Bio-electrochemistry

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Lecture – 07
Standard Potentials – I

Welcome back to the lecture series in Bio-electrochemistry. So, we are into the second week and today we are into the 7th class which is essentially the second class of the second week.

So, as I told you that we are moving little slow. Though this week we are supposed to dealt with a different kind of electrodes and the potentiometry, but instead we are still on to the basics. The reason being like this part after this we will be talking about Nernst equation this part is the basic core fundamental of your understanding of electrochemistry and if this part is clear then rest will be much more easier journey for us. And that is why I am extending it there is an spillover into this next week. But do not worry I am really pushing it on the fundamentals.

So, coming back let us resume this class. So, if you people remember that there was one question which I posed that the electrochemistry is what kind of science. So, interestingly electrochemistry is basically a surface science. It is, you can call it a surface analytical tool or it is a surface chemistry, it is precisely chemistry on the surface it is not on a bulk material it is all the reactions which are happening on the surface of xyz metal. So, when we talk about electrodes. So, as I told you our next week you are supposed to or the second week was the schedule for electrode the very fundamental electrode is called the reference electrode or standard hydrogen electrode in short they call it SHE.

Today, while dealing with our next topic which is our standard potentials we will talk about standard hydrogen electrode and as a matter of fact that we are first electrode what we have to understand and literally at times I always feel when I look back that this one really confused me and I was always confused that what is this standard hydrogen electrode is all about. So, today we together will explore that and in that process we will talk about the standard potentials what we mean by standard potentials.

So, before even getting into the class of a standard potential and what it meant, iI wanted to do a small recall. So, if you remember in the first class we talk about that there are different kind of metals, non-metals and or different kind of elements and each one of them have a certain power either to donate electron or to accept electron. So, we have to take one scale. So, say for example, we say each one of them have we categorize them each one of them with their power to donate electron or giveaway electron in other word they are getting oxidized.

So, their potential to get oxidized or we can call it a reverse way which is generally the convention which is followed a material or an element or a compound a potential to accept an electron in other word it gets reduced right. So, we can classify or we can classify will be a wrong word essentially we can make a ascending order or a descending order based on who will be able to accept electron. Say for example, I am standing here 5 other people are standing there and we all have a different power to grab electron. So, who will be grabbing it faster than the other, understand.

So, based on the power say I have say this much horsepower say 10 horsepower, someone has 5 horsepower, someone has 3 horsepower. I can put a categorization saying that he has 10 horsepower he can drag the electron faster. So, in other word one can classify any material based on this unique surface property of accepting electron or giving our electron and again I told you, you have to follow one scale you can follow both the scale, but you have to be careful which is scalar. So, you have to give the reference that I am following the oxidation scale or I am following the reduction scale.

So, now if we say that every material has a power to accept electron or to donate an electron you can classify them then in order to develop any kind of a scale whether the based on oxidation or based on reduction what you will be needing is what you will be essentially needing is a reference with respect to what; because that way only you can classify something. Say for example, just the most easiest example we call seven as the neutral pH. So, anything less than 7 6 5 4 3 2 1 0 they are all acidic side and; obviously, 2 is more acidic than 6.

Similarly, anything more than 7 8 9 10 11 12 13 14 they are all alkaline. So, what we say is 14 is more alkaline as compared to say 8. So, there is a scale. So, your reference is at 7. So, similarly in electrochemistry or any kind of electrical measurement you need it a

reference and you have to develop that reference and that reference is another electrode and that what we call as standard electrode. So, that will be our learning about the first electrode and as I mentioned in the assignment that electrochemistry is a surface science or a surface chemistry.

So, we will talk about those reactions which happened on that standard electrode and how we measure it. So, let us start with, we are into our, with this background. So, before I just jot down my points with this background. I wish to start this class that today we will be understanding those basic fundamental electrodes which are useful to decide or draw that chart by virtue of which you can say this x compound has more power to donate electron or more power to accept electron as compared to the y compound that whole gradation.

