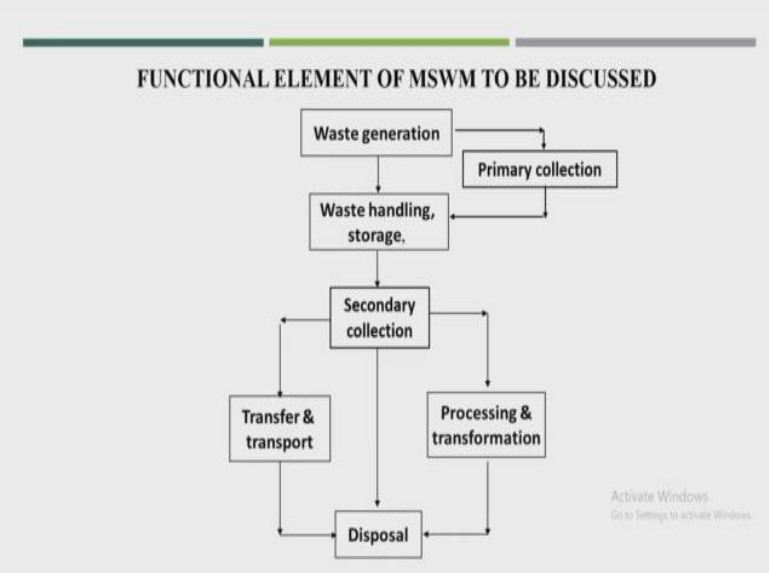
Municipal Solid Waste Management
Prof. Ajay Kalamdhad
Department of Civil Engineering
Indian Institute of Technology - Guwahati

Lecture - 34
Leachate Collection and Treatment

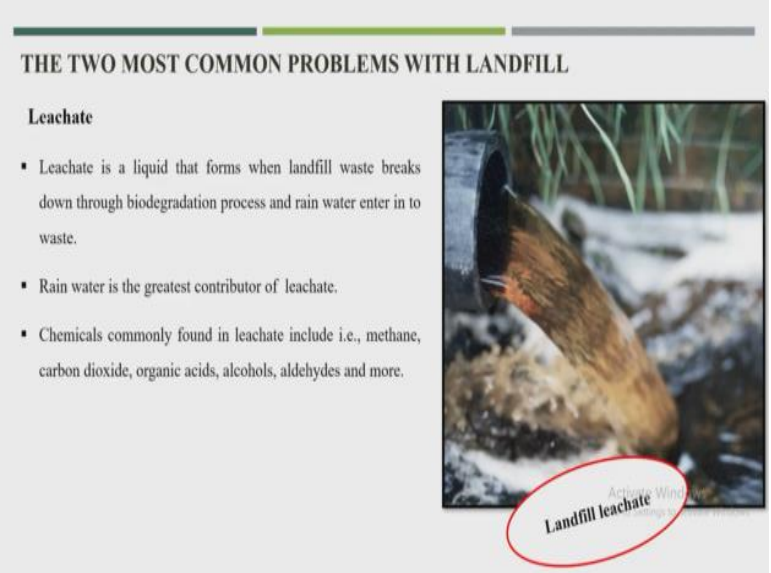
(Refer Slide Time: 00:34)



Hello students, so we are at module 11, disposal of solid waste. Now today we will talk about leachate collection and treatment. So as I explained in the previous lecture, there are 2 main environmental issues from landfill areas. One is leachate production and polluting gas production. So, normally, this landfill is also designed by the geo-environmental engineering academicians or researchers.

Because they are the lining things, has to be designed properly that liner things, soil quality, but for as environmental engineering, we have 2 major issues. One is the leachate problem and the second is a polluted gas problem, how best we will be able to collect leachate or gas and treat that is our task of further environmental engineers. So today we will talk about the leachate part.

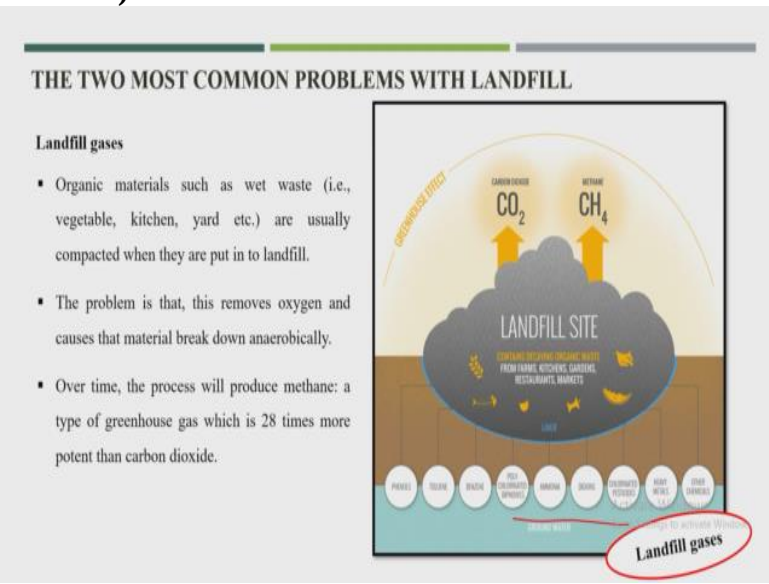
(Refer Slide Time: 01:32)



So the first that there are as I was explaining about there are 2 major common problems with the landfill. First is the leachate and that leachate is a liquid that forms when the landfill waste breaks down through the biodegradation process and rainwater enters the waste here the major concentration of that rainwater because they are open to the atmosphere. So, a huge amount of rainwater is entering the landfill area.

And I think that breakdown to the entire material. So which will collect all contaminants and that will go to the groundwater will pollute that. So this is what the landfill leachate so rainwater is the greatest contributor of the leachate. So, chemicals commonly found in the leachate include, methane, carbon dioxide, organic acids, alcohol, and aldehydes apart from BOD 5 organic matter, metals.

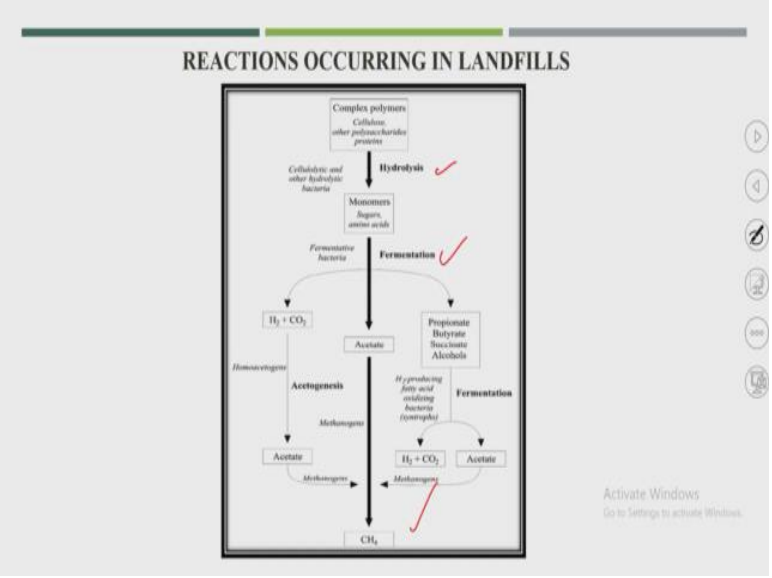
(Refer Slide Time: 02:34)



Now, next is the landfill gases so, because of the degradation of biodegradable matter, I think this is all groundwater again the different pollutants and the gases major is the methane and carbon dioxide. So, organic materials such as wet waste, especially vegetable kitchen waste, are usually compacted when they are put into the landfill. The problem is that this removes oxygen and causes the metal to break down anaerobically over time the process will produce methane a type of greenhouse gas that is 28 times more potent than carbon dioxide.

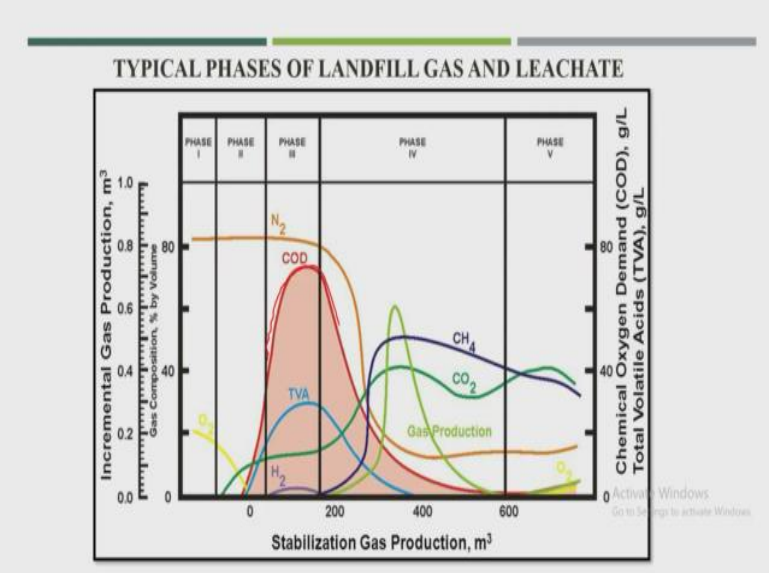
So, is a greenhouse gas methane see in the previous module, we talked that methane is a very useful gas once you will be able to collect that and to produce it can be used for the cooking purpose and can be able to produce electricity out of that. But in this case now, the methane we are not able to collect separately and the quantity is also not that large which can be utilized for further utilization.

