Fundamentals of Environmental Pollution and Control
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Lecture No. # 19
Wetland Treatment and Bio-Technology Applications

Well, we start this class you know here you know you would be discussing about the wetland treatment and some biotechnology applications. So, this is you know this the scheme of wetland treatment, aerobic wetland treatment schematic scheme what is generally done here is like this. If you just observe a wetland treatment system, this is you say waste flow coming in say this is as I have said if we remember to have said, I have said this requires a very open land, open land like this. Here this is what would be okay here you see this, this is what is the in this influent, the waste water that is coming, this would be discharged here, this would be discharged here and this is where the wetland would be, wetland would be. There are different ways to do it, different waste to design a wetland.

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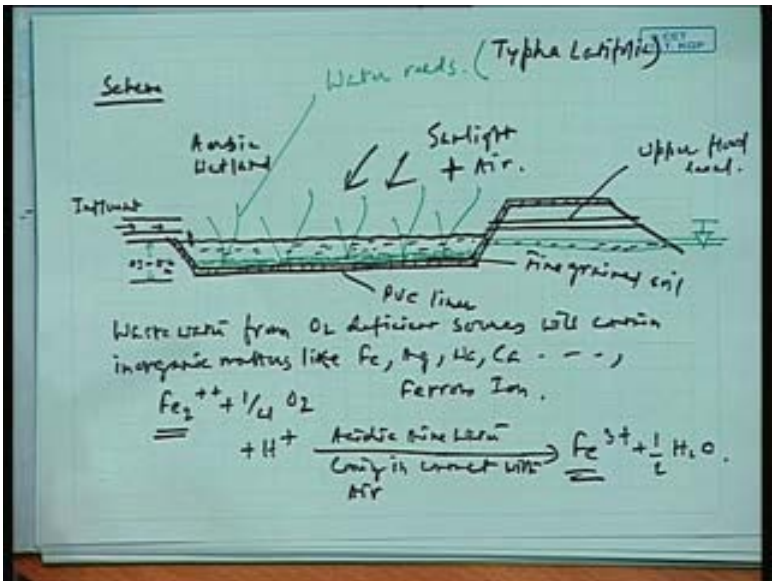

The most common one there are, there are in some cases it's optional. Remember this, this is purely optional to have a liner at the bottom, it's not necessary that all wetlands would require a liner. If there are, if it can be, the whole thing can be insulated so better it would be insulated. So, we have generally a liner in some cases but as I have said this is not mandatory, this is not mandatory just to well… This is what is the waste, this is what the waste water would be, there would be few other things here, there would be few other things here as you can see, in some cases, in some cases we will find that you know some substrate say the fine soil substrates are also generally spread over. If it is a designed wetland, if it a designed wetland this is, this is what is a designed wetland we can see find out this is the fine grained soil, this is a fine grained soil, soil. PVC liner, non-reactive liner, certainly non-reactive it should not react with the waste water, this is the fine grained soil, this is the fine grained soil, this is the fine grained soil.

This fine grained soil essentially works in for one very important reason is this, this works as a natural buffer, this also works as a natural buffer, okay. Now here this is, this is the wetland, this is the water we can see this is what is the water is, this is how it would look like, this is how it would look like. See here this depth, this depth of the wetland, this depth of the wetland, this depth of the wetland is about 0.3 to 0.4 meter, right. This is what I said 0.3 to 0.4 meter, it would be the depth of the wetland, this is the depth of the natural wetlands you must have seen you know near any city areas you will find natural wetland also in the villages, you say there is not much of a difference with an ordinary pond except, except the depth is shallow, it is of low depth, it is generally of low depth and it would be say this, this is what is the, we would try to keep a upper, so we just keep try to keep sometimes upper flood level so that the water if it is more than that the water would be generally passed out, water would be generally passed out.

This is an upper flood level just you know where it is the, there would be a pipe through which water would be passed out otherwise, otherwise there would be this water would be from the top of the water, this water stream would be generally would be taken out in a controlled manner, in a controlled manner, in a controlled manner this one would be taken out, this water would be generally taken out in a controlled manner, in a controlled manner, this water would be taken out of this wetland. This is an aerobic wetland, this is an aerobic wetland, this is an aerobic wetland, this is an aerobic wetland you can see this lot of sun, air everything is sunlight, sunlight see this important of sunlight and this air is paramount. The sunlight is this because of all this wetland reactions, all this wetland reactions are natural reactions. They are not aided by any kind of, any kind of agents like heat, mostly heat or say agents like enzymes agents like you know say any other substances like you know any other catalysts.

So, this the total energy is derived from the sunlight itself, total energy is derived from the energy of the reactions is basically a sunlight. See, all this reactions would require a certain energy to take place. Isn't it? So, this energy, the energy for the reactions should be obtained from the sunlight. So, here what happens is try to understand this, this is very critical here. What happens is say waste water, waste water from, waste water from oxygen deficient sources, oxygen, waste water from oxygen deficient source will contain, will contain say will contain, will contained inorganic matter, inorganic matter like inorganic matter, inorganic matter, inorganic matters like iron, iron, manganese, sodium, calcium etc. In a fashion you know which can be characterized by this reaction which is Fe 2, this is Fe 2 plus, this one is 1 by 4. This is what would be, this is what it would be characterized. This is you know is in a, in a ferrous ion. So, you know this if it is iron it would be available in ferrous ion, it will be available in ferrous ion so the basically in a deficient waste. Where do these deficient sources take place? Say at in the mine, inside a coal mine, inside a coal mine there is a short supply of air, short supply of air and there is more concentration of iron.