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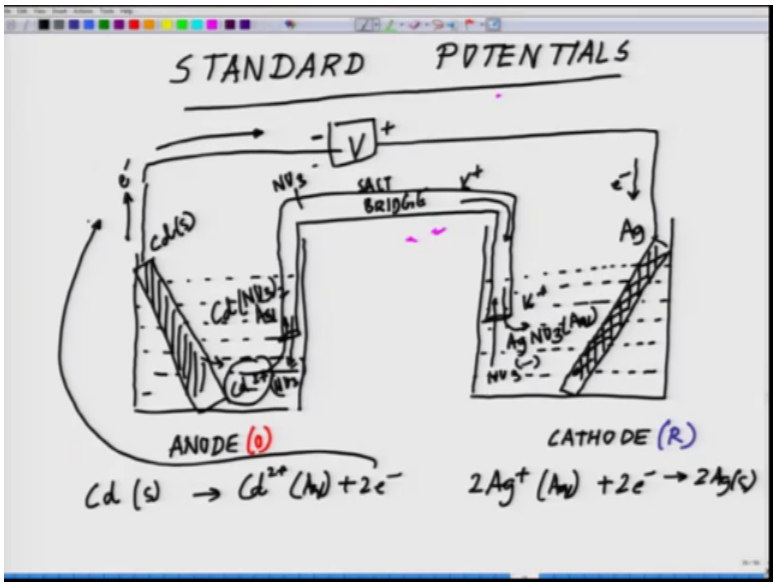

So, let us start our today we are into one second lecture 7 or in other word this is week 2. So, week 2, lecture 2 essentially it is which is in sum total this is the 7th lecture we will be dealing with. And the topic we will be dealing with is standard potentials.

Before we get into the standard potentials let us recollect what we where we ended up the last class. So, if you remember the last class we had this cadmium and silver electrode. So, you had this cadmium electrode on your left hand, right hand you have the silver electrode, the silver electrode sitting you know the cadmium electrode sitting at the volt meter and here is the connector so on.

So, here are the silver sitting in a solution of Ag NO 3, one second because from here we will build up our story. There are few axioms which I have to tell you which will be very helpful. So, you have this cadmium and you have Cd NO 3 which is the aqueous and here you have the cadmium solid electrode Ag electrode, then you have Ag NO 3 which is in the aqueous form and you have the salt bridge which was connecting the two and the salt bridge had they have KNU 3 potassium ions which were moving like this. And if you recollect those potassium sands were leaving this part and you have the NO 3 ions moving inside from the cathode side, this is your cathode, this is your anode, anode where you are having the oxidation taking place, cathode is where you have the reduction taking place and this is where we observed that some of the cadmium ions getting inside the salt bridge and some of the NO 3 ions coming out from the salt bridge this side. Here you have the NO 3 minus and this is your salt bridge. More or less this is what we have talked about.

And we told that on this cadmium surface we are having the oxidation taking place this oxidation leads to liberation of electrons, this electron goes on the voltmeter, this is the negative terminal and this is the positive terminal with I will come to this a axiom. So, this electron goes to the negative terminal and on the Ag surface where you are having the reduction taking place. So, electron is travelling essentially this is where you are having the reduction happening on this surface, on the surface of cathode.

And if you remember the reaction what we talked about 2 Ag plus on the aqua side plus 2 electrons making it 2 Ag solid. So, the solid whereas, on the cadmium side you have cadmium which is solid making cadmium 2 plus which is an aqueous as you could see the cadmium 2 plus coming into the aqueous solution whereas, in that process it liberates those electrons and these are the electrons which are getting carried.

And in summary if we follow up in the last class what we talked about the voltage measured in this figure this is where you are measuring the voltage, the voltage measured is the difference of the electric potential between silver electrode on the right and cadmium electrode on the left.