(Refer Slide Time: 03:43)



Now, what are the reactions occurring in the landfill area the major is an anaerobic one only. So the hydrolysis could be possible fermentation could be possible. And finally, after that, acid phase the methane will get produced, but the quantity is not that large. And almost you will see that the pH in that particular entire waste material will be always in the acidic condition. So the concentration of methane also will not be that high.

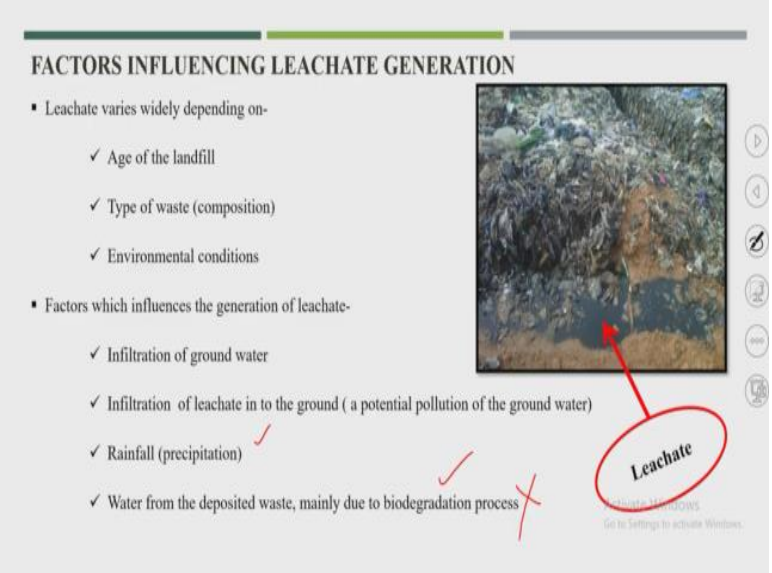
(Refer Slide Time: 04:20)



Now, what are the typical phases of landfill gas and leachate? So there are 5 phases. If you consider gas or leachate production, phase 1, phase 2, phase 3, phase 4 and phase 5. So like in the phase 1, the major gas production also the different gas production. So in this lecture, we will talk about majorly the leachate one. So you see here the graph of COD; that is major into the phase 3. So now the phase 1 is acclimatization.

The bacteria will get acclimatized and still that will be in the aerobic condition even phase 2 also will have some aerobic conditions, but mostly the entire condition will be converted in the anaerobic one and the fast is the degradation of that biological waste into the landfill area will be in the phase 3. So, that is normally called as an acid phase where the maximum degradation could be possible. So, in the same case, the gas production also will be possible and maximum COD will produce similarly in the phase 4 and even phase 5, the COD concentration will be very low.

(Refer Slide Time: 05:42)



What are the factors influencing leachate generation? The leachate varies widely depending on the age of the landfill, type of waste, and environmental conditions. So the age of the landfill obviously, the leachate production will not be that large in the initial period like a 2 year, 3 years, 4 years even the pollution load also will be not that high in the initial days. But after 4 years or 5 years, the more amount of leachate also will get produced.

Because until that all the voids will get filled up and entire waste also is getting compacted properly both kinds of manual compaction even the natural compaction also could be possible to a particular year and later on your leachate, very strong leachate will get produce and again depends on the type of waste. So, this was already discussed in the previous lecture. If you have the non-biodegradable matter, non-recyclable matter, and only the inert material some rejects from the treatment process are reaching to the disposal site.

So obviously you need not worry about the leachate production, the leachate will get produced but it will not be that polluted one you need not worry much about the leachate part, but now, the mixed kind of waste is reaching and in that case also like India kind of country where 60% or 50 to 60% is a biological waste are some other countries where the biological waste goes to 60%, 80%.

In that case, if the entire waste goes to the disposal site or landfill area, obviously you have too much worry about the leachate not only the leachate but even polluted gas production also is a more concerning issue in the landfill area and local environmental condition also is very important. Suppose nearby is habitations, nearby some water storage area or is a

floodplain. I think these are some important issue will be more concerned for leachate production.

And what are the factors which influence the generation of leachate is infiltration of groundwater, infiltration of leachate in the ground as potential pollution of groundwater table, rainfall, water from the deposited waste mainly due to biodegradation process. So, I think we can see that the major concentrations are of leachate production is one is the rainfall and the second is the water mainly produced from the biodegradation process. Now, if you take that there is no biodegradable matter that is reaching into the disposal area.

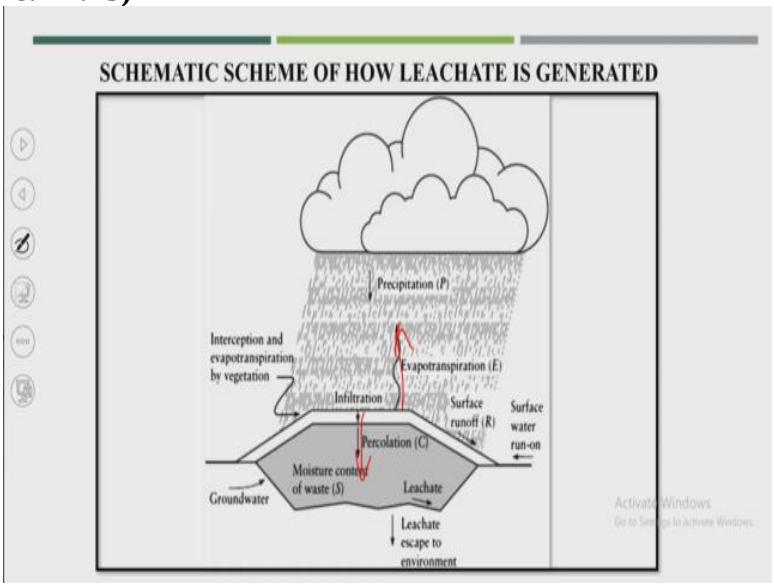
So this quantity, these factors is not important in that case. And now the rainfall or precipitation that you cannot do anything again depends upon that is why the local climatological conditions are important and some areas or some localities especially in the northeast part of India, where rainfall goes to 6 months in a year or somewhere 8 months in a year. So this is the most important influencing factor for leachate production could be there.

So, you need to look upon more daily cover issues in the landfill area even the final cover should be very strong enough so that these precipitations should not reach into the disposal area. And they're also in such areas suppose if you are disposing the biological waste into the disposal site, then obviously, you have to more worry about groundwater pollution or some surface water pollution that particular area.

Already I think such kind of things you can easily see in the northeast India, where the proper sanitary landfill has not been designed and mostly the waste is getting disposed in most of the cities in the northeast whether is Assam or the other state like Tripura, Manipur is mostly cities are disposing the waste into the low lying areas and because the rainfall is more than 61 means, your water table is also very high.

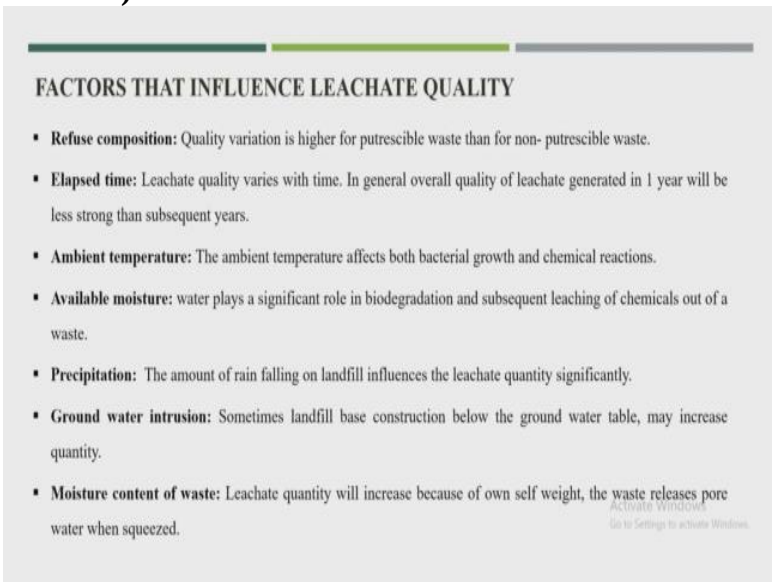
So, almost you can see that waste will be in the threatening conditions in most of the season of the year in that particular location and also need to be checked that infiltration of groundwater this is the important one. So, I think wherever the location you are finalizing try to find such location where the permeability of soil is very poor. So, suppose that some leakage also in the landfill could possible but if there is no permeability in the soil, so the leachate will not reach the aquifer area or that will not enter into the groundwater.