So, as a result of which as relatively, as relatively the concentration of iron is higher than the general concentration of oxygen in the air. So, the ionic state at which the iron would belong is basically ferrous ion state okay. But this one is radically changes, this one radically changes as soon as the water comes out of the mine area, outside the, from the oxygen deficient area to oxygen sufficient area. As soon as it comes down to that see what kind of reactions we generally expect there, you see as soon as this comes in this is H plus, H plus because if this is, this, this is the typically to characterize this acidic mine water, acidic because of H plus shows that acidic

mine water, acidic mine water in combining with you know coming in contact with, coming in contact with, coming in contact, coming in contact with air, coming in contact with water, coming in contact with air. This is ferrous ion, oxygen and hydrogen as it is coming out like this the reaction that takes place is Fe 3 plus, Fe 3 plus plus 1 by 2 H 2 O, so, here 1 by 2 H 2 O. So, is here as you can see this is just you know you can multiply it by 2 or multiply it by 4 you know as you can find out this. So, this is, this is conversion of ferric iron.

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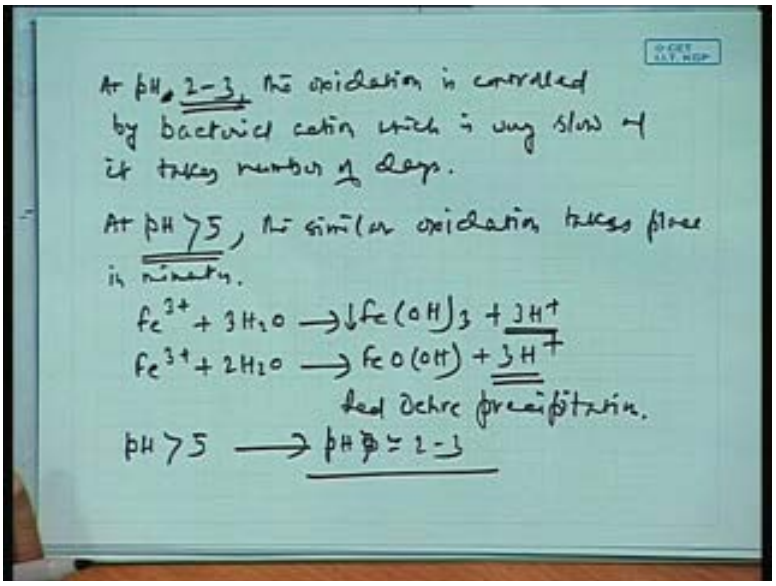

This, there is the, the biggest in the most important thing is now, the most important thing is now we know what is to be understood here is this particularly below ground this is at pH, at pH the water, the pH of the water here at pH between 2 to 3, at pH 2 to 3 the oxidation, the oxidation of the, oxidation from ferrous to ferric form, oxidation from ferrous to ferric form at pH 2 to 3, at pH 2 to 3, at pH 2 to 3 the oxidation, the oxidation, oxidation is controlled, oxidation is controlled by, oxidation is controlled by, oxidation is controlled by the bacterial action and can take a bacterial action controlled which is, which is very slow and the oxidation is very slow. So, it may take number of, it can take number of days. So, is a number of days it take and it takes and it takes number of days, it takes number of days okay, it takes number of days.

What happens now is, what happens now is at this what at more alkaline pH, at pH, at pH 4 say at, pH more than 5 hour, this is no longer bacterially controlled, this the whole reaction of conversion of ferrous ion into ferric ion is no longer bacterially controlled. This is at pH more than 5, at pH more than 5 the reaction is no longer bacterially controlled and it is a typical, it's a typical inorganic reaction, it is a typical inorganic reaction that takes is, that is generally aided by the, by sunlight and air and at higher pH, pH is equal to 5, we can find these reactions to take in matter of minutes.

The reaction this, the same, the similar oxidation takes place, takes place in minutes. Similar oxidation takes place in minute but this is not without certain problem that the problem is this, the problem is this you know is particularly is as finally, as finally we find this Fe 3 plus is being

formed, this should finally, a final another kind of reaction that would take place is H 2 O converting it to, converting it to Fe oH 3 plus 3 H plus 3 H okay. So, this similarly another reaction that we can generally say is this 2 H 2 O, 2 H 2 O converting ferric oxyhydroxide, ferric oxyhydroxide plus 3 H plus 3 H. What is interesting here is, what is interesting here is this one is particularly, so ferric hydroxide is feasibly dissolvable in water, so it would begin to precipitate, it would begin to precipitate, ferric hydroxide would begin to precipitate, this ferric hydroxide precipitation would take place and you can see in a says this is a red ochre, red ochre precipitation. The problem here starts is, the problem here starts is this production of this hydrogen ions.

