest 2000.

So, let us guess for thousand hertz band this 1000 hertz corresponds to what this is the fc. So, its fu will be what root 2 times 1000 which will be 1414 and fl will be 1000 divided by root 2 which will be 707. So, this 1000 hertz bands includes all the frequencies between 1414 and 707 hertz which means that the sound pressure level will be maximum in 1000 hertz band sound pressure level is going to be maximum in the 1000 hertz band. So, this is important to understand. So, now, based on this understanding we can calculate the value we can assign the value of F3 to all the industry standard octave bands. So, fc what are the industry standard octave bands 63, 125, 250, 500, 1000, 2000, 4000, 8000 and the fm; fm lies in which band fm lies in this band.

So, what is the value of F3 for this fm 2 where did I get from 2 look at this table when frequency is fm, then F3 is 2 decibels when frequency is fm then F3 is 2 decibels and fm lies in which band thousand hertz band fm lies in thousand hertz band because fm is what 1237 hertz; 1237 is between 1414 and 707. So, in this octave band fm frequency lies in 1000 hertz band and what is the factor associated with fm 2 decibels. So, I put 2 decibels in 1000 hertz band. So, this is the table which I have given you when frequency is fm the value of F3 is 2 decibels.

So, the question is in which band does fm lie; it lies in 1000 hertz band. So, at in this band F3 is 2 decibels. So, this is my pevet. So, now, I can put all other values in the table.

So, the other values are 2, 8, 14, 21 and then on this other side I have 7, 7, 12, 18 and 25. So, this is my F3. So, basically I have just use the values from the table above. So, using this table now I can compute Lw for each octave band. So, now, let us first compute Lw. So, Lw actually we have already computed Lw; Lw is 142 decibels Lw is 142 decibels. So, what is Lw OCT. So, Lw OCT is Lw minus these factors. So, it is 142 minus 25. So, it is 1, 1, 1, 742 minus 18 is 122, 130, 135, 138, 132, 128 and 121. So, this is Lw OCT everyone understands how did we compute Lw OCT; this was Lw minus F3 this.

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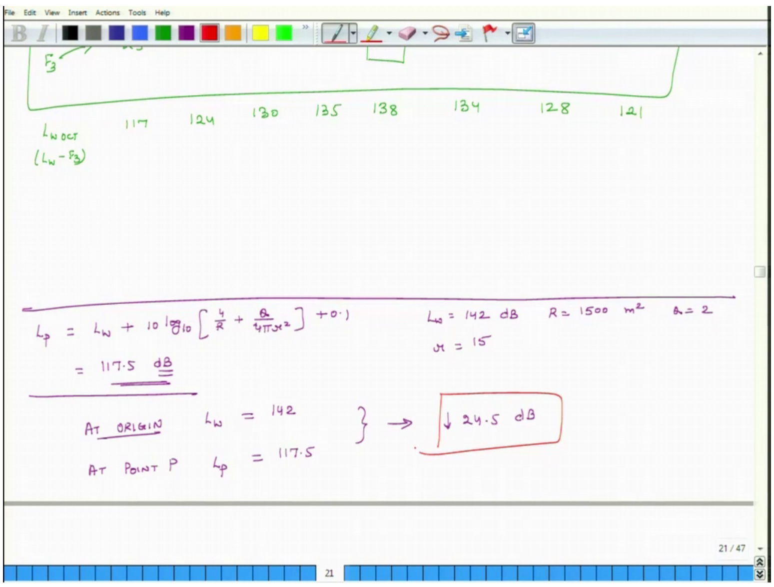

How we calculated Lw OCT and F3 is this table Lw was 142 decibels. So, I have subtracted, but what is the question I have to compute LP indifferent octave bands I am not even computed overall lps. So, now, I will do calculation of LP ill leave some space here because I will come back to this table again. So, what we will do is first we will compute LP. So, LP is equal to Lw plus 10 log 10 of 2 over r plus Q by 2 pi r square plus 1.2. Now we know that Lw is how much; 142 decibels, we have calculated it; what is r what is the value of r.

Student: 1 5 double 0.