(Refer Slide Time: 11:23)



Now the schematic scheme of how the leachate is generated. So, I think it is a simple one so, these are precipitation, and because precipitation, infiltration will be there and also parallelly some kind of evaporation also will be there. The moisture content will be available in the waste material. So because of that the leachate is getting generated and is not that entire the rainwater is getting infiltrated the because of that some runoff also will come up. So, this runoff also is adding to the somewhere in the local surface water locations or in the pond or some other reservoirs nearby that will get polluted because of that.

(Refer Slide Time: 12:14)



So, factors that influence leachate quality first is the refuse composition. So quality variation is higher for the putrescible waste than for non-putrescible ways means biodegradable waste. So, obviously, for biodegradable waste, the quality will be something else that variations will be more as compared to the non-biodegradable material. Elapsed time so leachate quality

varies with time in general overall quality of which are generated in 1 year will be less strong than the subsequent year.

So obviously in the initial period, the leachate quality will not be strong, but later on, the leachate quality will be very strong for the subsequent year, the ambient temperature affects both bacterial growth and chemical reaction. So, this is also very important as some of the locations where the temperature goes to 40 degrees for a longer period. So, obviously, your microbial activity will be very strong and the degradation will be very fast.

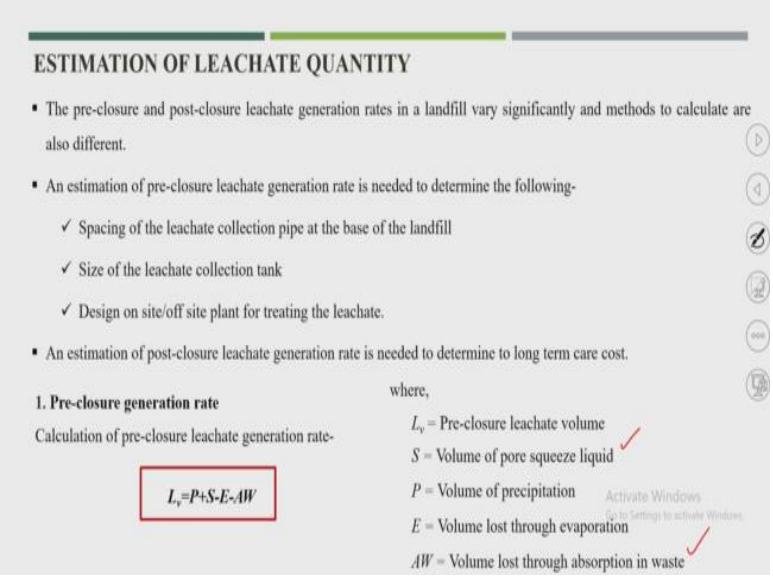
So, available moisture in the water plays a significant role in the biodegradation and subsequent leaching of chemicals out of the waste. So the available moisture also will come up because of biodegradable waste coming to the landfill area. So, more biodegradable waste more moisture, so more moisture means there will be more leakage or more production of leachate, I suppose there is low moisture like 15, 20% moisture in the waste.

So first, the leachate will get absorbed into the waste material itself, it will not come out so easily, precipitation obviously the amount of rain falling on landfill influence the leachate quantity also and even the quality also. So, because the rainwater does not have many pollutants, so whatever the leachate is generating because of the biodegradation process, and if that rainwater is mixing into that, so your quality will not be that strong.

Quantity will be large, but the quality will be not that strong, groundwater intrusion sometimes landfill-based construction below the groundwater table may increase the quantity. So this is also 1 factor the groundwater intrusion could be possible into it ages depend upon the groundwater is very close to the surface or wherever I think you excavated the soil, then these intrusions could be possible we can find these kinds of intrusion very easily in the northeast part of India and moisture content of the waste.

So leachate quantity will increase because of own self-weight and waste release as pore water when squeezed. So, this is also that moisture available in the waste material.

(Refer Slide Time: 15:32)

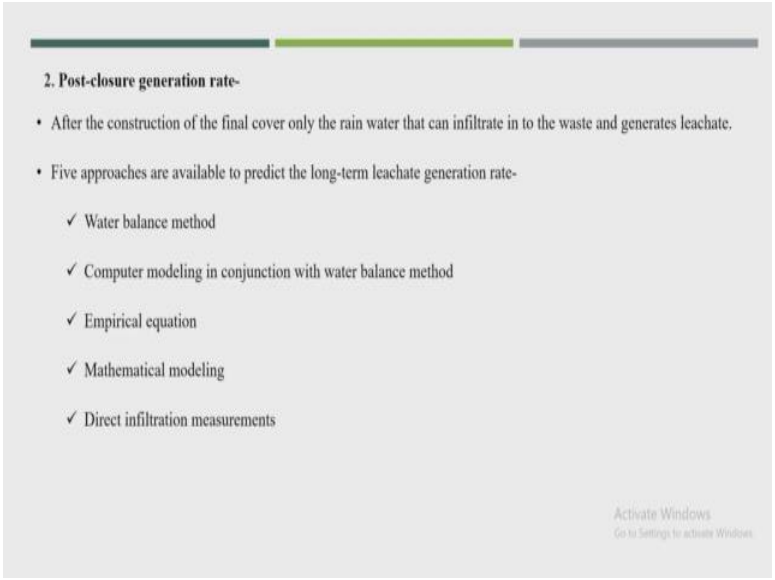


Now, the estimation of leachate quantity so, the pre-closure, post-closure leachate generation rate in the landfill vary significantly and methods to calculate are also different. So, the estimation of pre-closure, leachate generation rate is needed to determine the following spacing of leachate collection pipe at the base of the landfill, size of the leachate collection tank, design on-site or off-site treatment facility. And in the estimation of post-closure leachate generation rate is needed to determine the long-term care cost.

So normally, for pre-closure generation rate, you can calculate by a simple equation that is a pre-closure, leachate volume we can calculate by the sum of the volume of precipitation and volume of pore squeezed liquid that is the excess moisture you can reduce that from the volume lost through the evaporation and volume lost through the absorption in waste material. So that is why to know that this S volume of pore squeeze liquid you need to know the moisture of the waste material.

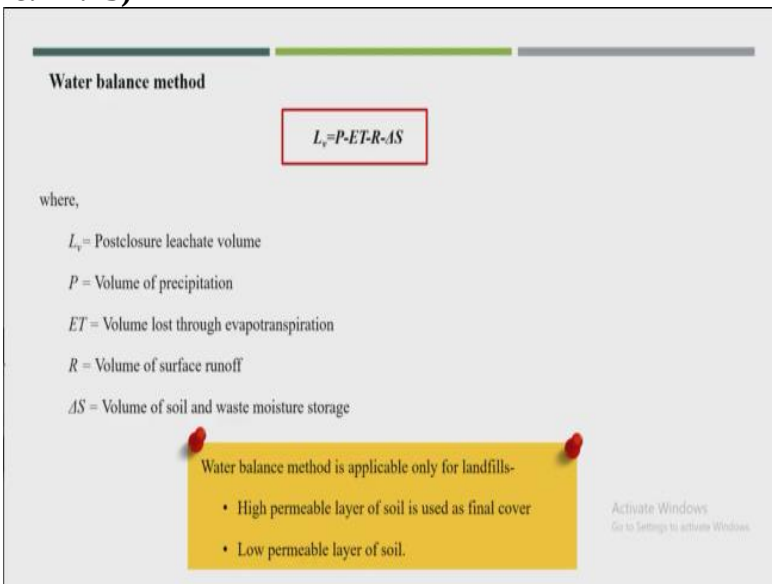
And because of that, you will also come to know that how much volume lost through the absorption into the waste material has to be checked from time to time. And by that way, we can calculate how much leachate generation rate could be possible.

(Refer Slide Time: 17:01)



So, in the post-closure generation rate after the construction of the final cover, I think is closed entirely only the rainwater that can infiltrate into the waste and generate leachate. So the 5 approaches are available to predict the long-term leachate generation rate is a water balance method. There are 5 methods by that way we can calculate. The first is the water balance method, computer modeling in conjunction with the water balance method, empirical equation, mathematical modeling, direct infiltration measurement, but I think in these approaches I think water balance is very easy.

(Refer Slide Time: 17:43)



What I am going to explain here is a simply we can calculate by post-closure leachate volume from reduction from the volume of precipitation of volume lost through the evapotranspiration, the volume of surface runoff and volume of soil and waste moisture storage. If you know that these things we can easily calculate how much leachate could be possible to produce.