What this production of hydrogen ions will be driving, it would be driving the pH say pH more than 5 it would drive towards pH more than say pH equal to 2 to 3 because increased of, increase hydrogen ion, increased hydrogen ion produced due to in the formation of this ferric hydroxide. So, this would lead to, this would lead to the earlier state of 2 to 3 when the reactions is very very slow. So to for an efficient wetland, for an efficient wetland we have to see that we have to control the production of, we have to control the production of hydrogen ion only then the wetland treatment method becomes successful. So, to produce this you know to reduce the supply, so what we generally try to do here is we generally try to increase the supply of oxygen in the water. How you do it? With there, there is a process you know by which, by which we can very well do this.

If you can bring back the earlier slide, if you can bring back the earlier slide, you can see now this can be done, this can be naturally done a supply of, supply of oxygen into the, into the wetland again can be separately done by natural reeds, the natural reeds. There are different kinds of reeds, water reeds you have seen those, the tall grasses that grow in the water the generally by the side of the ponds. These are the reeds, these reeds the, so what we have to do is we have to in the wetland also we have to controllable fashion, in a controllable way we have to grow weeds, this is called the water reeds, water reeds. This is the type of you know there is the type of water reeds that general Typha latifolia, Typha, Typha latifolia, Typha latifolia. So, they would be, they through the roots root system the reeds, the reeds, through the reeds, the reeds through their root systems, the reeds through their root system would the reeds, the root system, through the root system will supply, will supply oxygen to the soil substrate.

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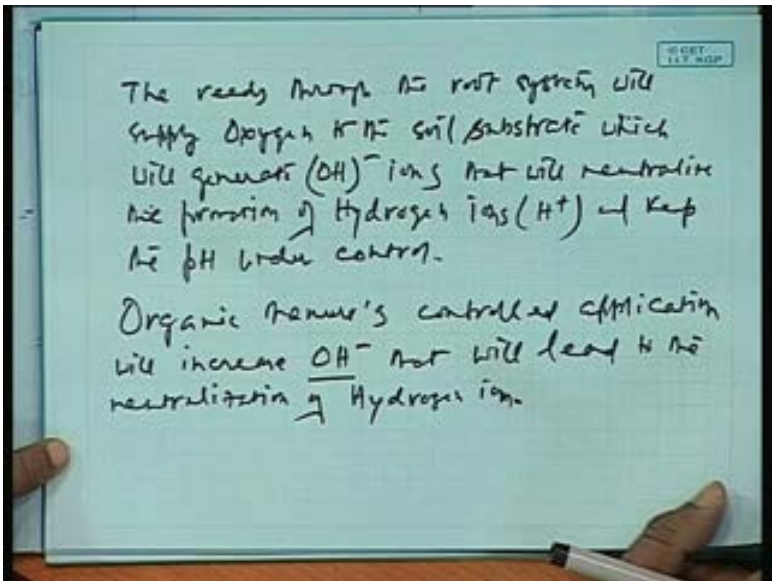

So, the soil substrate which will, which will generate, which will generate hydroxyl ion, generate hydroxyl ions that will, that will neutralize the formation of, formation of hydrogen ion, hydrogen ion and keep the pH under control, keep the pH under control. So, what the reeds through the root system will supply oxygen to the soil substrate, oxygen to the soil substrate which will generate hydroxyl ions that will neutralize the formation of hydrogen ions, hydrogen ions and keep the pH under control.

So, we can keep the pH above more than 5, more than 5 so as to, so as to reduce, so as to increase the rate of reaction, to increase the, keep the reaction rate to make the wetland system more efficient, to keep the wetland system more efficient. Another method of using this is organic manure in the water. Organic manure also serves the same purpose organic manure, organic manure's controlled application, controlled application will increase, increase, will increase this hydroxyl ion, will increase hydroxyl ion that will lead to, that will lead to the neutralization of hydrogen ion, neutralization of hydrogen ion, neutralization of hydrogen ion okay. Now this, the neutralization of this hydrogen ion, so this is, this is the aerobic wetland treatment method, this is what is the aerobic wetland treatment method in the anoxic lime stone drain which is generally comes before this, comes before this aerobic wetland treatment is ALD, we call it as ALD anoxic limestone drain.

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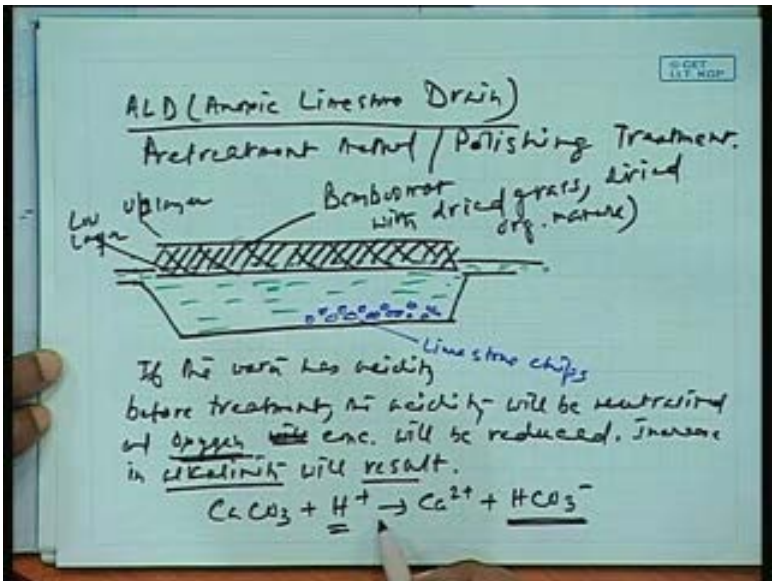

What we generally try to do here is we generally anoxic, in an anoxic limestone drain is generally you know particularly related certain kind of extraction method, certain kind of extraction method before it is, the water is turn, before the water is send to, before the water is send to the aerobic wetland, an anoxic limestone drain is kept before it. This is all that this is anoxic limestone drain with that is why you know it's known as a pretreatment method.

