Environmental Quality Monitoring Analysis
Physical and Chemical properties of interest
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Lecture – 7
Introduction to Equilibrium

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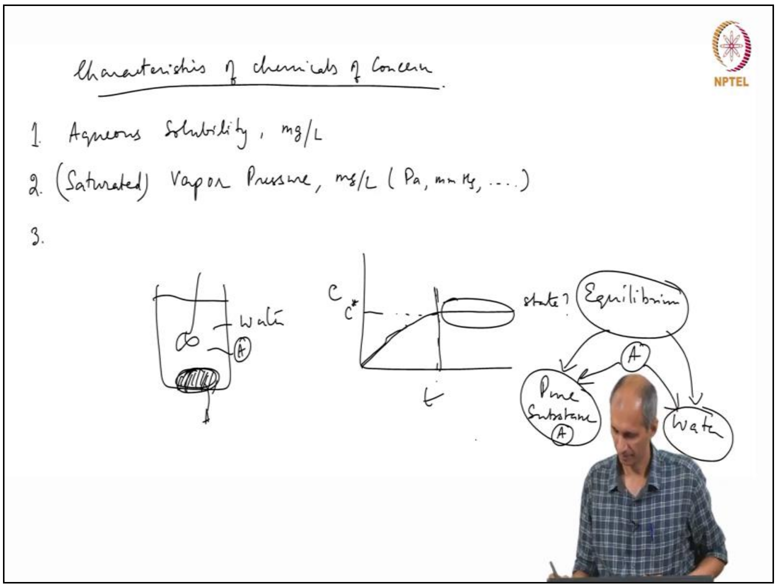

So now, we will go back to the characteristics of some of the Chemicals. So we are talking about the physical and chemical characteristics of the chemicals now. So, we are looking at the physical properties. From a faith and transport point of view, we have already setup the problem, what could be what is our area of interest what is it that you are interested? We are interested in chemicals entering water interest and chemicals entering air, chemicals entering plants and animals, soil, sediment and all that.

So, there are some properties of chemicals that are of interest to in this context. So, which are these properties straight away can you what is, what is what are the properties that could be of interest? If I give a name of chemical and if I ask, what will be the health hazard in water, what is your first first question or response? What is it, what is the solubility? Aqueous solubility usually referred we are going to be in this class, we are going to be using absolute units.

We are going to be using units. No we will try to refrain from any other use, absolute units like this milligram per litre milligram per units like that. Typically we will use milligram per litre or unit like that even for the so this is called Aqueous solubility. And then, Like Aqueous solubility corresponding to air, is it? Vaporization. What is the property of a chemical indicate Vaporization? Volatility. Vapour pressure or saturated Vapour pressure you can call whatever you want.

So vapour pressure we will again give it as milligram per litre, you can also have other units people describe as Pascal millimetres, mercury and so on. Many units are possible for this. Then what else is important? So, what is what are these two? Aqueous Solubility and vapour pressure these properties correspond to, correspond to something they can be classified as one particular measurements, when do this and how can you, how do you find solubility of a chemical?

You put it in water and then, how you measure, when you are measuring it when you know its solubility? If I am trying to find out solubility of chemical in water if there is a small experiment what I can do? Solubility in water solubility, resolving take a pure substance is put into water it will dissolve. We are trying to find out what is this aqueous solubility. What is the solubility this number how do you find out? Ah, concentration when?

Saturation, how do you find out saturation? Precipitation, no we are starting with pure substance if I take salt or sugar and I put it into water and I am trying to find out what is the solubility of salt and sugar. What you are talking about your salt solid is already there. I am asking you what is the solubility limit based on that. Suppose I take a kilogram of some chemical dump it into water? What is aqueous solubility definition? From a layer point of view what is the solubility?

It is the maximum, maximum concentration that it can attain in water, which means if you want do experiment, how will you do it? When will you when do you know that has reached maximum? yah no, no. Aqueous solubility, it is one number, One number. Depending on how people do it, it may vary a little bit. But essentially, it is one number. No, at same temperature, I am asking about one particular temperature, pressure all conditions how do you get this number?

With, no I think you are going off. I am I have I have a container. I had a large amount of Solid A and I put water and I start mixing. Stir it, stir it. What happens to the concentration of A here, it increases with time. The concentration increases with time and then when will you reach solubility when you know you reached solubility? Ah, it will, what happens to concentration with time? It will become do this at some point. This number is the solubility. What do you call this state?

Saturation, is there another word for it? Equilibrium what is this equilibrium, what is equilibrium? Equilibrium is, equilibrium is defined between two States, two particular state. So, what is this equilibrium between? So we are talking about equilibrium of what in this case? Of this particular chemical A between the liquid, what is the solid phase? In this case, what is the solid phase? We are looking at the equilibrium of A between water and what is the solid phase? of what? There is a very specific definition of this, very important. What is that?

What is the solid phase is what? This is what? It is made of what? It is a pure substance, nothing else, only A. All of A, your pure A in contact with water so is equilibrium of A between pure substance and water is solubility.