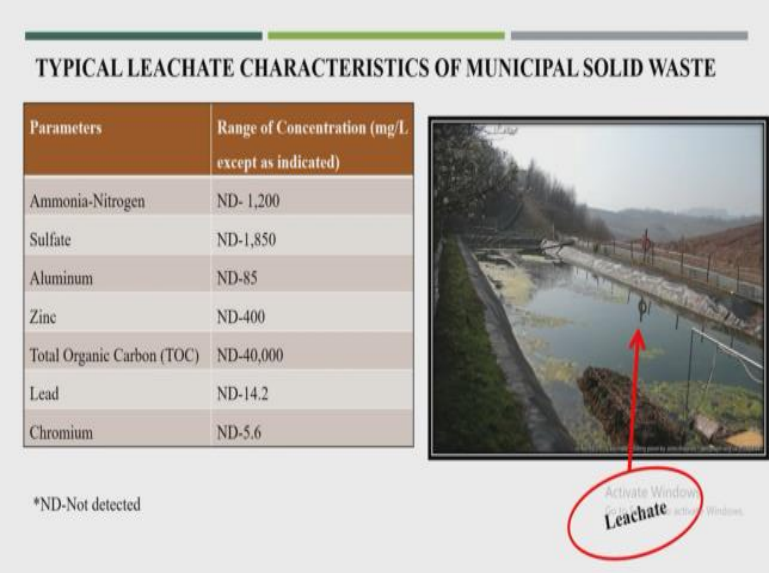
So, the water balance method is applicable only for the landfills like a high permeable layer of soil is used the final cover a low permeable layer of soil. So, I think these water balance method, these are the 2 considerations the low permeable layer of soil in the ground and the high permeable layer of soil that used in the final cover, so that rainwater will enter into the waste material. And suppose the low permeable soil has been added on to as a final cover. So a very small quantity of rainwater will enter the landfill area.

(Refer Slide Time: 18:55)

Now if you see the typical characterization, leachate characteristics, so, the pH will be as I said, is a huge variation in pH. So initially it starts with the acidic pH and is followed by alkaline pH. Even the electrical conductivity will be very high because of a lot of solid productions, the leachate and BOD 5 can go up to 1,95,000 can this is a maximum is possible.

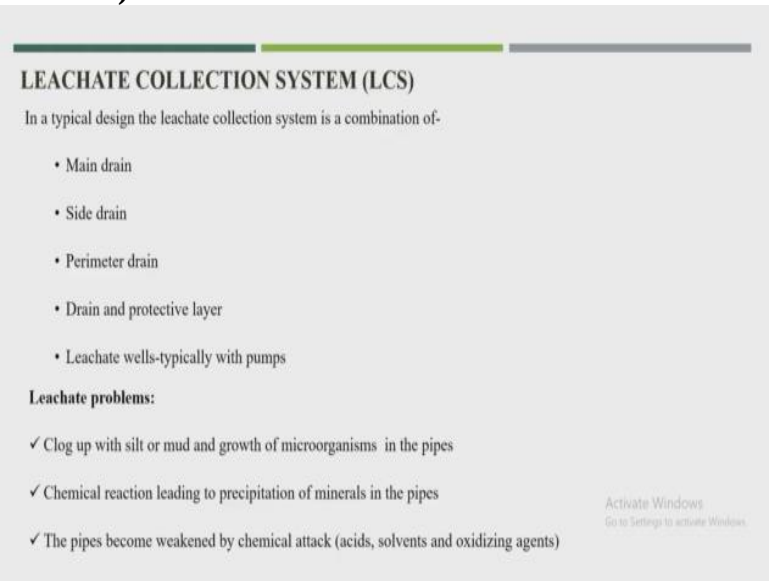
And again I think this BOD 5 or COD value again depends upon the how much amount of biodegradable will matter that percentage, if it is large, obviously, BOD 5 and COD value will be more, and if there is no biodegradable matter. So obviously your BOD 5 and COD value will be very low in that case and also that the metal concentrations will be very large in the leachate so this is one leachate flowing through a pipe in a sanitary landfill.

(Refer Slide Time: 20:12)



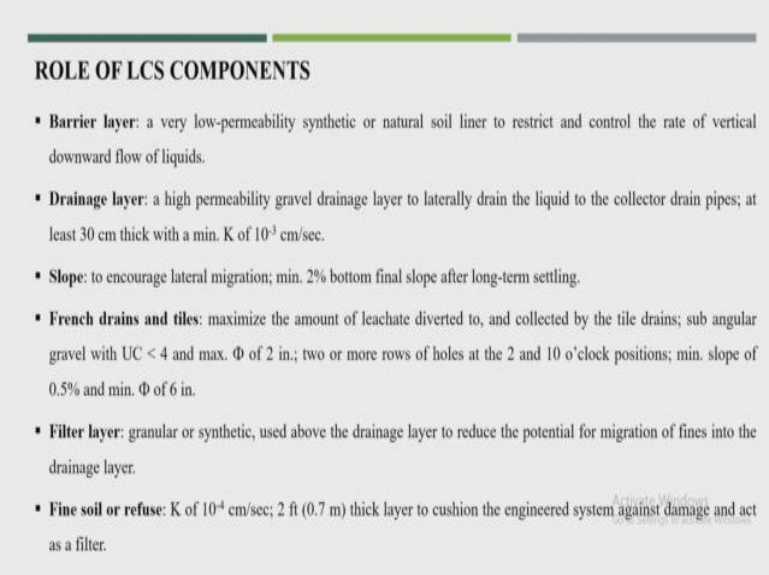
Now, these are the metal, the other parameter which I was talking about like ammonium, nitrogen, sulphate, aluminum, zinc, lead, chromium, these all trace metals are getting generated or we can find in the leachate. Now, this is the major problem this once these metals are reaching into any surface water or if it is reached into the groundwater is very difficult to treat. That kind of water will not be possible for consumption purposes.

(Refer Slide Time: 20:51)



Now, the leachate collection system will have a main drain, side drain, perimeter drain, drain and protective layer and leachate wells typically with pumps these are combinations in the leachate collection systems. And now what could be the problem of leachate problem there is clog up with silt and mud and growth of microorganism in the pipe, chemical reaction leading to precipitation minerals, pipes become weakened by a chemical attack could be corroded that is also possible. So, these are the few issues that will come up because once you put the drainpipes into the landfill facilities, so obviously we have to see from time to time.

(Refer Slide Time: 21:43)



So what is the role of landfill or leachate collection system components the barrier layer very low permeable synthetic or natural soil liner to restrict and control the rate of the vertically downward flow of liquid, drainage layer or high permeable gravel drainage layer to laterally drain the liquid to the collection drain pipe at least 30 centimeters thick with a minimum permeability of 10^{-3} centimeters per second, the slope that particular pipe slope to encourage lateral migration with minimum 2% bottom final slope.

After long-term settling and French drain and tiles that are also important and filter layer that will be granular or synthetic used above the drainage layer to reduce the potential for migration of fines into the drainage layer. Final soil or refuse permeability should be less than 10^{-4} centimeters per second.

(Refer Slide Time: 22:55)

So, leachate collection system you can see here this is the entire excavation. Now these are the pipes, slotted leachate collection pipes, this is perforated normally you will see here the perforations will be like this suppose this is a pipe so the perforation will be of this size like in the top area. So likewise, the perforations will be there so that leachate will enter into the pipes, and finally, I think all these lateral pipes are attached with a leachate collection line. So, you can see here these are those pipes that are a slotted pipe connection leachate collection pipes.

(Refer Slide Time: 24:02)

So you can see here these are the collection pipes. Now I have one the small 2 minutes video you can by that way also you can see how these pipes are laying down.

(Video Starts: 24:28)

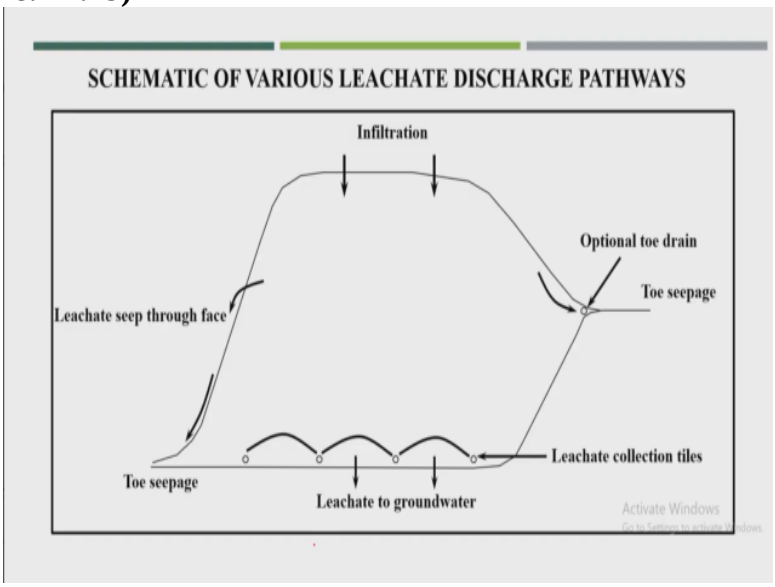
So you can see here the landfill area this is a particular landfill area, this particular, so, these are the drainage tubes. Now you see here this is the installation in the slopes. So, these are the HDPE liners. So, you can see here the pipes are getting joined for the leachate collection. And now this is the leachate collection pond finally from this landfill area so, now this is ready for the operation.