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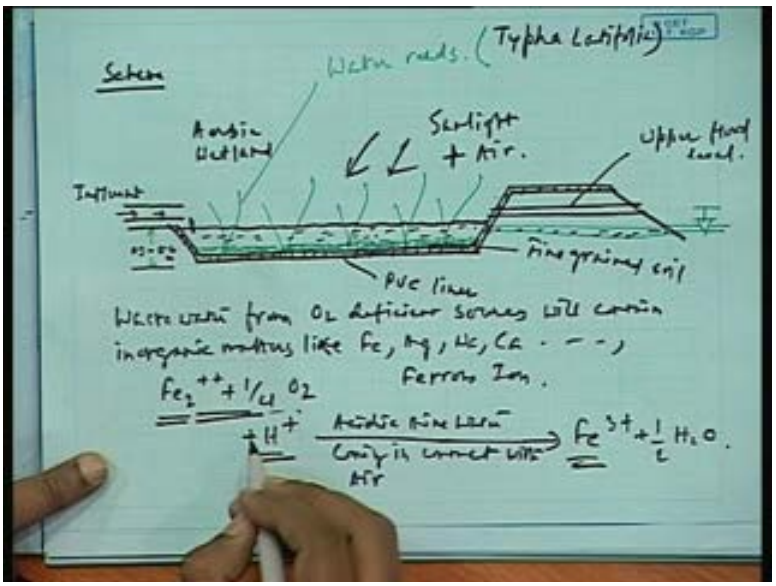

It's a method is not work a major treatment method, it is the pretreatment method of water pretreatment, pretreatment method or we can call it as polishing treatment, we generally call it as polishing treatment. So, you know here it is not the primary treatment method is just you know

this is the not the principle treatment method, is a auxiliary treatment method, it's an auxiliary treatment method. What we are trying to do here is a basically what is generally done here is other things being same, other things being same, what is generally done here is we generally use a capping, we generally use a capping here say something like this. This is where, this is where say this is where the cap is, this is the cap this is okay this is a, this is a cap, this is say bamboo mat, layers say two layers, top layers of bamboo mat, layers of bamboo mat with bamboo mat, with say dried grass say dried organic manure, dried organic manure of this. This is bamboo mat, this is a bamboo mat, this is one layer, one layer, this is the second layer, upper layer and lower layer, upper layer, this is the lower layer in between the bamboo mat, between the two bamboo mats you have dried grass, dried organic manure things like that and this one here is this is how the stream is, this is how the stream is, this is what you know finally as you can see here this water would be coming out like this, this water would be coming out like this.

What happens here you can see this, you can think of this water coming out like this. This is what is the level of the water you see this, this is what is the level of the water. The water would be, water would be just touching the mat, water would be just touching the mat. So, what is happening here is water is, this air is somewhat being air is also circulated to a certain extent air is circulated but here there is no sunlight or any other agents are being allowed to go in. So, it is in a reduced supply of oxygen and reduced sunlight, very reduce sunlight, so you know it would be almost dark inside. So, here you would be, you would use this limestone clipping should be used here, some of sometimes the limestone chips are also used here limestone chips, limestone chips, lime stone chips.

So, here this is, this is the water, this is if you just see this, this is the water, this is how the water would pass through, this is how the water would pass through, this is how the water would pass through. This is what is happening here is this is the, if this is particularly, if the water just write down, if the water has acidity, if the water has acidity before treatment, before treatment the acidity would be, acidity would be, acidity would be neutralized and oxygen concentration, oxygen concentration would be reduced, the oxygen concentration would be reduced and this should be acidity would be neutralized and so increase in alkalinity will result, increase in the alkalinity will result.

So, here we can see is that you know here what happen is here as it is can be, as it can be seen this the alkalinity would be result and so what is happening in the first place you know that reaction if you remember that reaction you know where I have said you know you can see this reaction here, this particular reaction, this particular reaction would be prevented from happening, this particular reaction would be prevented from happening. The reason is, the reason is here you know instead of having a partial deposition of ferric hydroxide in the wetland, what would be done is the ferric hydroxide would be formed in a controlled manner, ferric hydroxide would, the water would be alkaline so that the water there would be the ferric hydroxides that would be formed, that would be formed only in the principle wetland not before it.

So, what we are trying to do is we are trying to this oxygen concentration would be reduced, the oxygen concentration reducing, so this reaction is not going to take place in the anoxic limestone drain, would not continuously, would not continue to take place in the anoxic limestone drain. As a result of this, this would this would help in, this would help in finally the total oxidation, total

precipitation of this iron oxide, ferric oxide would take place in the principle wetland. So, anoxic limestone drain generally says it reduces the acidity will be neutralized and the oxygen concentration would be reduced, increase in alkalinity will result, increase in alkalinity would result, this the reaction is this one is you can see this the acidity is being destructed by is the formation of, formation of plus bicarbonate ion, the formation of this bicarbonate ion. So, you can see this acidity becoming, acidity being destructed. This acidity being destructed and as the oxygen concentration is, oxygen concentration is, oxygen concentration is controlled, oxygen concentration is controlled, we can see that, we can see that you know the formation of ferric hydroxide armouring.

