Noise Management & Its Control

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Lecture – 37
Microphone Parameters

Hello, welcome to noise control and its management. This is the seventh week of this particular week. And today what we planned to discuss is continuation of our last week discussion, which was what makes a microphone really good microphone specially from the standpoint of making good scientific measurement which are reliable and credible. So, two criteria which we had discussed last week were firstly, we are discussed about linearity of the microphone that as the signal strength increases, the output from the microphone typically which is in volts that should also increase proportionally, so that is the implication of the term linearity. And the second parameter which we had said was important was a flat frequency response that is the ratio of input and output or the transfer function of the microphone remains same and it remains a constant flat line a for different frequencies. So, two parameters which we had said were important to consider a microphone would where linearity of the microphone and also its frequency response should be flat.

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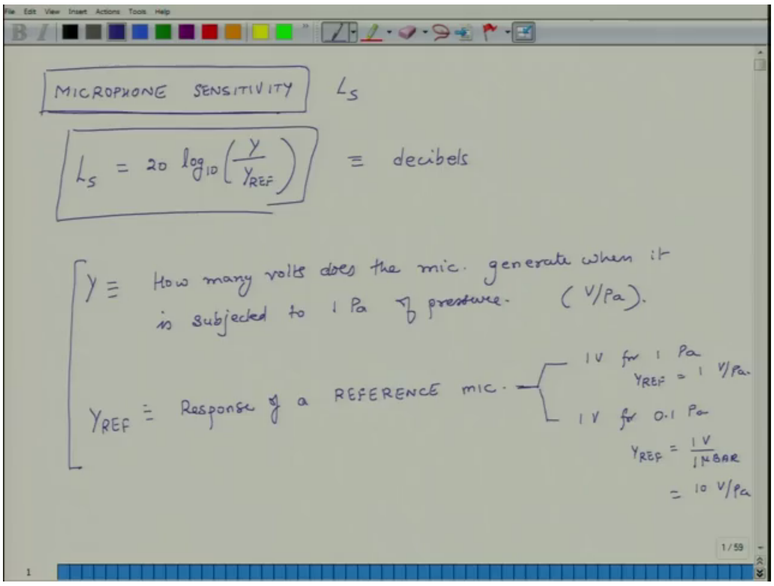

The third and equally important parameter is microphone sensitivity. So, what is microphone sensitivity; essentially what it tells us is that how sensitive is your microphone. Now, in general the microphones which we have discussed measure pressure, so to the system to the input of this system measurement system is pressure in pascals. And then what microphone yields when it get excited by the these pressure signals is some voltages typically in milli volts or micro volts. So, essentially a microphone which is more sensitive will for 1 pascal of excitation pressure, it will yield larger number of volts, so that is what is known as microphone sensitivity.

Now as we have seen that in the land of acoustics a lot of terms are expressed in decibels. So, similarly we also have the unit of microphone sensitivity is specified in terms of decibels, so that is what we are going to discuss today. So, let say so the symbol for microphone sensitivity is L s standing for sensitivity. So, how do we define L s equals 20 log of 10 Y over Y ref. So, we will explain what this expression means. So, L s which is microphone sensitivity and this is in decibels. So, it is actually measured in decibels that is 20 log 10 of Y over Y REF. Now, what is Y and what is Y REF. So, Y is it tells us that how many volts does the microphone generate when it is subjected to 1 pascal of pressure. So, if you have a microphone and you subjected to 1 pascal of pressure and it gets excited, and it generates half a volt, then Y will be 0.5 divided by 1 which is half a volt per pascal. If you subject it to 3 pascals, and it generates 3 volts then it would be 3 over 3 which is 1 volt per pascal. So, the units of this are volts per pascal.

And then Y REF is the response of a reference microphone, it is a response of a reference microphone. Now, so there could be let us consider some microphones which we said that this is an reference microphone. So, we always compare a real microphone with respect to some imaginary reference microphone and this. So, again when this microphone is subjected to some pressure, it generates voltage. And we assume that this reference microphone, this comes in two flavors, the first type of reference microphone it generates 1 volts for 1 pascals. So, for this Y REF is equal to 1 volts per pascal. So, this is the first type of reference microphones.

So, whenever we specify the sensitivity of microphone, we should always state what is the reference microphone. The other reference microphone, which people use is one which generates 1 volt for 1 micro bar, so 1 volt for 1 micro bar. So, 1 bar is 10 to the power of 5 pascals. So, 1 micro bar is 10 to the power of minus 1 that is 0.1 pascal. So, this is one. So, it is for 0.1 pascals. So, in this case Y REF equals 1 volt per 1 micro bar. And if I just do it this is or you can say it is 10 volts per pascal. So, based on this understanding, we can calculate the sensitivity of a micro phone.