The equilibrium of pure substance of A between its pure form and air is saturated vapour pressure. If you leave something in a container, it will have a vapour pressure it will evaporate and it will come to a point where it will not happen anymore. That will be vapour. For example if you put water in a jar, water will evaporate and it will reach its maximum concentration of water vapour in a jar that is the saturated water vapour pressure of water, at a given temperature and pressure. So these are all conditions for this all will change. Thermodynamically all these will change.

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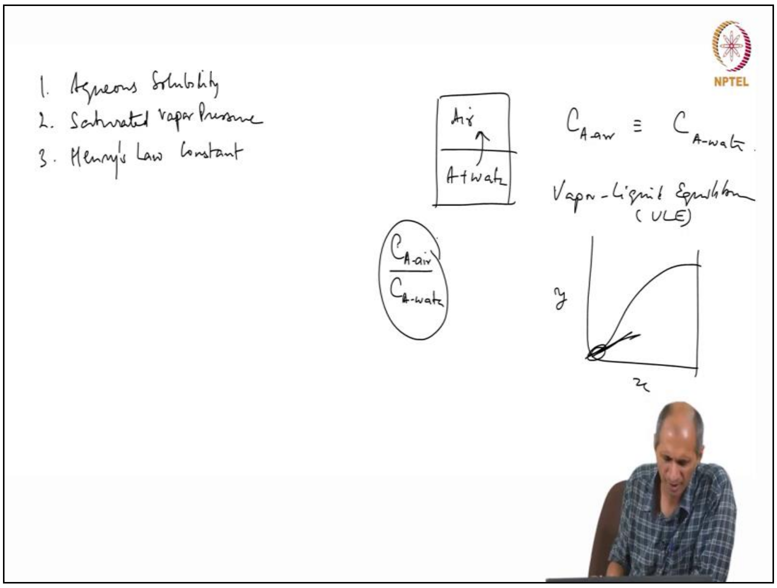

Aqueous solubility, Saturated Vapour pressure, two things which are equilibrium of A between its pure form and water and pure form of air. What next? Modify dump large amount of chemical into water all of it dissolves when it comes in contact with air how much of this will going to air? Now we will not have a pure substance. But we have a solution in contact with with air, ok. If I have mixture with a plus water and air, how much of A will go to the air if I leave it long enough to go to equilibrium?

So this is a equilibrium between the concentration of A in air versus the concentration of water air and water in air contact with each other and they go to equilibrium? They allow it come to equilibrium. What is that number? What is the ratio? It is the distribution of distribution of power between air and water at a given temperature and pressure. What is the General name and what is the specific name here?

There is a general name for this kind of relationship, relationship? It is a thermodynamics relationship. Everything is chemical potential. Chemical potential is what we are discussing. What we are discussing is simpler forms of it. The distribution coefficient here yah, for the specific system of air and water is there a general name is between any two phases is a generalised name, that is correct? We call it as a partition Coefficient and distribution coefficient or one of those can be used, yah.

So, from a Chemical engineering background there is a generalized equation, generalized name for lot of this is drilled into you in thermodynamic course. When you look at ah, relative volatility, no no. It is some equilibrium, what equilibrium it is? It is equilibrium between what and what? Chemical potential is a general term. Equilibrium between what and what? This is called Vapour Liquid equilibrium or VLE.

It is applied in several things but here, generalized vapour liquid equilibrium in Chemical Engineering applications extends to a very large range of compositions. But in our case, we are not worried about that. We are worried about evaporation of component from water to air in this case. The only components which are going to evaporate are organic compounds. Most of the organic compound do not evaporate that much, ok. Very few one or two cases are there.

And we also known as the solubility of organic compounds are very low. So if you get vapour liquid equilibrium general diagram it is nonlinear also. We are now this is ah, concentration in the aqueous phase, concentration in the gas phase, vapour phase. We are working in this small region here, very small which is a linearized version of the vapour liquid equilibrium. And this small region, linear region where is the dilute portion of the liquid is known as Henry's Law constant.

Henry's Law which says that there is this, linear relationship is very linear. On the other hand it is called Rowl's law on the higher end. So, Henry's Law, the definition of Henry's Law constant is very straight forward. It is very simple that the partition constant as we described. So, it is really the ratio of the concentration in air versus the concentration in water. This is general definition, this is how we described. In contact with each other this is the equilibrium ratio in which the concentration in the vapour phase and the liquid phase is distributed itself.

So compounds which are very high Henry' Law is essentially lot of people will go into the air and little will remain in the water, partition itself to that extent. In some applications the Henry's Law is reversed where the concentration of water goes on top so you have to watch out for it? I will come to that one of those cases later. In Literature you will find. People will do all these things for convenience.

For example, this Henry's Law is very small. Henry's Law is 0.00001 so you do not like to put 0.00001 so you want to reverse it and say Henry's Law is 1000. But the concentration of A in in water is more than that of air. It happens in cases where does it happen where the partitioning is favourable in water than in air. This is like absorption and for sulphur di oxide absorption and all that, you will use a reverse of it.