Basics of Noise and Its Measurements
Prof. Nachiketa Tiwari
Department of Mechanical Engineering
Indian Institute of Technology, Kanpur

Lecture – 24
Selecting the Right Microphone

Hello again, welcome to Basics of Noise and its Measurements. This is the last lecture for this week on the topic of microphones, and what we will do essentially today is continue our discussion, to understand how we go around making the right selection; selecting the right type of microphone, which meets our requirements. In the last class what I had discussed was that there are 4 parameters which are crucially important, in terms of selecting the microphone.

The first parameter we had discussed was sensitivity, it should be as high as possible the second parameter which we had discussed was the linearity of the microphone, which means that has the sound pressure level increases in pascals, the response of the microphones in terms of voltage it generates, should proportionally increase. If it is perfectly proportional, then it is a perfectly linear instrument, and that is a something extremely desirable. The third parameter we had discussed we had mentioned was the frequency response of the system, and that has to be as flat and as horizontal as possible and at least in the operating band width of our interest.

So, those where the 3 characteristics which we had discussed, and today we will discuss a few more characteristics which are important, and that is what we are going to do, but before we do that, I wanted to show you some different types of microphones. So, that you get a feel for all the types; some of the important types of microphones. This is one microphone and you can see it from this side also and its diameter is one eighth of, I am sorry, its one-fourth of an inch, it is about 6 millimetres, in diameter, and this is. So, I am just trying to show you different topologies of microphones, what are available and this may not be the only most comprehensive shapes, but I wanted to give you some idea. So, this is, and here the microphone is separated and then I have to connect this microphone with a pre-amplifier, so that I can use it successfully.

I am just looking at the sensitivity of this microphone, and it says that its sensitivity is 48.1 minus 48.1 decibels, when the reference thing is one volt per pascal. So, this is one microphone, the other microphone I wanted to show you is, it looks something like this. So, this is another microphone and essentially it looks like a flat disc very thin flat disc, and the signal is coming into this wire and this a side; is the side which senses and it is very flat and thin like a very thin coin this is what this microphone looks like.

And a lot of times you use these microphones you stick them on the surface of an aircraft and when the aircraft is flying, you can stick it using some glue or something like that, and it will tell you what kind of noise it hears as the plane is flying. Why it is so thin? It is because you do not want the surface of the wing to have a lot of you know roughness and projections. So, they have made very thin microphone, which fits this topology.

So, I will show you maybe 1 or 2 more different types of microphones. So, that you aware you become aware of what is there in the field, then you have this microphone which we had already seen. This is again are quarter inch or 6 millimetre in diameter microphone and right and then, this is a half inch microphone. This is a half inch microphone and once again in this you have the diaphragm, is there which is the shiny thing and its protected by this covering and there is this microphone is on the top side and then this is the preamplifier.

So, that is there and then the last microphone, which I wanted to show you is actually designed to take measurements for high temperature applications. So, what you have is some sort of a tube, and this tube cannot take a lot of high temperature like other regular microphones, but if you have noise in a high temperature zone, what you do is, you attach this hallow thin slender steel; stainless steel pipe to it. And you insert this pipe into the area where you want to sense the sound pressure level at high temperature.

So, all of a sudden all the hot temperature will not reach this side and if you are careful you can protect this microphone from high temperatures and you can still manage to take ah you know sound measurements. And if the distance is even longer, what you can do is you have this plastic; not plastic polymeric pipe and so, if let say the location of the sound source is fairly further away. So, I can connect one and of my this steel pipe to this

polymeric tube and the other end could be connected to the thing, this thing and that way I can measure pressures in hot environments.

The other thing I wanted to show you, was that these microphones in general, they are attached to our data acquisition system by 2 types of cables. They are actually 3 types; but today we are going to show you only 2 types; one is this ferlin standard cable and this type of cable is known as B and C cable. So, you can do Google on it and you will see a lot about B and C cables. These are inexpensive and easily available. These are B and C cables and you can actually get these connectors in the market and you can make the wires or cables yourself.

And then, there are another category of cables, and it looks something like this. So, in B and C cable you have one cable in the x running on the axis of the cable, and then there is another conductor which surrounds that core, but here you have 6 on the periphery.