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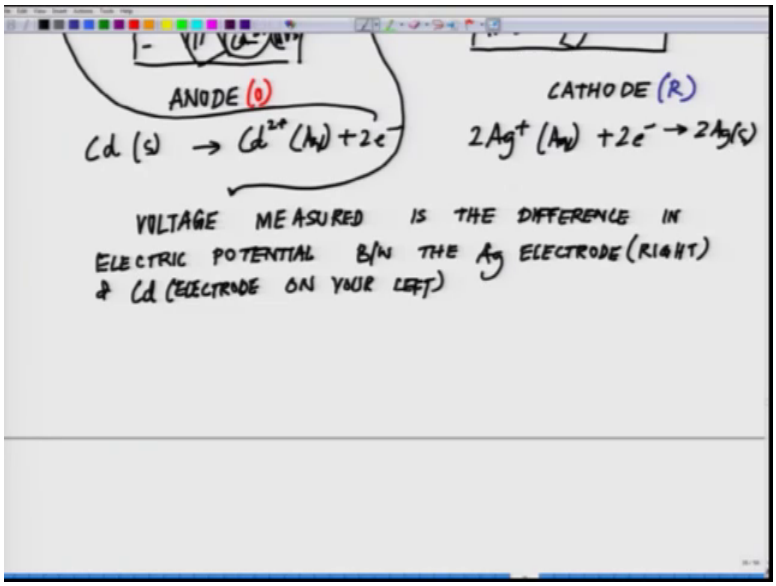

So, basically voltage measured is the difference in electric potential between the silver electrode that is on your right and the cadmium electrode that is on your left and cadmium electrode on your left. This is precisely how the configuration is and voltage tells us that how much work can be done when the electron is flowing from one side to another.

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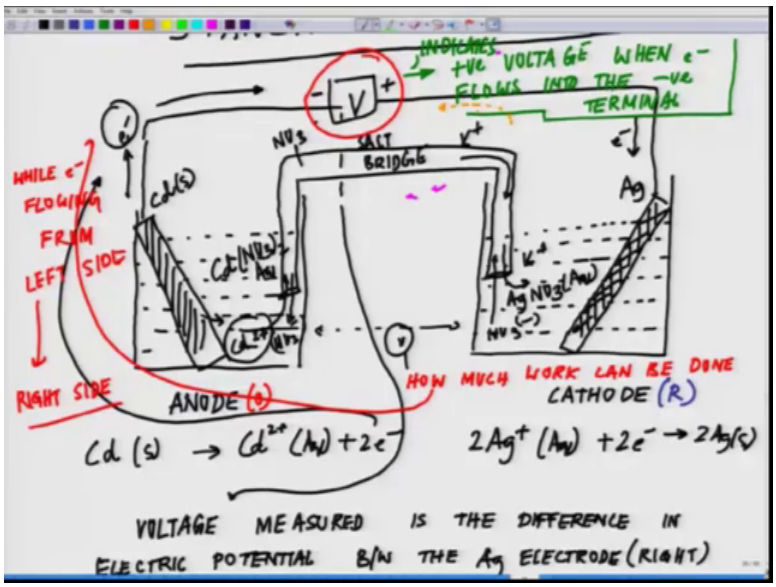

This electron flow and this voltage across it tells us how much work and this will take you to the all the basic formulae can be done, how much work can be done while the

electron flowing from one side to the other, while electron flowing from one side to the other which is essentially you are from left side to right side. This is what we talked about.

And there is one more axiom which is very important for you to realize here is this part is very critical that is why I am putting it in green just mark this. The potentiometer the voltammeter indicates a positive voltage, this indicates a positive voltage when the electron flows into a negative terminal; indicates positive voltage when electron flows into the negative terminal. So, there could be a vice versa and this will come very handy and please mark this word while we will be talking about the electrodes and the visa versa if the electron flows in the other way.

So, for example, the electrons say for example, suppose the electrons are flowing like this then the terminal is going to show you a negative voltage. So, keep that in mind. If the electrons are flowing onto the negative terminal of the voltmeter, if the electrons are flowing into the negative terminal of the voltmeter it will indicate a positive voltage. Reverse, if the electrons are in the reverse direction means on the negative terminal of electrode electrons are not going they are coming from the other direction then; so this is all about how you place the potentiometer which polarity are following.

From the negative terminal electrons are flowing on to the negative terminal of the potentiometer then it will show a positive deflection. Remember this, this will come very very handy as will move through.