(Video Ends: 26:25)

(Refer Slide Time: 26:26)

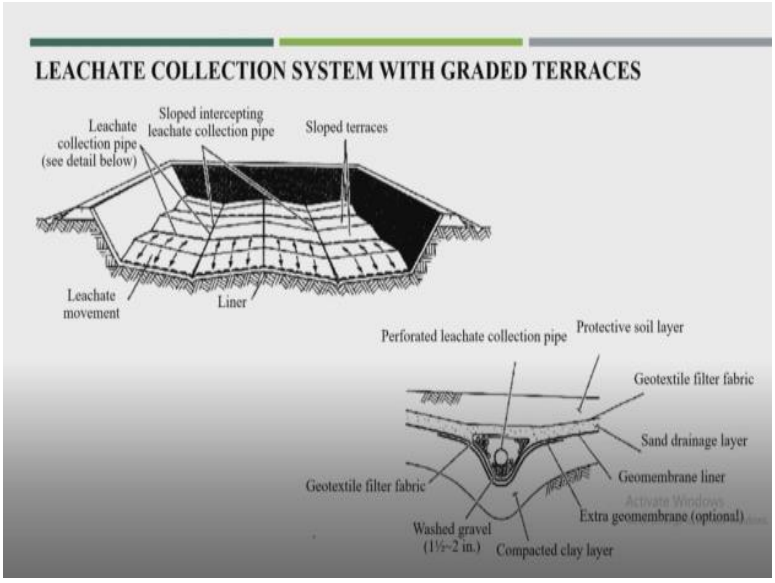
So, you can see here how the pipes are getting inject the perforated pipes are getting into the landfill area, so likewise, so, in the pipe, I think there is a low permeable layer where we are injecting the pipe because there are a lot of fine particles are getting generated and these fine particle can clog those openings or those perforations to avoid those perforations wherever I think we are injecting the pipe perforated pipe the outer layer will be less permeable one, these fine particles should not be entered into that particular area water will only enter into the perforated pipes.

(Refer Slide Time: 27:29)



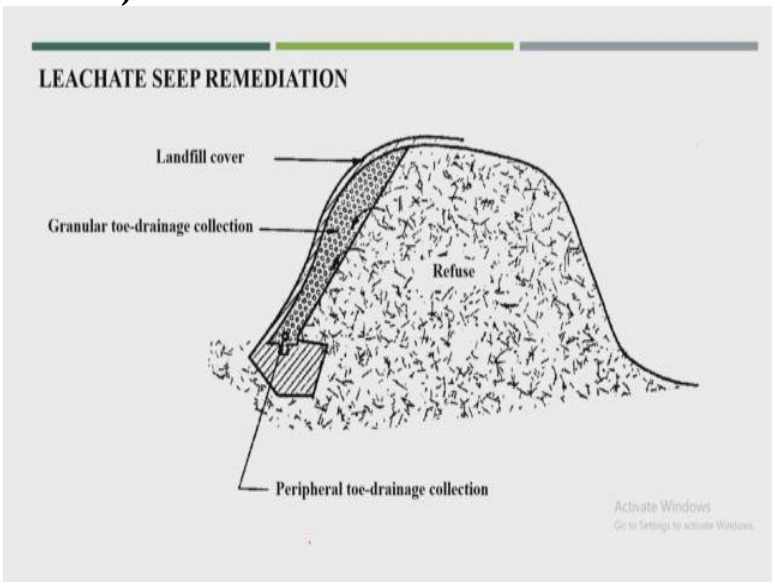
So, this is the 1 schematic of various leachate discharge pathways. So, this is the one way the discharge is finally coming out of the leachate and toe seepage also is possible.

(Refer Slide Time: 27:50)



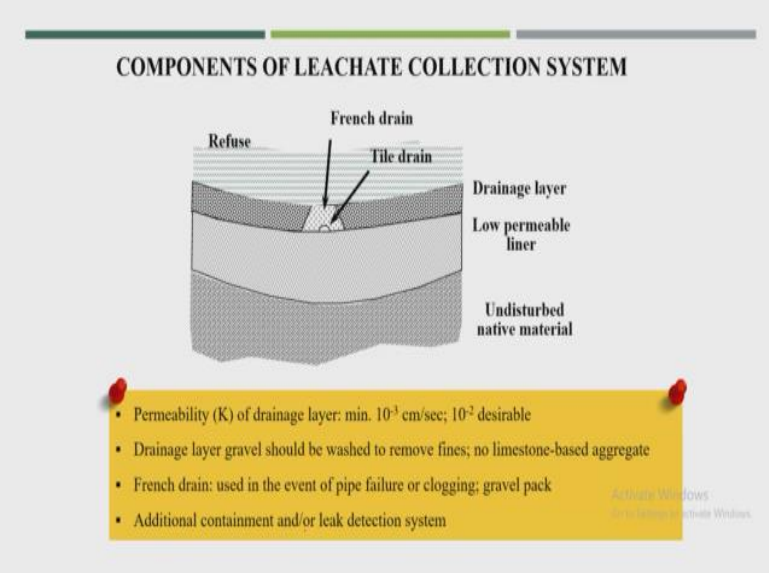
So, this is how it will look like the collection pipes. Now once I think these pipes are getting, put them in the landfill area along with the liner, now the waste is getting disposed of off onto the top of this liner and leachate collection pipes. So this is one more this is a leachate collection pipe this is how it is getting injected.

(Refer Slide Time: 28:30)



So, this is also toe drainage collection peripherally also we can put other than in between.

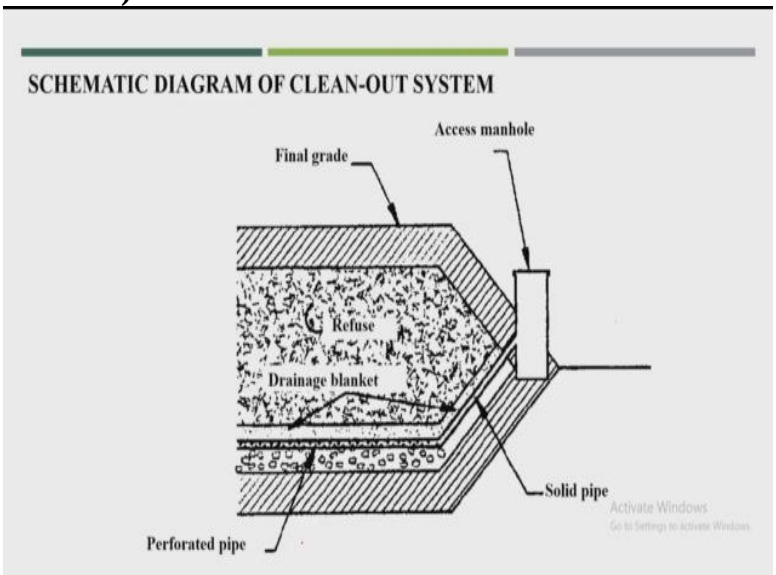
(Refer Slide Time: 28:43)



This is also 1 view we can see. So, nearby this is a low permeable layer, this is the drainage layer and I think to refuse and only the fine particle will not enter into this area so that the clogging will not be a much issue. So, the permeability K of the drainage layer should be a minimum of 10^{-3} centimeter per second, where 10^{-2} is desirable drainage layer gravel should be washed to remove fines.

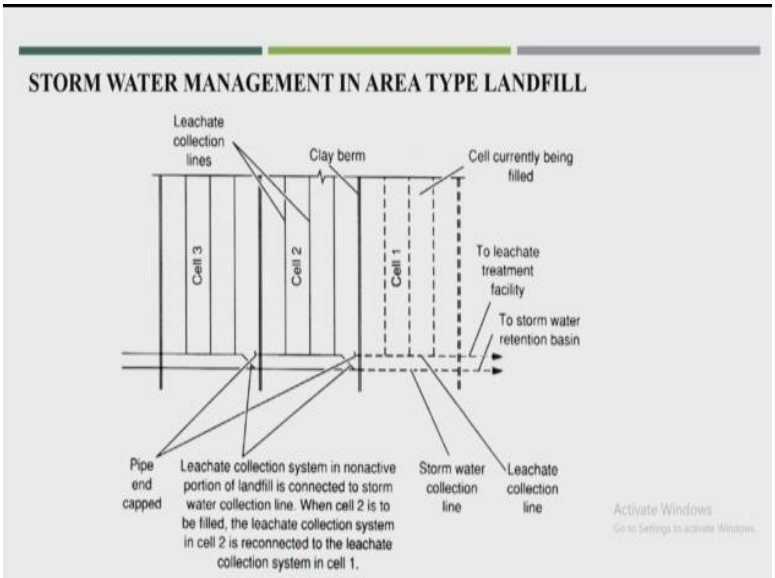
And no limestone-based aggregates in the French drain used in the event of pipe failure or clogging and additional contaminants and or leak detection system is required. So, time to time monitoring is also required if there is a leakage that could be possible.