1500 meter square; what is the value of Q 2 and what is distance 15 meters. So, put an all these things everything is known on the right hand side LP comes out as how much it comes out as I have done the calculation 117.5 decibels. So, what does that mean that is the sound power level, if it is 142 decibels directivity is 2, then at that distance and that angle the person will feel 117.5 decibels of sound pressure level. So, this is the LP overall now I have to see that for each octave band; what is the sound pressure level sound pressure level now. So, now, here is the thing at origin Lw is what 142, right, this is what we have calculated and at point p sound pressure level is how much 117.5 decibels which means that there is a change of how much decibels 22.5 decibels there is a drop of 22.5 decibels sound power level is 117 decibels.

So, the point what I am trying to make is that if the sound power level is 142 decibels the sound pressure level will be 117 decibels. So, if the sound power level goes up my x decibels the sound pressure level will also go up by x decibels because these differences are what factors, right, if the power which is getting doubled suppose the power limited by the machine doubles the pressure will also proportionally increased it will proportionally increase. So, that difference is 22.5 decibels this is what we are seeing what; that means, is I can use this information directly.

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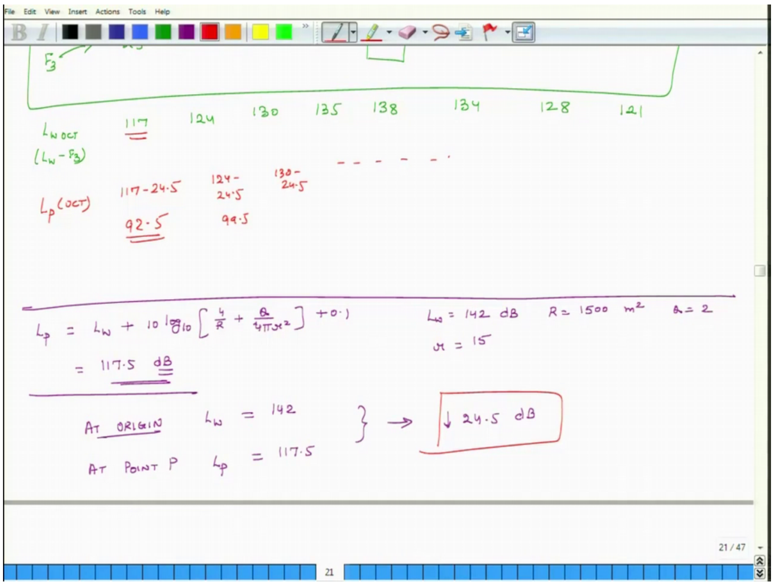

So, the question is that if the sound power level was 117 then what will be LP OCT it will be 117 minus 22.5 for each.

So, basically that is what I am saying. So, this comes to what this is 0.57 minus 232; 92.5 similarly here also you do 122 minus 22.5. So, that is 99.5; 130 minus 22.5 and so on and so forth why I can; I directly sub do this subtractions these subtractions can be directly done based on the understanding that suppose. So, so what happens when sound power level increases by a factor of let say 2 sound pressure level will also professionally raise a sound power level goes down sound pressure level will also proportionally go down, right.

So, in the linear if the so, but these are logarithmic scales in the linear scales it will be a constant factor right it will be a constant in logarithmic scales it will be this constant difference. So, what is happening in each octave band in this octave band we do not have 142 decibels we have just 117 decibels of power level. So, what will be the pressure level I have to just bring down the pressure level by 22.5 from here and for I do the same thing for all other frequency bands. So, in this way I can calculate LP octave. So, this is what I wanted to cover in this week and I hope you have found this entire exercise very useful and practical more importantly from your standpoint and from standpoint of your professionals and areas of interest.

And with this we conclude the discussion for this week next we will week we will again cover some more machines and then we will move into the third phase of this or the next phase of this particular course is that; now that we know that how to estimate a sound pressure levels at a point either inside the room or outside the room how can we actually reduce it how can we control the level of noise to acceptable levels. So, we will start discussing may be in the later half of next week and then over the remaining part of this week, we will actually focus our entire efforts an energies into how to reduce sound pressure level to acceptable levels using different methods which could be passive or active. So, with that we conclude our discussion.

Thanks a lot and have a great weekend, bye.