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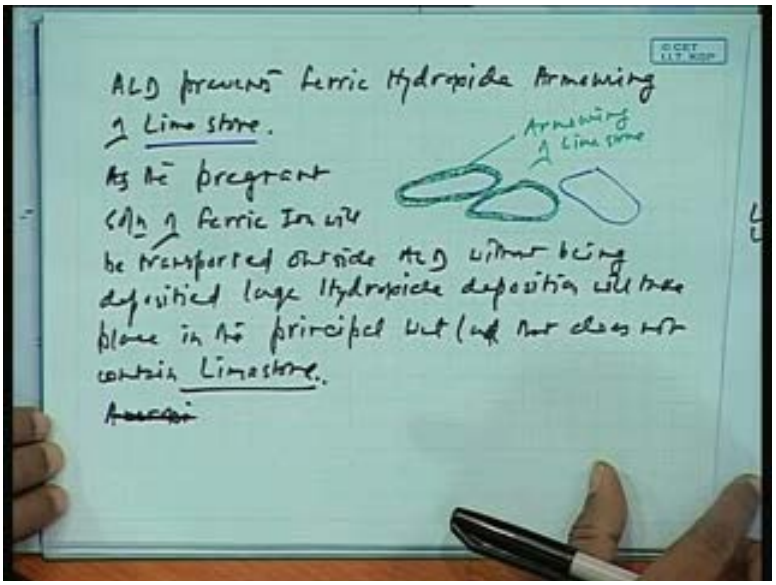

So, the ALD, ALD prevents, prevents ferric hydroxide, ferric hydroxide armouring of limestone. This is what is an armouring, this is what is an armouring say you know all this particles of this, this limestone chips that would be present there, what would happen is the ferric hydroxide, the ferric hydroxide would deposit on top of this, the ferric hydroxide would deposit on top of this. As a result of this the ferric hydroxide as it is depositing on top of this, there would be lesser surface area exposed for the limestone the two activate, limestone to activate.

As a result of this you know here, so we would stop this ferric hydroxide deposition here, we would reduce the ferric hydroxide this is called the armouring, armouring of limestone, armouring of limestone, the limestone, the chips, the limestone. So, a ferric hydroxide armouring of limestone, ferric hydroxide armouring of lime stone prevents ferric hydroxide armouring of limestone and as this as the pregnant solution of, as the pregnant solution of say this ferric ion will be transported outside ALD, outside ALD without being deposited, without being deposited large hydroxide deposition will take place in the principal wetland, principal wetland that does not, that does not contain lime stone, that does not contain the limestone.

So, this is, this polishing that takes place the reduction of this, reduction of this hydrogen ion generally present in acidic waste water, acidic waste water would be, the concentration would be

controlled, concentration would be controlled with the formation of this bicarbonates. As this the water would be more alkaline, water would be more alkaline, ferric hydroxide deposition would not take place at all in the ALD but as soon as it is exposed to the principal wetland the increased, increased oxidation and high level of a ferric, ferric ion already found, high concentration of ferric ion found, large deposition of ferric hydroxide would take place in the principal wetland. So, this is how this ALD is generally used for a polishing treatment. So, ALD should always come before the principal main wetland treatment. So, this is another anaerobic wetland treatment in anaerobic wetland treatment is I will not find time to discuss this, okay.

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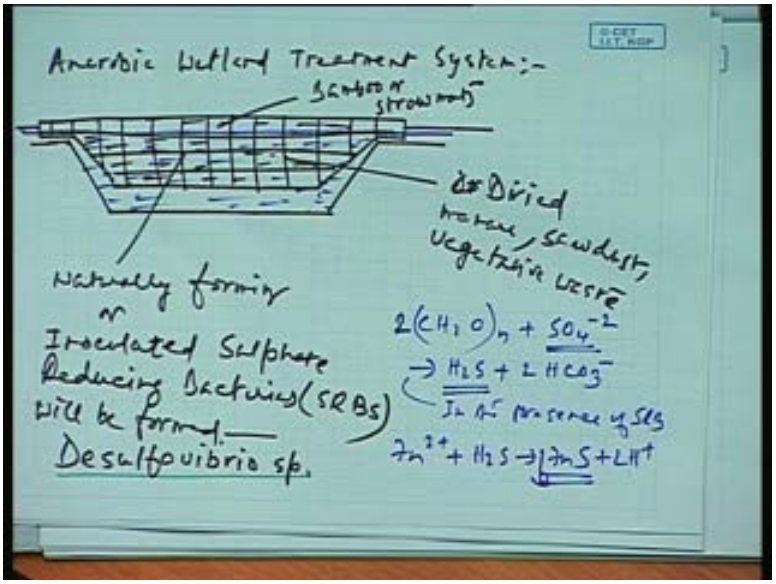