(Refer Slide Time: 29:52)



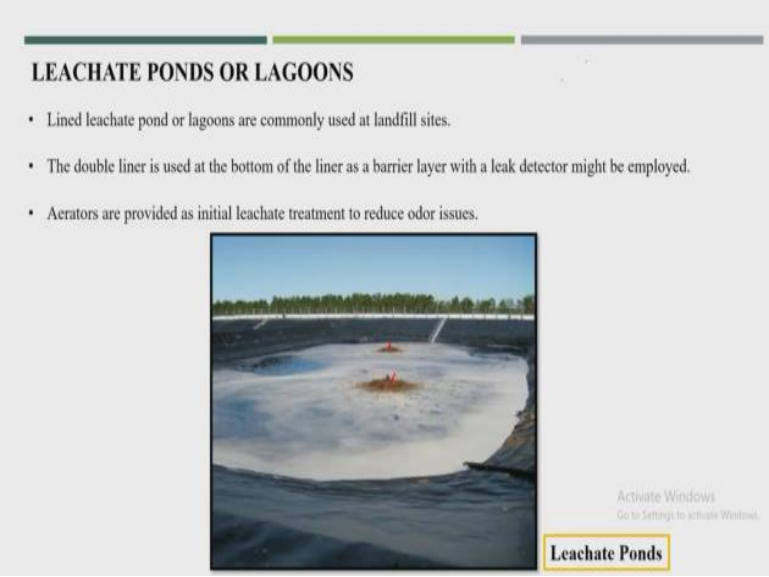
So, this is a one more diagram of clean out system so, all the pipes is connected with the manholes or where the entire leachate is getting collected.

(Refer Slide Time: 30:08)



And here I think the leachate collection is separate and even stormwater or whatever precipitation the surface water should collect separately and their collection also will be separate. And then storage also is separate because that will not have that much kind of pollutants but the leachate should get collected separately.

(Refer Slide Time: 30:35)

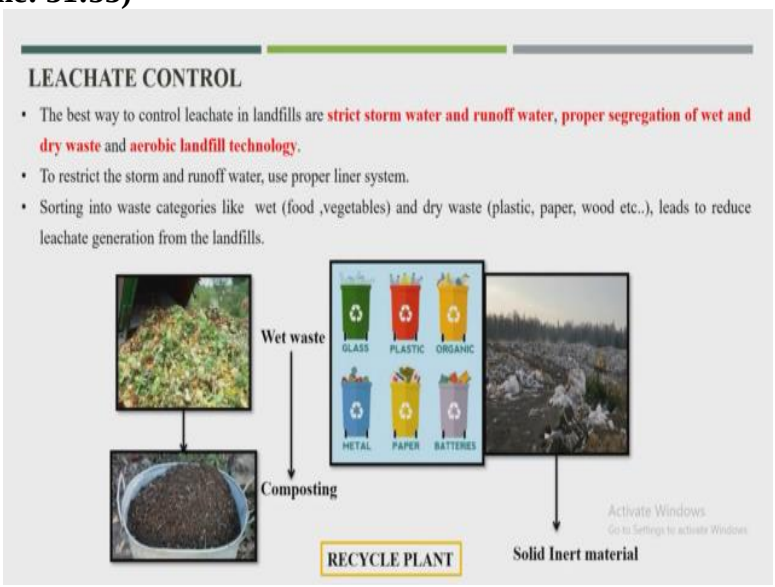


And now these leachate ponds or lagoons, after from the landfill is getting stored. So line leachate ponds or lagoons are commonly used at landfill sites. The double liner is used in the bottom of the liner is barrier layer with the leak detector might be employed and aerators. Now we can see these are some aerators so that not only the storage but also the treatment also could be possible to provide the initial leachate treatment to reduce the odor issue.

(Refer Slide Time: 31:12)

Now the leachate storage tank is a structural basin with primary construction material include steel, fiberglass or concrete. So it is fiberglass or glass-lined steel leachate storage tank, I think we will not see in India such kind of collection but in the US their maximum waste is going to the landfill area. So they have too much worried about the leachate collection also storage tanks are remained open to the atmosphere and often include manifold diffused of air addition.

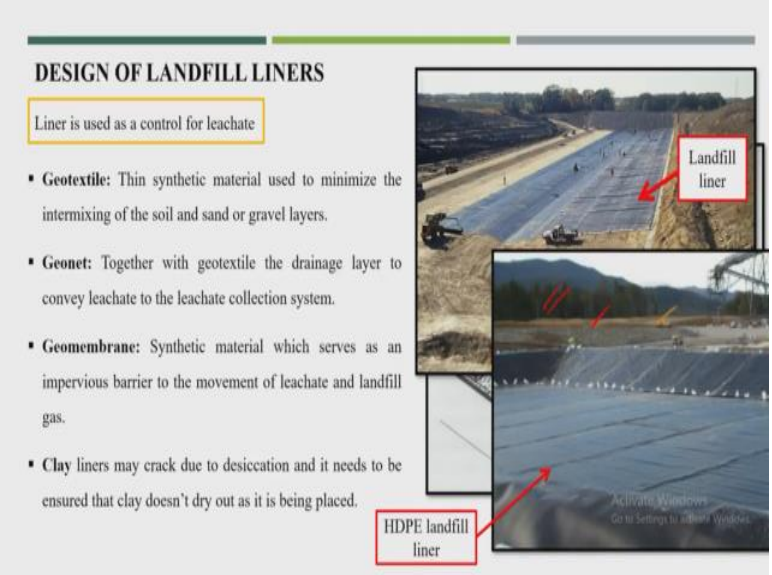
(Refer Slide Time: 31:53)



The best way to control leachate in landfills is strict strong water and runoff water proper segregation of wet and dry waste and aerobic landfill technology. I think this is the best way we reduce the control. So, I think we were talking about that the wet waste is not coming and going for composting your recyclable matters is also not coming only the solid inert material are reaching into the landfill site.

So you need not too much worry about the landfill, leachate production will be very low. So, I think the same thing to restrict the storm and runoff water and sorting into the waste category like food waste, dry waste and biological waste should not be entered into the landfill area.

(Refer Slide Time: 32:47)



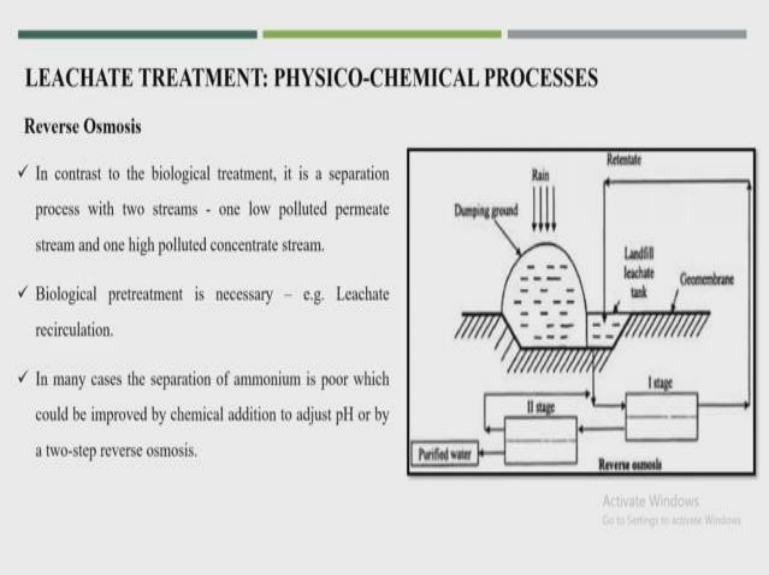
So, how to design the landfill liners? So, majorly you can see that when you talk about liner, the, it will start from the bottom 2 feet to compacted clay layer followed by geomembrane, geonet, geotextile and again the soil layer and after that, we can deposit the waste onto that. So what is the benefit of having these kinds of the liner the like geotextile will help that is the first layer after the soil thin synthetic layer used to minimize the intermixing of soil and sand or gravel layer.

And geonet with geotextile the drainage layer 2 convey leachate to the leachate collection system. So this geonet is a where only we are injecting the pipes, geomembrane the synthetic water which serves as an impervious barrier to the moment of leachate or landfill gas. So the geomembrane will be in the bottom so that this is the complete impermeable barrier for the leakage of leachate into the ground.