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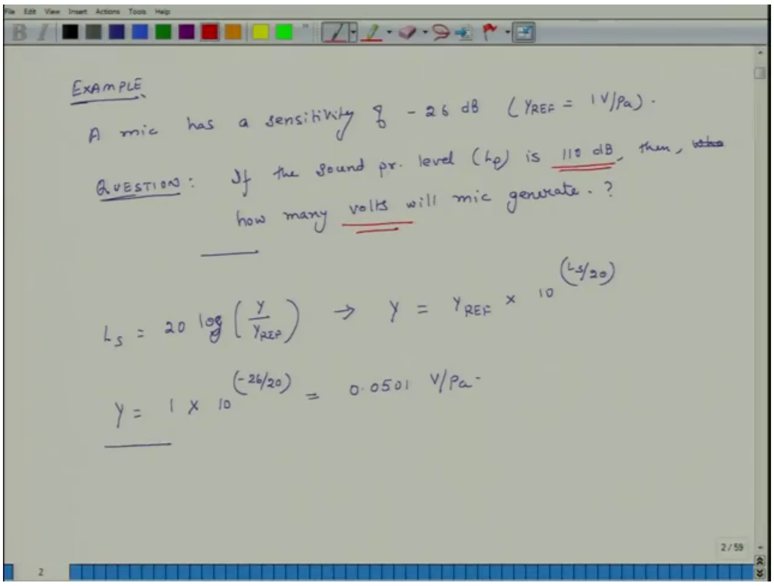

So, let us do an example. So, consider a microphone, a mic has a sensitivity of minus 26 decibels. And whenever we specify the sensitivity, we always a specify what is the value of Y REF. So, we will say that Y REF is equal to 1 volt per pascal. So, the question is if the sound pressure level, so sound pressure level we define designate it as L p. So, L p is 110 decibels then how many volts will mic generate, how many volts the microphone is going to generate. So, this is the question.

So, what do we do, first thing we have to do is for this microphone first we have to calculate if it is subjected to 1 pascals, how many volts it is going to generate. So, we know that L s equals 20 log Y over Y REF. So, from this, I can say that Y equals Y REF times 10 to the power of L s by 20. So, Y equals and what is Y REF, it is 1, 1 volts per pascal times 10 to the power of what is L s minus 26 divided by 20. So, if you do the math, it comes to be 0.0501 volts per pascal. So, what this tells us is that this particular microphone which has a sensitivity of minus 26 decibels, it will generate half a volt of single for each pascal of pressure when it is going to be exposed to. So, now what is the question, the question is that if the sound pressure level is 110 decibels how many volts it is going to generate.

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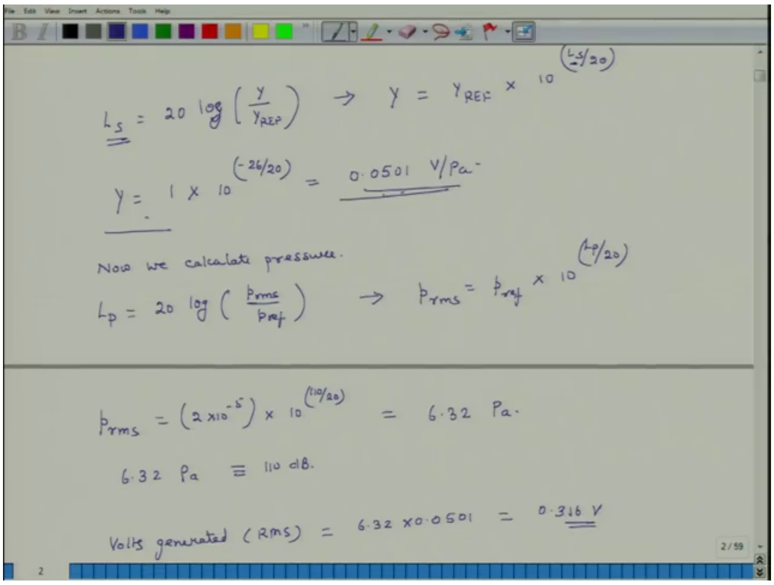

So, now we have to figure out how many pascals corresponds to 110 decibels. So, now, we calculate pressure, calculate pressure. So, L p is equal to 20 log p rms by p ref. So, this gives us p rms equals p ref into 10 to the power of L p divided by 20. So, p rms equals p ref. So, what is p ref reference pressure is 2 into 10 to the power of minus 5 pascals times 10 to the power of and what is the value of L p the question says that it is 110 decibels divided by 20. So, this if you do all the calculation, it comes to 6.32. So, 6.32 pascal corresponds to 110 decibel.