Since, anaerobic wetland treatment, anaerobic wetland treatment system, in the anaerobic wetland treatment system is you know say the mine water is, here in the anaerobic wetland treatment, anaerobic wetland treatment this particularly say there are different types of construction, different types of construction that takes place in the different types of construction that takes place. Generally, the column is somewhat more, this column of the column is if you can observe this column now, this column of say this is what we have observed. So, you can see here that what we did in the anoxic case we have just extended it, we have just extended it and this is what is if you just observe this now this is what is an anaerobic wetland treatment method say this is the level of water, this is the level of water you would try to keep say this is the level of water, this is the level of water, the water going out like this okay. This is, this is the, this is the construction, this is the bamboo mats, this is the say bamboo or straw mats, mats, this would be organic dried, dried manure, sawdust, sawdust say then other any different kind of sawdust you know is one say any other kind of vegetative waste say a dried fruit say the covers dried fruit covers all this you know can be, can be used in this case you know this is what would be the capping.

So, you can see this water completely being, completely being, almost completely being soaked into a medium which is highly, high inorganic content, this is high inorganic content. All this, all this you know here, it can be here naturally or inoculated. Here, it will be naturally forming,

naturally forming or inoculated or inoculated sulphate reducing bacteria's SRBs, SRBs will be formed will formed, will be formed. This would result in you know this is particularly bacteria, this one of this species is Desulfovibrio, Desulfovibrio species. This is a particular typical species you know Desulfovibrio species. This kind of particular species should be formed, this particular species would be either naturally forming, can naturally form because this bacteria's are the naturally forming bacteria's, if you want to have a more control reaction, if you have to or more control reaction or specific reaction it has to have inoculate the bacteria. You have to particularly separate the bacteria from the body of the other bacteria's, keep it growing in a particular medium then using them for growth in a particular medium, go in a particular situation like this. This will do in a controlled experiment, we can generally try to do this.

Now, here it does a very simply reaction that is you know is the reactions that generally form here is this is 2 CH 2 O, this is all this 2 CH 2 O, this is C CH 2 O, this is, this is to, this is just to represent, this is just to represent the all the organic material present in the mat itself. This is 2 CH 2 On this is an organic substance plus this one is forming with you know a say sulphate reducing bacteria SRB, sulphate reducing bacteria this is, this is minus 2, this would finally form into H 2 S, H 2 S plus 2 HCO 3 minus either bicarbonate would be formed, this would this the n is you can take care of this n basically you can consider this to be an single element CH 2 O CH 2 O CH 2 O like that these are bonded okay. CH 2 O CH 2 O bonded is a large bond that takes place, you can consider to be CH 2 O n, this CH 2 O n reducing at this sulphate reducing bacteria working with the sulphates this is the, in the presence of, in the presence of, in the presence of SRB, in the presence of SRB, in the presence of SRB that we call it in the presence of SRB sulphate reducing bacteria, sulphate reducing bacteria form H 2 S.

This H 2 S, this H 2 S then would react with the present of, presence of any zinc, any metallic ion say considering zinc here would form H 2 S, would form zinc sulphide, zinc sulphide plus 2 H. So, this zinc sulphide as we was discussing about this amphoteric property you remember that zinc sulphide, this zinc sulphide would precipitate, this zinc sulphide would precipitate, this zinc sulphide would precipitate okay. This is an anaerobic wetland treatment method, this is an anaerobic wetland treatment method, this is just to suggest this zinc is just to suggest how the metal cation would be precipitated as metal sulphide. So, there can be many other metals which can be reduced by this, which can be actually, which can be actually deposited like in the form of sulphides, in the form of sulphides.

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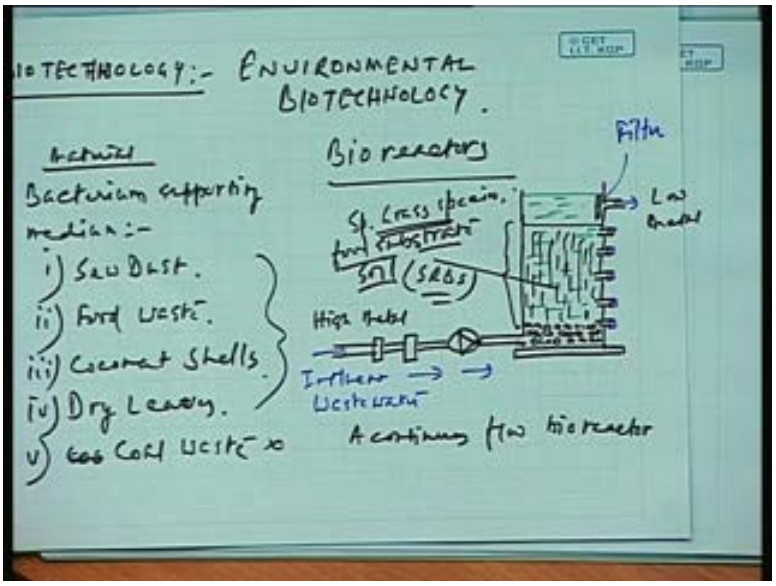

Apart from that there is a continuously you know great use of today, this is the use of biotechnologies forming you know a word is a increasing area of use in environmental you know this, this is a subject which we today know as environmental, environmental biotechnology. Say I will not get much time to discuss in this let me explain you know what are this, the medium, the typical things that we generally use here is that you know for water purification or any kind of things like this, the material, the material, this is material is you know bacterium supporting, supporting medium like sawdust say then say food waste then coconut, coconut shells dry leaves, dry leaves. Then say also being used, also being used is you know this a coal waste, coal waste.