And finally, clay liner may crack due to the desiccation and it needs to be ensured that clay does not dry out as it is being placed. But I think is a very costly task. But in most cases what we are using, I think wherever the in India, the sanitary landfills are coming up, rather than because they are very costly units like geotextiles or geomembranes. So what we are doing is we put clay liner, clay gravels and HDPE liners, this is the common kind of liner we are using

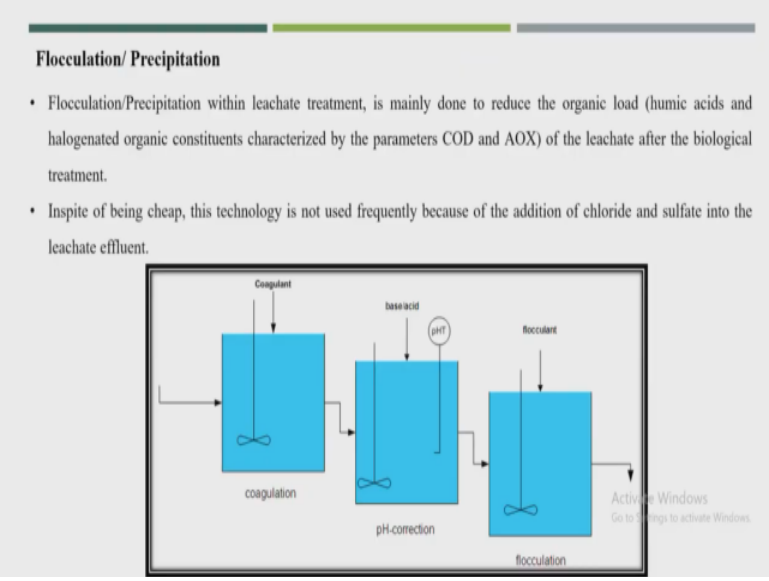
in India. So you can see here this is an HDPE liner, which I was talking about this entire area is covered by an HDPE liner.

(Refer Slide Time: 35:03)



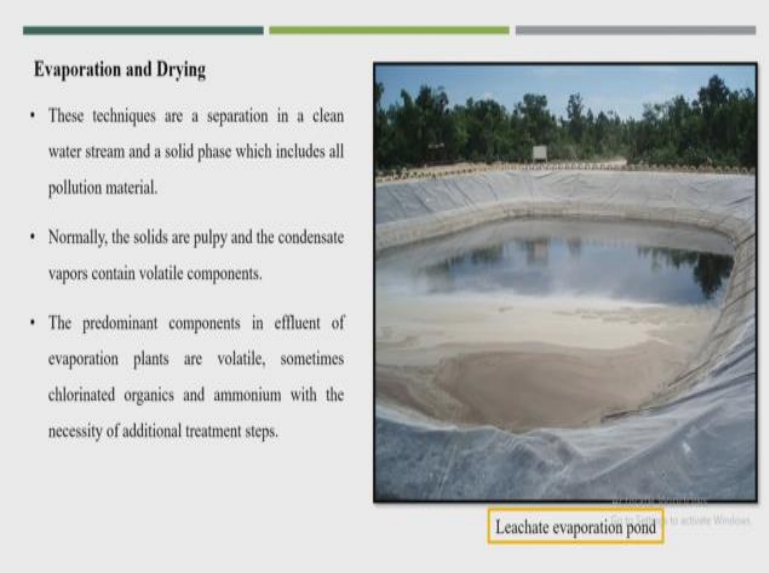
So what kind of treatments of the leachate once you are able to collect that we can go for reverse osmosis, but it is very costly unit for the treatment process.

(Refer Slide Time: 35:18)



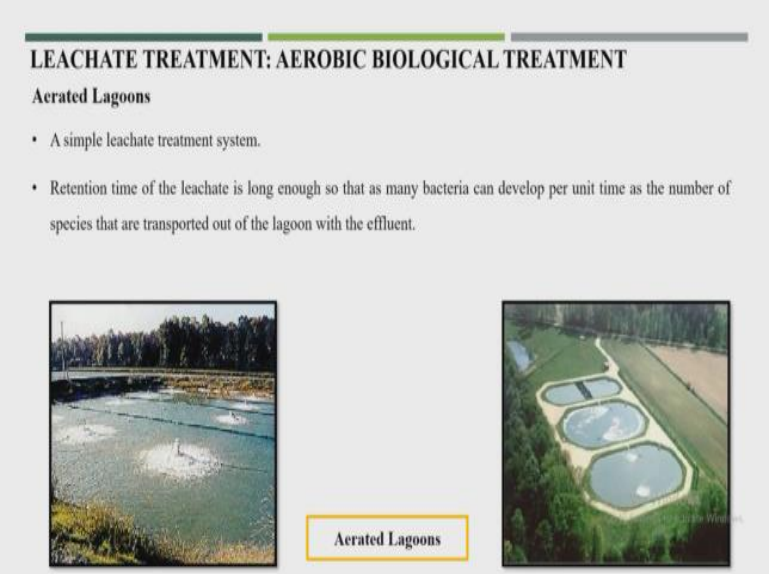
This could be possible by I think this is one of the easiest methods for that we can go for flocculation, precipitation. So, if some coagulant if you add and because as I told that BOD 5 value is because of mostly with the suspended solids, so, these suspended solids if you are able to remove by coagulation, flocculation process followed by precipitation maybe 70 to 80% of BOD 5 will get removed out of that.

(Refer Slide Time: 35:55)



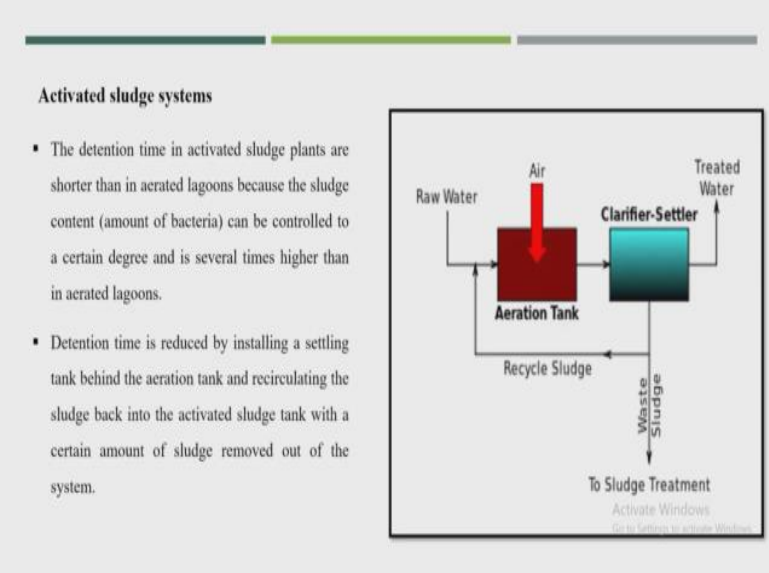
And this is one of the cheapest methods of the treatment process now, one more technology could be like evaporation and drying. So, these techniques are separation in clean water steam and solid phase which includes all pollution material. So, you allow the entire leachate to get evaporate and get dry.

(Refer Slide Time: 36:26)



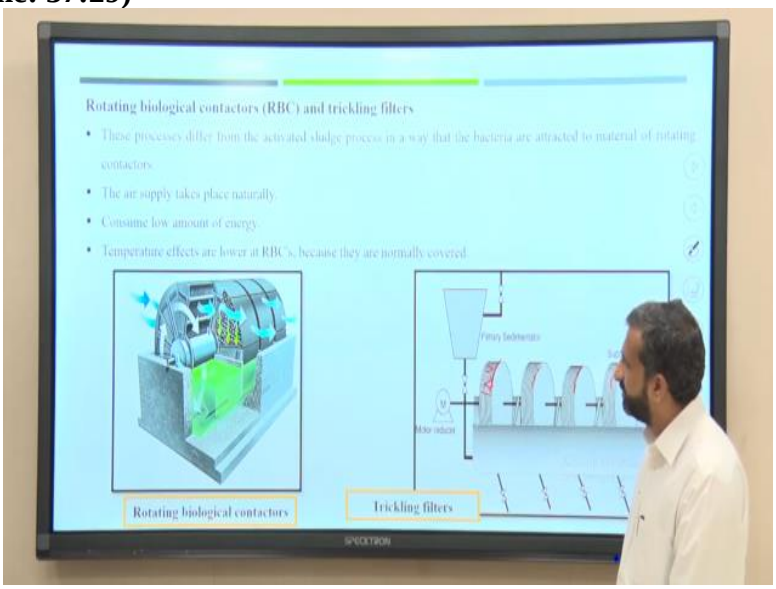
And very common treatment process other than flocculation and precipitation is aerated lagoons, say lagoons also a similar kind of ponds, big ponds and where some aerators were providing for the aerobic treatment process. The simple leachate treatment system retention time of leachate is too long is long enough. So that as many bacteria can develop per unit time as the number of species that are transported out of the lagoon with the effluent and maintenance operation costs relatively low.

(Refer Slide Time: 37:08)



And this is also one technology we can use activated sludge system also which contains 2 units like started with the aeration tank followed by a secondary sedimentation tank.

