Basics of Noise and Its Measurements
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Lecture - 23
Microphone Sensitivity

Hello again, welcome to Basics of Noise and its Measurements. I am Nachiketa Tiwari, I am your instructor and right now we are discussing in this particular MOOC, is all the stuff about microphones and today, what we will be discussing is how do we go around making, selecting the right type of microphone for our application and in that context we have introduced one parameter known as microphone sensitivity in the last lecture.

Before I start discussing about different criteria, which have to be used while selecting a microphone is extremely important that we just very briefly revisit this sensitivity and what we will do is, we will actually look at the data sheet of a microphone and see what it tells us.

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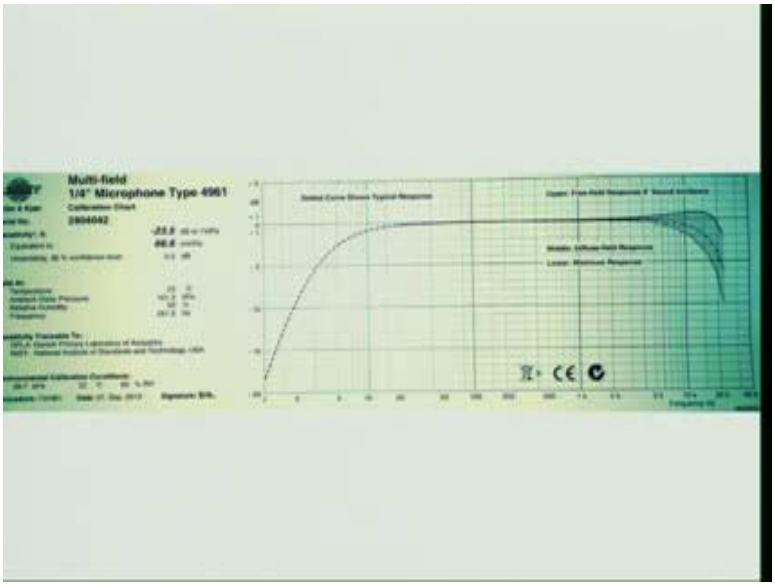

So, what I have here is the data sheet of a microphone 4961 and I am going to show you that microphone. So, what will do is, we will go line by line, this is the microphone I am talking about and it says it is a multi-field one forth inch microphone, type 4961. So, 4961 is some number which the manufacturer has given us. This actually is the microphone, so see I mean there is a small microphone which is screwed to the top of it

and there is a diaphragm you can see and I would not remove it in usual cases, but this is a class and I wanted to show you. So, there is a very sensitive diaphragm in top of it and that is the microphone and behind this, so that is the sensor, that is the diaphragm and this shiny part is the actual microphone and this black part is the conditioner or the preamplifier of the microphone. So, you have a microphone which is on the top and then you have a preamplifier which is on the bottom portion of this thing and it is all right now integrated, so this is an integrated microphone with this.

Now, what you see here is the calibration of this entire microphone and the first thing you see in this chart that there is a serial number; 2804042. So, again there is some related to manufactures number, so we are not going to worry too much about it, but then you have this sensitivity of minus 23.5 decimals per decimals, that is the microphone sensitivity and then the manufactures says that, what is the reference value of the sensitivity is 1 volt per pascal. So, this is what we talked about in the last class, so using this information minus 23.5 and 1 volt per pascal, I can actually calculate this value that for each pascal of sound how much volts it is going to generate and if you do this math the same way which we had done earlier, you will come at this number 66.6 there is nothing magical about it. So, this is a calculated number, which is based on this 23.5 number.

Then the manufacturer specifies that, there is uncertainty in this estimate of decimals 23.5, it may not be necessarily 23.5, but it will vary between 23.5 plus 0.3 decimals and minus 0.3 decimals. So, the actual microphone sensitivity it can be anywhere between minus 23.8 and minus 23.2 decimals and then it is important to understand these are the parameters because when we use these microphones we should be understand that they were calibrated under certain conditions.

So, when they calibrated this, I had tested it at 23 degree centigrade the ambient pressure was 100 and (Refer Time: 04:32), so this is environmental calibration conditions. So, this is a little different, but this is there environmental calibration condition they tested it at 99.7 kilo pascals. So, that was an a atmospheric pressure in their lab, the temperature was 22 degrees centigrade and the humidity and it is an important parameter actually for microphones and hopefully we will talk about it either today or in the next lecture was 50 percent relative humidity.