What we are trying to do is all this cases we are just except this, except this all this, what we are trying to do is we are just trying to provide food for the bacteria's to grow. When the bacteria's grow, see the bacteria is just like you know why the bacteria, the bacteria's are the first of all the reason is their medium of exchange of food is a liquid medium of exchange. Isn't it? It's a perfectly an osmotic process by which the food the bacteria's take food, you have they generate, they generate say one area remains the high potential area, another is low potential area, so the material from one side to another flows in. Now what is interesting about this bacteria's is that these they would generally try to take mostly the organic material in the carbohydrate forms, they are generally used in the used taking food mostly in the carbohydrate form.

Apart from the carbohydrates are basic food but they would also require the nutrients. The nutrients are different kind of nutrients that they would take, they can take you know they then since they can change their characteristics, they change, they can change their cellular structure. So, they might adopt they might take different kinds of, different kind of metals also along with that. So, not only the carbohydrates are the things which would, which would bring them towards the foods, carbohydrates is what would draw them towards the food and in the process of taking the food it would also take away some many of the metals along with this. This particularly this particular feature of this micro, micro the bacteria's are being used in biotechnology to particularly deal with this, deal with the reduction of metals in the water.

The one of this you know he says they very typical kind of, very typical kind of you know the bioreactors are, the bioreactors are bioreactors are being developed, this bioreactors are being developed which are used like this. Let me explain a simple bioreactors that is in use generally is like this. You can see this bioreactor, this would be a small pump, this is called a peristaltic pump, so this pump would be fending water like this, this is, this is a column gross species say food substrate, food substrate, food substrate then say soil this is what it would be, this is what it would be, so it would be connected like this. See you see this flow here, this is waste water, influent waste water, influent, influent waste water right influent waste water, influent waste water would flow like this. This influent waste water is entering into a column like this and finally this is a column, this is a column, this is the total is the column here the column that is being discussed. This particular water, this particular water as you can see here this, this is the level of water it would rise to, this is the level of water it would rise to you can see this water being continuously fed like this, there would be a filter here, there would be a filter, there would be a filter here, filter and through this the water would be out, through this the water would be out.

This is a, this is a continuous flow, this is a continuous flow bioreactor say a continuous flow bioreactor, continuous flow bioreactor, these are the ports these are the ports to characterize the water at different level, the ports to characterize the water at different level. So, this is a continuous flow bioreactor, continuous flow bioreactor, continuous flow bioreactor you can see this now here you can see this high metal, high metal should be preferably low metal waste water. So this would be, what would be pass through is a low metal low concentration of, low metal concentration of concentrated waste water. So, this is you know this is what is the mostly, what it would rise is all this sulphate reducing bacteria SRBs that would be used here the SRBs, SRBs will be present, all this SRB is present here would generally try to accumulate the metals from this solution. And since this would require a particular medium of grass, foods, substrate, soil because only then the microbes would be attracted to the water, only then the microbes would be attracted to the water, this helps to form, this helps to form the microbial colony where the metal would be absorbed, the metal would be absorbed by the bacterial cells, absorbed by the bacterial cells and what would come out would be low metal enrich, low metal concentration wastewater.

There are many such areas of biotechnological application actually emerging is also growing in a you know in wide areas now. Environmental biotechnology is a big area of research today and this is one of the emerging areas of biotechnology, so and there you know many of this methods can be very industrially used, whenever there is a water is contaminated with particularly the metallic pollutants of things like that. So, with this you know I come to the end of this class. Next class we will deal with, we will deal with soil and its pollutants okay. This next is the soil, will begin with soil and then finally after the soil is covered will consider about having the air pollution. So, the water for all practical purpose water and its pollutants are practical purpose over okay, all right.

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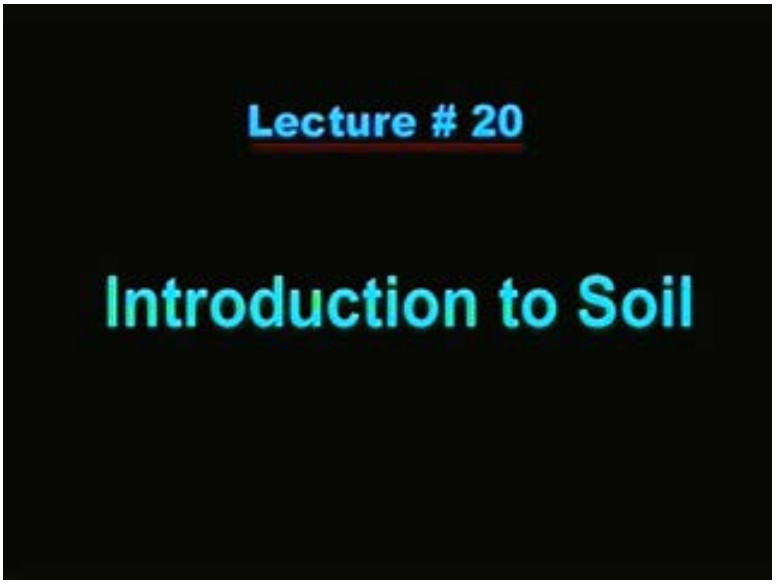

Well, I mean today we start with soil, I mean as I have said you know in the last class we concluded about water pollutants and things like that. We have worked in detail about water pollutants here today we will discuss about soil.