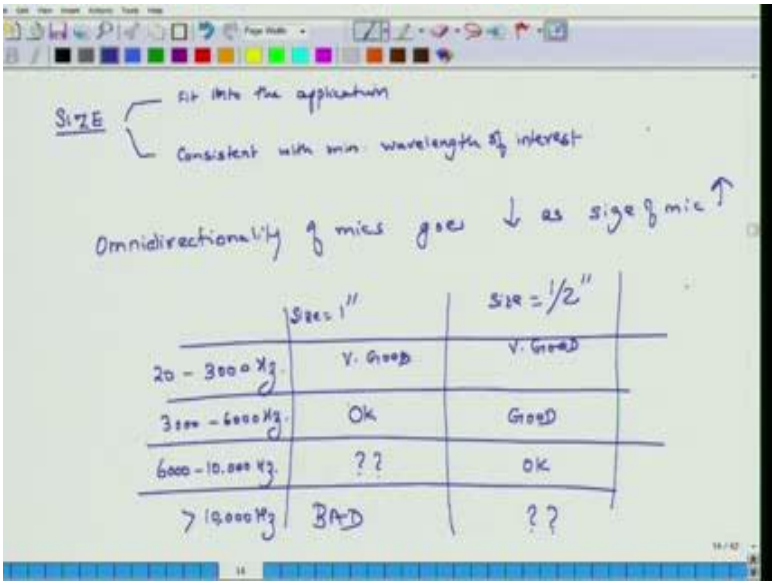
(Refer Slide Time 08:28)

So, if you take a front view of this thing, then it will look like the cable, has the overall cable has one conductor on the inside and then 6 on the outside. And so they are overall 7 connectors going through it. So, this is another cable, and why I bought the issue of cable up was that, while selecting microphones you have to be cognizant, that what kind of

cables you want because, you may have all the equipments and then you may realise that you may not have the right type of cable to connect your microphone to your acquisition system. So, you may be having problems because of that.

So, now what we will do is, we will look at some of the other important parameters, while selecting microphone.

(Refer Slide Time 09:33)



So, the first parameter, in addition to all the 3 parameters which we had discussed was size. Now, size is important because of 2 reasons, one is that if I have an area which is constricted then, I need a small microphone where it can fit into. So, that is one reason that where the microphone should be able to fit in, but the second and equally important reason is. So, size should be selected that it should fit in to application.

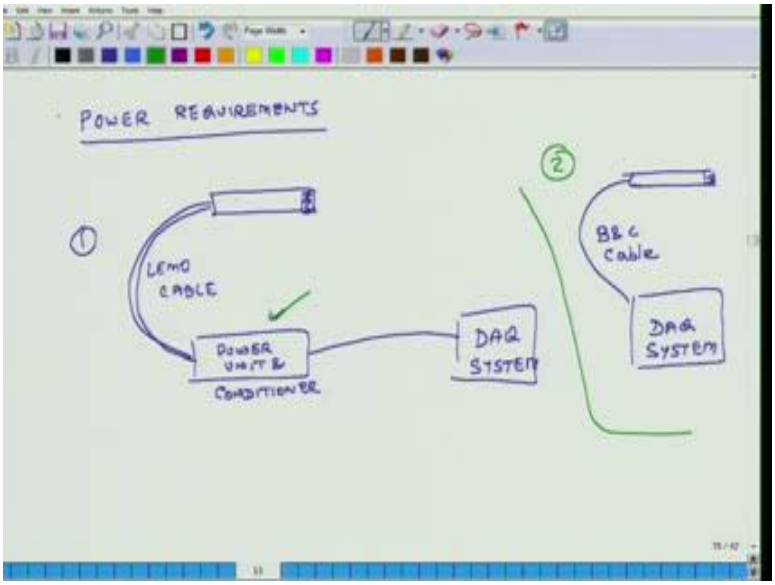
The second thing is that it should be consistent with minimum wave length of interest. And I will elaborate this further. So, I had mentioned earlier, that if my wave length is fairly large to the size compare to the size of the microphone then, the sound pressure field does not get significantly altered because of the presence of this for an object which is the microphone. So, that is one consideration.

The second consideration is that, the directional characteristic of microphone also depends significantly on the size of the microphone. So, omnidirectionality of mics goes down as size of mic goes up. Omnidirectionality of mics; if I have a larger mic then it will be less omnidirectional, especially at high frequencies. If I have a smaller mic then it will be more omnidirectional even at high frequencies and I will give a table.