Now, what is again our original question that how many volts the microphone is going to generate? How do you figure it out we know that for 1 volts, 1 pascal it generate 0.05 and it is a linear microphone. So, volts generated and this is the rms value because we are using the rms pressure. So, rms value of volts generated is equal to 6.32 times 0.0501 and that comes to 0.316 volts, so that is how we can calculate. So, if we know the sensitivity then using that number for whatever decibel level is there, we can figure out how many volts is the microphone is going to generate.

And the point is that the higher the sensitivity which means the value of Y if L s is high then Y will be also high why because this term is going to be high. So, if L s is high which is a more sensitive microphone this Y will be high, and it will generate more voltages for any measurement. So, if we are really interested in measuring very, very low pressures then what we really want a microphones which have high sensitivity. So, the point is that if you think your microphones if your pressure ranges are very low, then you need high sensitivity microphone and to some extent vice versa.

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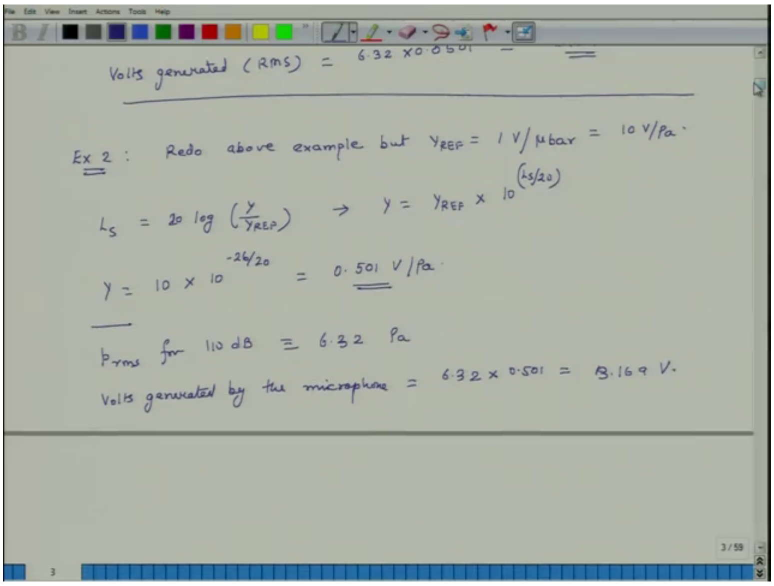

Now, the example another example, example two is that we just redo the whole question again redo above example, but Y REF is what. So, we had said that there could be two standards in one case the reference mic is 1 volt per pascal, here the reference mic is 1 volt per micro bar and that corresponds to 10 volts per pascal. So, in this case, L s equals twenty log Y by Y REF and Y comes to be, so Y REF is what, Y REF is 10 times 10 to the power of L s by 20. So, Y equals 10 times 10 to the power of minus 26 by 20 and that comes to 0.501 volts per pascal. So, what I am saying is that because the reference microphone was more sensitive that implies that Y will also be more sensitive.

So, now in contrast with the earlier, the earlier mic was generating only 0.05 volts per pascal this is generating 10 times as many volts it generating half a volt per pascal. And then we know that p rms for 110 decibels, it corresponds to 6.32 volts, excuse me three two pascals. So, volts generated by the microphone equals 6.32 times 0.501 and that comes to 3.169 volts. So, this is what I wanted to discuss about sensitivity. Now, so these are the three important considerations when we are talking about microphones. The first thing is that we are interested in its frequency response, the second thing is linearity, and third thing is sensitivity; and then of course, there are other things also.

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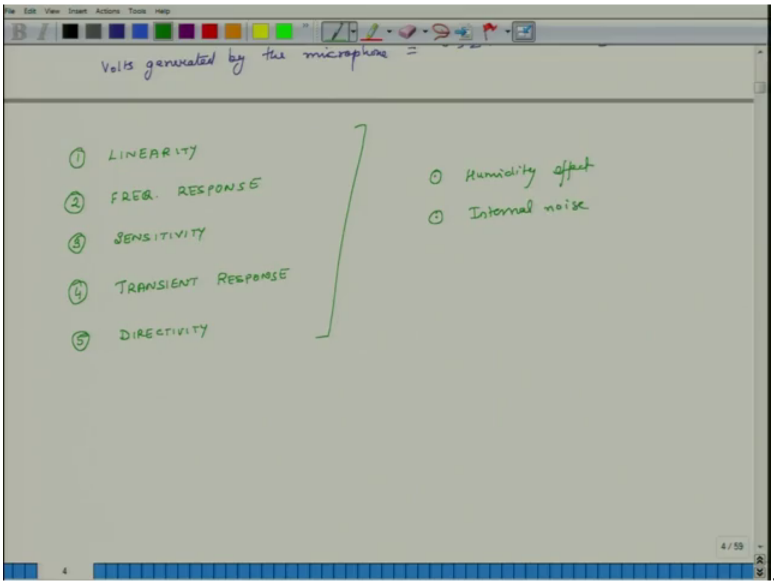

So, there some other parameters also which we will talk about. So, important considerations we have discussed are first one was linearity, second one was frequency response. So, microphone which has a very flat frequency response is good. Third one was sensitivity. And then there are two more important characteristics. So, the fourth one is transient response and we will talk about it; and the fifth one is directivity. So, these are some of the more important considerations and then of course, there are other considerations also when we are talking about microphones. So, others are humidity effects, noise - internal noise and so on and so forth, but these are the five important characteristics.