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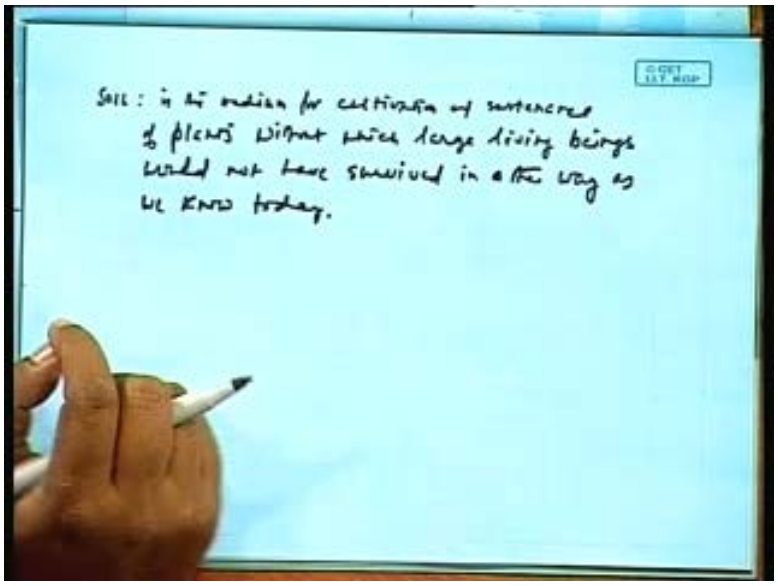

Soil is you know soil as you know soil is the medium, medium for, is a medium for cultivation, cultivation and sustenance, sustenance of plants without which, without which large living beings would not have survived in the way as we know today, is a medium for cultivation, medium for cultivation and sustenance, there is a medium for cultivation and sustenance of plants without which large living beings would not have survived in the way as we know today. So, this soil remains you know is a most important productive medium by which, on which the human culture has developed, human culture has developed. Remember one thing that you know say is today's population of 6 billion people throughout the world if that can be fed, if that can be fed that the single largest medium on which the food resources can be generated is basically soil.

We have different other medium like you know we have some water medium also where plants grow but that would not have been sufficient to feed at this large mass of people, large population of people not only that apart from man, apart from humans you know they are other animal, other animal beings that we know of they also survive on plants. So, soil remains a very important area of environmental science and engineering because it's a big as you see that an understanding of soil and understanding of soil in terms of a medium for vegetative growth that is very important for us. You will see that a large part of the soil being you know being drained off, large part of the soil being drained off and it is coming you know the initial block of soil is spreading in to the roads, spreading in to the walk ways and places like that. That is the, that is where the soil is actually getting degraded, the soil structure as getting destroyed. So, it is any kind of engineering excavations, engineering excavation like related subjects like mining then say dam construction, civil construction say and then say in many cases you know like any kind of say home construction, all this kind of industries the typical what happens is soil degradation, the degradation of the characteristics of the soil, degradation of the characteristics of the soil.

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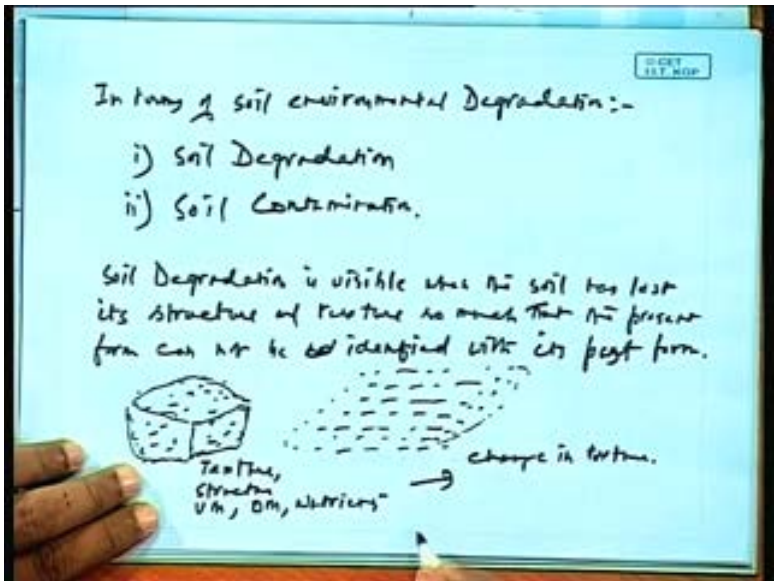

So, here what we will find is say the texture, texture I will come back to this texture structure say a, say volatile matter then say organic matter, organic matter, volatile matter, organic matter say then say a nutrients, the typical the metallic ions the nutrients that you know this nutrients, this would lead to this would to lead to different texture, change in texture, change in texture there would be a texture but the texture would be changed that is you know you would have seen that the fine particles should be missing. One good way of seeing the soil degradation you will see is that you will find that, if you find in the soil the after the rain, the soil the finer particles of the soil has left it and then you know the soil has been degraded because that soil is not a desirable soil, that soil is not a productive soil.