So, keep that in mind. And then from here we will go to the colour coding if we just for your practical interest whenever you come across any of these things. So, there are certain colour coding, which are being used pretty frequently. So, you will see a black colour and a red colour, much of these potentiometers when if you look around.

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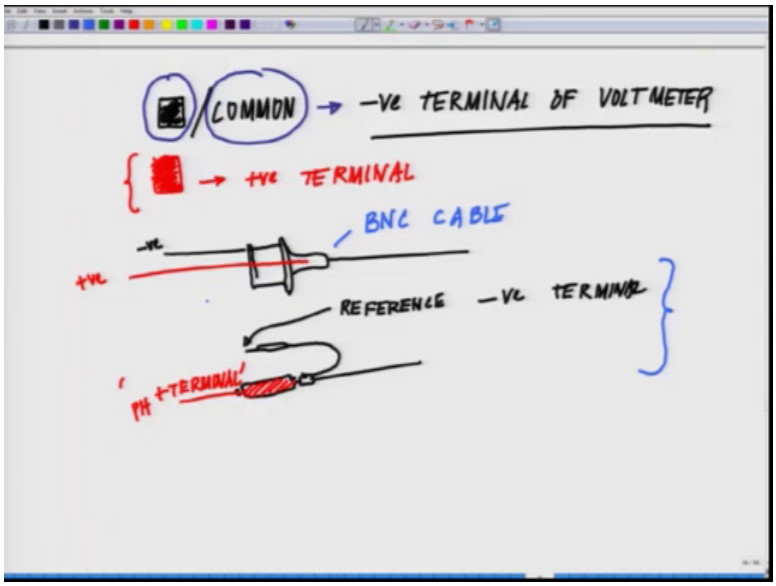

So, the negative terminal of a voltmeter is labeled as sometime it is also labeled as common. This one is also called common and this is your negative terminal of voltmeter. Keep this in mind. This may come very handy. Whereas, the red terminal is the positive terminal this is the positive terminal. So, whenever now onward you handle the voltmeter you should know that if it is a red it is the positive terminal and if it is a black and if it is written common then it means. So, there are two catch either it will be written common or it will be colored black. So, in that case this is the negative terminal of the voltmeter.

Keep these two aspects very clearly in mind and it may be colored black or positive [FL] a when say for example, when you see a socket like this I will draw a socket for you guys. So, something like this, you must have seen this kind of sockets, all the time wait when you use pH meter and all that you must have seen something like this a socket you will see or you will see something like this a thin connector like this especially in the pH meter. If you look at the pH meter very carefully something like this. So, the positive terminal is the where at the center the inside the connector.

So, in other word, here your positive is like this out here and this rim what you see is where the negative is. So, try to realize if some time you want to do, do some kind of a trick. So, is the center which is the positive and the outer periphery is the negative. Similarly if you look at these older style ones which is mostly you see in devices imported from us you will observe this one there is an additional thin stuff like you

know. So, these pH meters this is called the reference or negative terminal and the pH is on the positive terminal. So, this is the positive terminal which is pH positive terminal.

So, this is basically you will see all the instrument, pH instruments or something if they are imported from us you will observe this. And when a pH meter with a BNC socket is used the potentiometer the center of the wire is the positive input as I showed you and the outer connection is the negative output. So, this is basically we are talking about the BNC cable. So, all the standard BNC cables are like that. So, keep that in mind. So, these are some of those I can say, some of those practical knowledge what I wanted to put forward.

So, the first thing what I put forward is about the volt meter whenever you look at the volt meter. So, it could have a positive and a negative terminal. So, if the electrons are reaching the negative if the electrons are reaching the negative terminals and it will show a positive deflection. If electrons are reaching its positive terminal it will show a negative deflection this is the first thing what you have to learn. And the second thing is some of these BNC cables whenever you use you should know that which terminal is what. So, the center of these BNC cables will be positive and the outer periphery will be negative.

So, I will stop here and the next class we will with this background we will move on to the next lecture where we will be talking about the standard potentials, with this background in mind. Specially please do remember the axiom on the potentiometer or volt meter.

Thank you.