So, let us look at 2 microphones, 1 inch size and half inch size. So, I have, I am looking at 2 microphones I will compare; one is having a size of it looks a little odd. So, size equals one inch and size equals half inch. So, I am looking at 2 microphones and then we will see how the size influences there direction omnidirectionality and let us say from 30 to 3000 hertz. So, if the frequency is of 20 to 3000 hertz and if the microphone is indeed design to be omnidirectional. Then, its omnidirectionality will be very good, for both 1 inch microphone and half an inch microphone from 3 to 6000 hertz this is. So, from 3 to 6000 hertz, this will be omnidirectionality, will be OK, it may not be great. But it will be and this will be Good, from 6 to 10. So, sound wave has a frequency of between 6 and 10 kilo hertz then this will be questionable.

It will not be probably, it will not be acceptable and this may be OK and if it is more than 10 kilo hertz then this will be actually, Bad and this will be questionable. So, size of the microphone, the diameter of the microphone matters for 2 reasons; one it help, you may not be able to fit into the application of your interest that is one reason and the second reason is that it may significantly influence the directivity of the microphone. So, you have to be careful what kind of microphone you are using what is it size and what influence it has on the omnidirectionality of your microphone, or directive directional characteristics of your microphone. So, that is the first thing.

(Refer Slide Time 15:11)



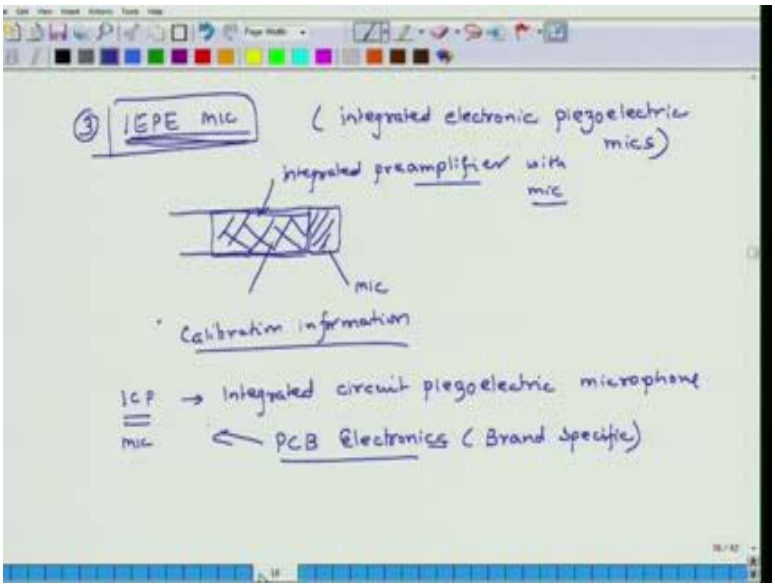
The second important parameter is power requirements. So, what does that mean? So, some microphones need an external power supply. So, there may be a particular type of microphone if I have to run it, I have to connect it to an external; especially the one some of these microphones which use these lemo connectors. They need an external power supply for running them.

So, I need one extra piece of hardware to run them. There are some microphones. So, the data from microphone, suppose I have a microphone, you know the data. So, this is my cable, it goes to some box and from here it goes to data acquisition system. This is one configuration. So, this is, sometimes it is a lemo cable. So, this is case one. In case 2, I may connect it directly to my data acquisition system, using B and C connector using a B and C cable.

Here, I have a power unit and a conditioner; here I have eliminated this thing. Here, I have in this in configuration 2, this power unit has been eliminated and the way microphone gets its power is that this cable the B and C cable it does 2 things. It provides power to the microphone and it gets signal from the microphone. So, it does both, here you need a separate power unit.

So, you need in your configuration one, you need a separate power cable now each of these configurations have their advantages and drawbacks, and I will not say this is better or that, but this is less complicated configuration 2 and if you can get away with it, it also has a simpler cable. So, if you can get away with it then it is good for you. So, this is another important consideration, that you need an extra power unit or you can get away with it and then that has to be could also be a consideration for making the choice related to your B and C cable.

(Refer Slide Time 18:23)



The third parameter is, there are some microphones and IEPE option, what is IEPE? It is an industry standard term and it means integrated electronic. So, some microphones could be IEPE mics, similarly we have some accelerometers IEPE accelerometers, integrated electronic piezoelectric mics. This is an industry standard terminology. So, it is not specific to a particular company or something if you have this type of a microphone. So, what does this mean? A lot of times you have this microphone this is your mic and the signal as we have seen which comes out of a mic, it is not in volts or millivolts, but sometimes it may be in micro volts also it may be very small.

So, you have to be very careful that if you want to send the signal over a large distance it may get corrupted due to noise. So, before you send it over a large distance you may

want to condition it, and make it more robust. So, lot of times you may have an integrated preamplifier you cannot separate it, you can get the microphone and the preamplifier as a package. So, you have an integrated preamplifier with the microphone, and this may be a piezoelectric with mic. So, this type of configuration is what is known as an IEPE type of microphone.