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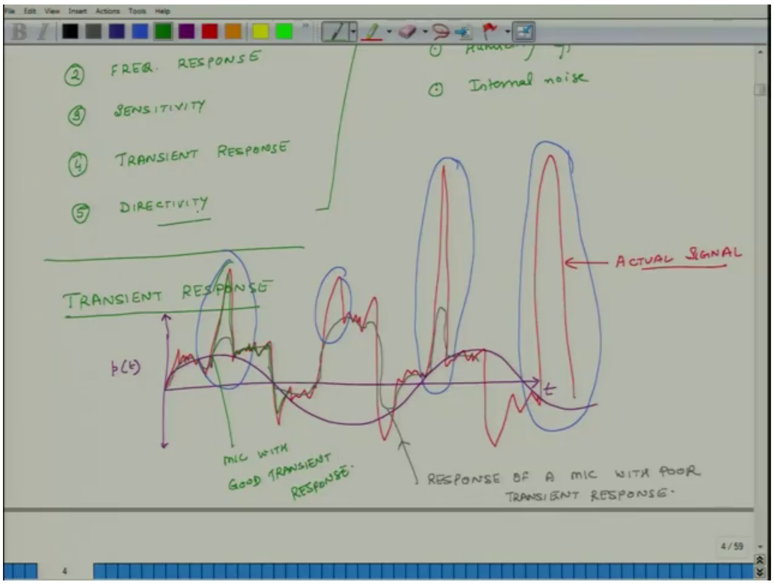

So, the next thing we will talk about is transient response transient response. So, what is transient response? What this means is that how good is your microphone in terms of capturing signals, which occur for very brief periods of time. So, I will give you an example. So, you can have a sound signal. So, on this axis, I am plotting t; on the Y axis, I am plotting pressure as a function of t. Now, we can have so a lot of times we talk about sound or noise or acoustics we talk about nice gently changing signals right like sinusoids, but real sound or but for that say real noise is not like this, the real noise is it may go like this. So, the microphone has to be sensitive has to be smart enough to capture all these sharp peaks. Within small periods of time, there are very large changes in the pressure. And if it is able to capture these sharp peaks then we will say that it is a very good dynamic transient response; if it is unable to capture these sharp peaks then it will not necessarily have a good dynamic response.

So, a microphone which has poor transient response.. So, the red color is the actual signal. Now, we can capture this signal by using a microphone, which has poor transient response and a good transient response. So, let us see how the signal is going to look like when it is being captured by poor transient response. So, if there is a poor transient response as a microphone then so I am going to just plot. So, poor transient response they do something like this, you know something like this. So, this is the response of a mic with poor transient poor transient response, a lot of times a system has a poor transient response, if its mass is more.

So, what do you have in a micro phone, there is a thin diaphragm; and when pressure hits it, then the diaphragm vibrates. Now, if the mass of the system is large then that system becomes sluggish. So, you know, so it does not gets excited very easily and it its whatever its motion it does not goes down easily also. So, if the diaphragm is heavy that is why a lot of this microphones have extremely thin diaphragms they try to minimize the mass as much as possible. So, it could be either because of the mass of the diaphragm is large or something accidentally got deposited on the microphones diaphragms small amount of water or some dirt or something which increase its mass and the transient response becomes bad, so that is the case. Or in some cases even the electronics of the system could be that it filters out all these sharp peaks. So, that also gives you poor transient response. So, the causes for poor transient response could be either mechanical or electronic in nature electrical in nature.

And now if you have a microphone which has a good transient response then it will capture these peaks easily. So, it will go like this and then it will do all this. So, these green curve is a mic with good transient response so that is another thing. And the last important parameter for a microphone which has to be good is that it should be and most of the times we are looking for microphones which have a specific directivity response and in general we want that microphone should be able to capture sound from all the directions. So, they should have they should be less directional in nature, so that is another thing. But we will talk about this directivity in our next class, but till so far what we have discussed about are four important parameters, which for good microphone. One is that they should be linear, second is they should have a flat frequency response, third is thast they should be highly sensitive, fourth is that their transient response should be nice and good, and the last thing is about directivity which we will discuss tomorrow. So, with that we conclude for today and we look forward to meeting you tomorrow.

Thank you, bye.