And then they had this procedure date; date when it was calibrated. This date is important because if you have a microphone which was calibrated long time back then it is important to check whether it is a still doing what it is supposed to do or is sensitivity has changed significantly since then. So, it is important to know that and then there is some person who signed it, but then this is their temperature was 23. So, this calibration was conducted at this, but this will be working, this calibration will be true for 23 degree centigrade at 101 kilo pascals of pressure relativity humidity of 50 degrees and it was calibrated not at all frequencies, it is valid at 251.2 hertz. So, and then they have this calibration chart on this side and on the x axis you have frequency, on the y axis you have decimals.

So, what does this say, that if you have 0 decimal sound it is actual value is 0 decimals then what this microphone will sense will be pretty much 0 decimals at 50 hertz, that is what the chart says, but if you come below 50 hertz, then it senses may be at 20 hertz it senses minus 1 decimals. Then you come down further and then at 10 hertz it senses lesser amount of sound, then you come down further at 3 hertz, so this is again a log axis. So, at 3 hertz, its senses minus 5 decimals, so its sensitivity decays below, roughly below this 40 hertz or so or below 50 hertz definitely.

And then between 50 hertz to 1000, this is 2000, may be 3000 hertz; its sensitivity is more or less constant, it is more or less constant and then after that it starts doing something strange. So, what does it say that, the curve looks like this dark line, if you have free field response and so what does free field mean that there is no reflected sound coming and if the sound source is that in the 0 degree direction, then the sensitivity curve looks like this and sensitivity curves changes by something like 1 decimals, at the most 1 decimals up to 20 hertz and then after this it start decking very fast.

So, its response changes between 3 kilo hertz and 20 kilo hertz in the direction of solid line for 0 degree sound in free field and then if there is defuse field, what is defuse field the sound is coming from all the directions, then the response curve is this dotted line; this dotted line is the response curve. So, this is what the sensitivity of the microphone will be for these types of frequencies, if it is defuse thing and then the lower one is the minimum response. So, the actual response will be somewhere between this and so it is perfectly defuse then it will be like this middle line, but in some cases it could be as low as the lowest line possible.

So, your sound pressure level will be somewhere in this dark green band, that is what this chart means. So, I thought this is important to see because these type of charts are available for all microphones and if you have a microphone and you do not get this chart, then I do not think you can make any meaningful measurements. So, you should have this chart otherwise the microphone will you telling you nothing because you do not know, how to convert the voltage which it will be generating into some pressure level because it is the chart and this sensitivity number which will help you understand what is the actual pressure it is going to generate and it is important that the sensitivity is true and if your microphone is very old then it may be worthwhile to get it recalibrated, you can do it yourself or you can get it recalibrated by some agency.

So, that is what I wanted to talk about and now what we will do is; we will discuss different types of criteria which we can use for selecting a microphone. So, what we are going discuss is criteria for selecting mics.

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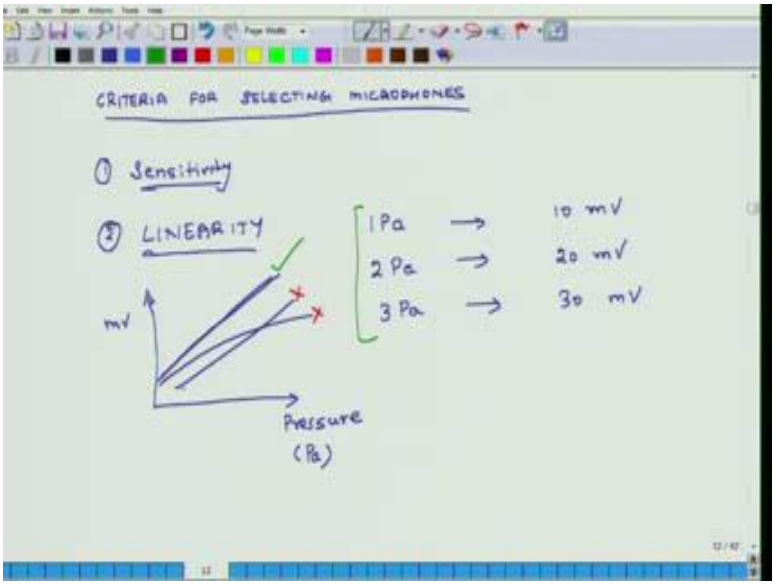

So, we will list some of the important criteria first and then we will talk about less important criteria. So, first one is sensitivity, so why sensitivity important, it is very important because if you have very insensitive mic, then the amount of voltage is it will generate for the sound which you will ask it to measure, it will be very less and if that sound, if that voltage level is very less then what is that mean, that it may get they will also be noise in your signal. So, your signal to noise ratio will be low and then you may

not be able to clearly understand the nature of your sound, so the higher the sensitivity the better it is.