Now, there are several advantages of this type of thing, one is that, so this thing it may doing all the conditioning and it may also have the calibration information. So, you it was the signal which you get will be directly interpreted as pascals. You may not have to convert it into volt using your minus 20 you know this sensitivity level and all that stuff. You may get directly pascals you know.

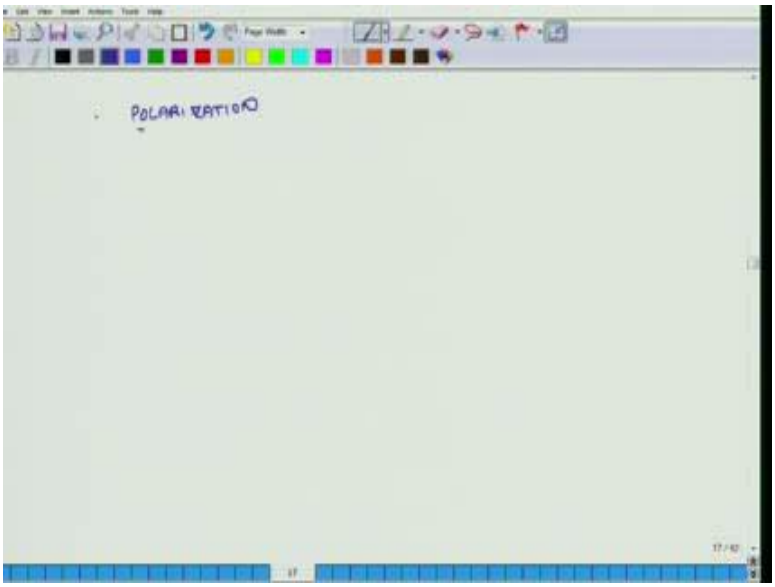
So, this preamplifier may already have a lot of calibration related information it may make the signal cleaner it may remove a lot of noise from it, you know and it may also amplifier it a little bit before it is sent out for data acquisition purposes. So there are some microphones, which are having this type of a feature and those are known as IEPE systems and what.

Now, there is another term called ICP. So, it is integrated circuit piezoelectric, ICP mic microphone. Now, IEPE is an industry standard term, it is not specific to a company. This ICP is something, which is used by a particular company called PCB. It is used by PCB electronics. So, this is a brands specific terminology, it is a manufacturer specific terminology. It essential more or less means say as IEPE similarly, there are other companies they have come up with their own terminologies, but the point what I am trying to make is that; if you want to check, whether your microphone is IEPE or not.

You may have to ask your manufacturer, whether it is IEPE or not. He may use this term ICP or some other term, but in general they will also be able to tell you whether it is same as IEPE or not. Because that gives you certain advantages or it has calibration information it has preamplifier built into it and thing. So, those are some of the advantages associated with it.

So, that is another thing. So, these are some of the important considerations I wanted to talk to you about, the other thing is that, if you have a preamp which is integrated with this, then it again says you less cable the connections are not there, physical you cannot physically separate the 2 parts which has an advantage because whenever they joined the microphone and the preamplifier in their labs. There it would have been a clean environment they would not have been any moisture. So, all that connectivity is more robust. So, those systems may be more reliable. So, this is another one.

(Refer Slide Time 24:34)



And the last parameter I wanted to bring to your attention is a polarization. So, we had while we were discussing about different types of mics, we had said that there are some mics which are, prepolarized for instance these electric mics, the charge is already frozen into them. There are other mics which need an external power supply to polarize. So, in those you have to have this external power supply.

So, you need some voltage to create the charge. So, you may want to a make a choice whether you need a polarized mic or prepolarized mic, which requires external polarization, that again in some sense dries down to the question whether an external power supply is needed or not. Some of these prepolarized microphones have somewhat of a lesser sensitive. So, that is the limitation, but then they do not need an external

power supply, the once which have polarization based on outside power supply they are a little bit more sensitive. So, again each of these mics have their advantages and limitations, but at the end of the day you should be aware of all these parameters and then you should understand these parameters see what your needs are and then make a decision as to what kind of a microphone will meet your needs.

So, with this we close today's lecture and also this weeks of you know, this entire week of lectures related to microphone. I hope you have benefited from all this discussion on microphones and next week we will meet once again with another set of topics, which are pertinent to the area of noise measurement. Thank you very much and we will meet next time.

Thank you.