The second parameter which is extremely important is linearity, so what does it mean it means that if my sound pressure level is 1 pascal and let us say, add 1 pascal my microphone generates 10 millivolts, then suppose my sound pressure level goes up by a factor of 2 then I should generate 20 millivolts of signal and if it goes up by 3 pascals then I should generate 30 millivolts.

Essentially what that means, that if I plot a curve or a relationship between pressure and here I am not plotting pressure in decimals, but in pascals and on the y axis I am plotting in millivolts or volts then it should be a straight line that is what it means and the straighter this is your some, a poor microphone may be doing this or doing this. So, this is not good, but if it is a straight line then this is good because otherwise I cannot predict how much my pressure is because my curve is non-linear or I have to do some more complicated calibration each time I measure, but if it is a linear thing then if I know the slope, I can very easily calculate the pressure, I do not have to look at the exact curve. So, that is the second thing that is the second criteria that is linearity.

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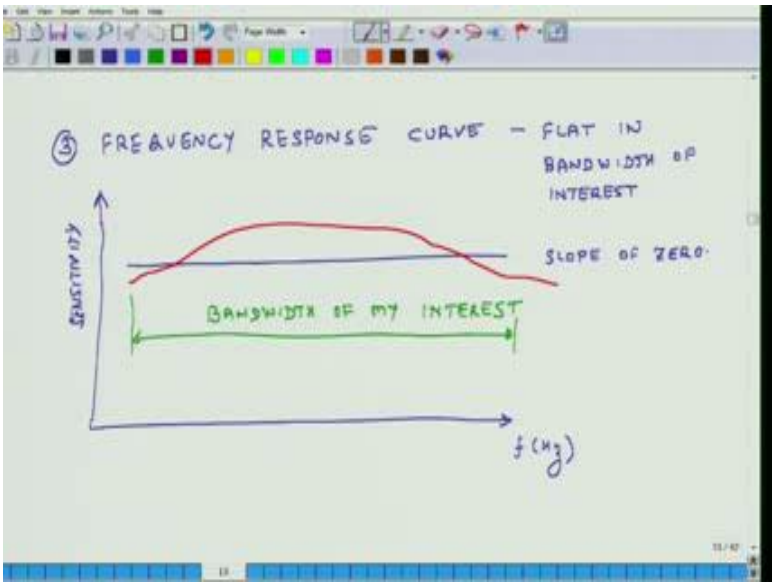

The third criteria; is frequency response. Frequency response this has to be flat in bandwidth of interest what does this mean. So, what it means, we had seen the frequency response curve of this particular mic in the last class or in the todays class itself and what

it means is that, if I am plotting on the x axis frequency in hertz and on the y axis I am plotting sensitivity then ideally it should be a straight line and it should not only be a straight line, it should have a slope of 0 and it should be straight line. So, it should be a straight line, it should be a slope straight line with the slope of 0 and it should be straight line at least in the bandwidth of my interest, this is extremely important should be flat in the bandwidth of my interest.

Suppose it is like this, so if it is flat then it does not matter, suppose I am measuring sound at 1000 hertz, then I have the same constant number. Suppose, this sensitivity comes out to be 5 millivolts per pascal then I have to multiply the same proportionality factor at all frequencies to get my pressure, but if this sensitivity curve is more complicated then I have to be more careful and I have to do more complicated calculations. So, again that is not good, so that is another important thing it should have that the frequency response curve. So, first one is the sensitivity should be high, second one is linearity should be high, it means the relationship between amplitude and voltage should be straight line, the third thing is that the frequency response curve should be as flat as possible and it should be and it has should have slope of 0 at least in the bandwidth of my interest.

So, those are some of the key things we are interested and we will continue this discussion in the next class also, but these are some of the key parameters which we have to be careful about when we are going around choosing a microphones, there are some additional important parameters also and we will discuss the importance of these additional parameters in our last class for this week which will be the concluding part of this week and with that we will close the discussion on microphones because I think with that discussion we would have a fair idea as to go around, how to around selecting the right type of microphone for your needs.

Thank you very much and have a great day. Bye.