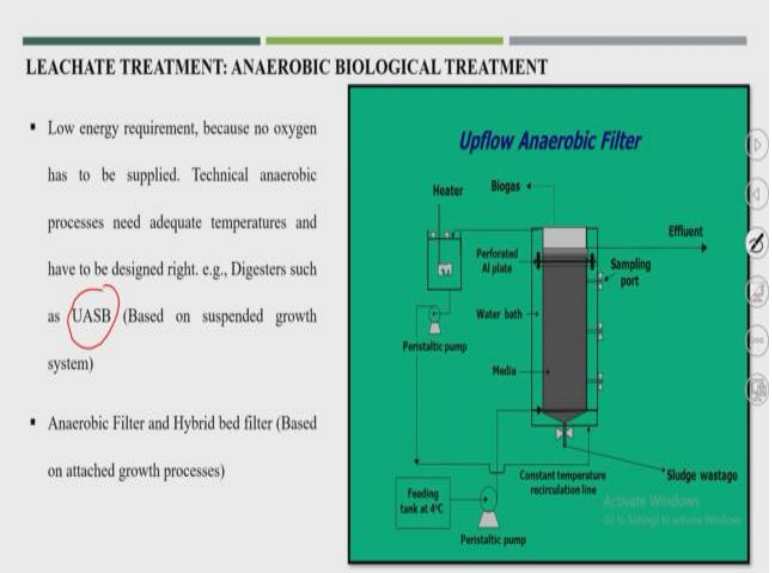
(Refer Slide Time: 37:29)



This is another technology we can use like RBC or rotating biological contractor. So, there will be, rotating cylinders you can see here rotating cylinders and because these are half is getting emerged into the leachate and half will be open to the atmosphere. So the bacteria will grow onto the surface. And once these bacteria will insert into the leachate they will get degrade the organic matter.

So, this is different from the activated sludge process the air supply that takes place naturally consumes a low amount of energy and temperature effects are lower at RBC because they are normally covered.

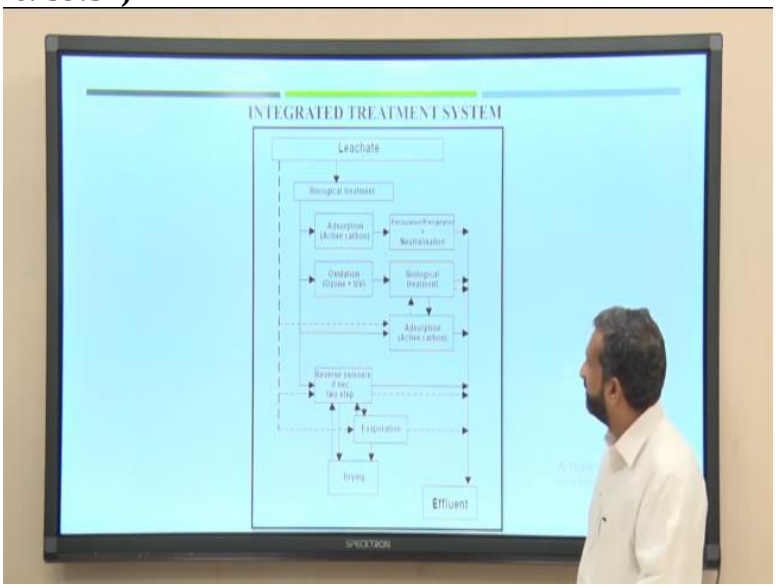
(Refer Slide Time: 38:20)



So, is an anaerobic biological treatment facility like a major unit is a UASB technique. So UASB is upflow anaerobic sludge blanket clarifier this is a very common technology for sewage treatment and even the activated sludge process, RBC aerated lagoons are all sewage treatment facility it can use an anaerobic filter or even hybrid bed filters also can be utilized. So is a this is the upflow anaerobic filter.

So, this is somewhat different from the UASB unit. So, USAB will be a long cylinder or long vertical vessel, here also the vertical vessel, but this vessel will be filled with media and the bacteria will grow onto that media and because of that, the degradation of organic matter could be possible.

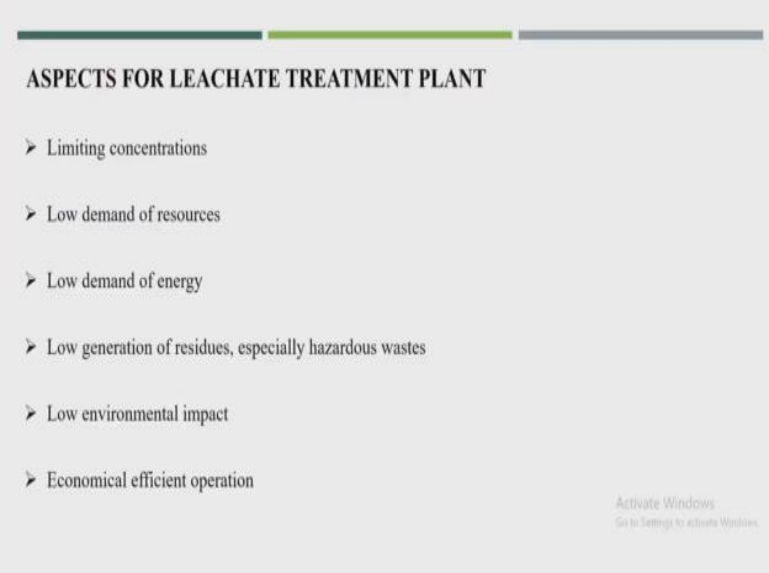
(Refer Slide Time: 39:34)



So there could be integration we can do for the treatment process like we can go for the biological treatment process first these biological treatments with flocculation, sedimentation,

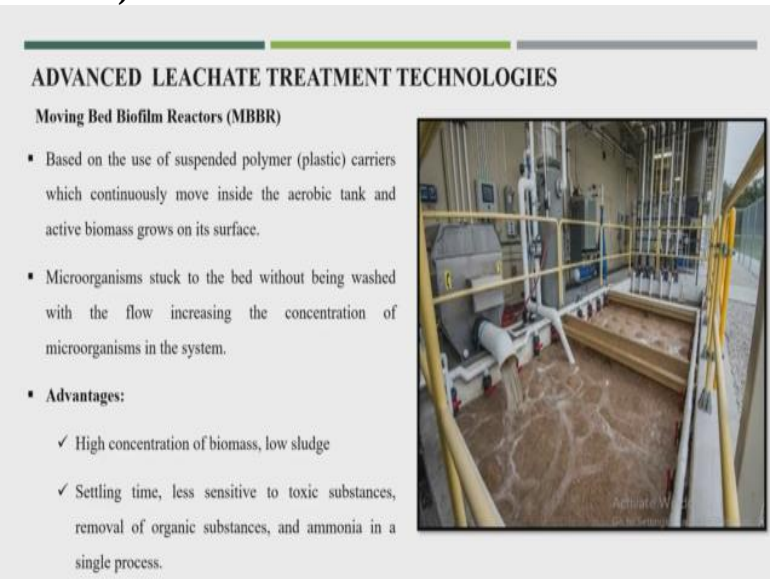
or any kind of biological treatment process, like activated sludge process, lagoon process followed by the reverse osmosis and evaporation. By that way, if we can combine 2, 3 technologies we will be able to treat properly this leachate.

(Refer Slide Time: 40:10)



So, what are the aspects for leachate treatment plants and finally, what has to be looked upon the limiting concentration. So, whatever the concentration with the pollution pollutants should be as low as possible low demand of a resource, low demand of energy, low generation of residue, low environmental impact and economically efficient operation I think this is the criteria for the treatment process has to be there.

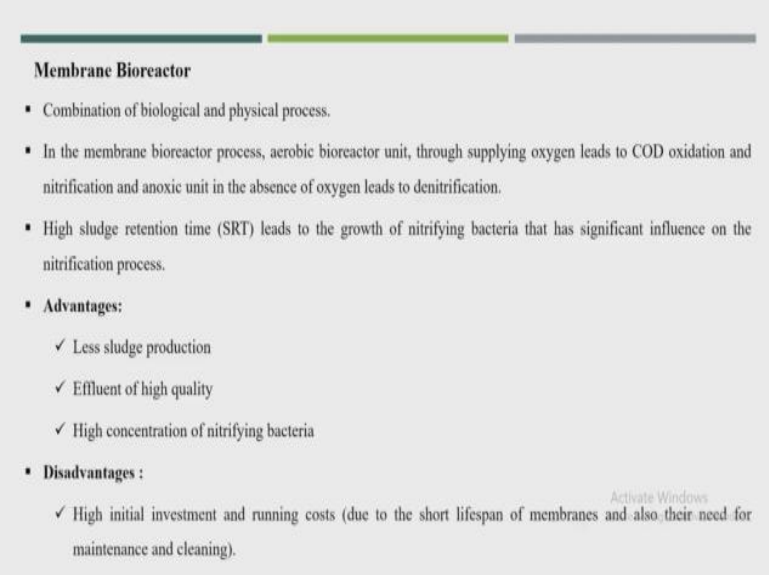
(Refer Slide Time: 40:48)



So, the advanced leachate treatment technologies like MBBR technology we can use is also a very popular technique for sewage treatment or industrial wastewater treatment. So, there is a

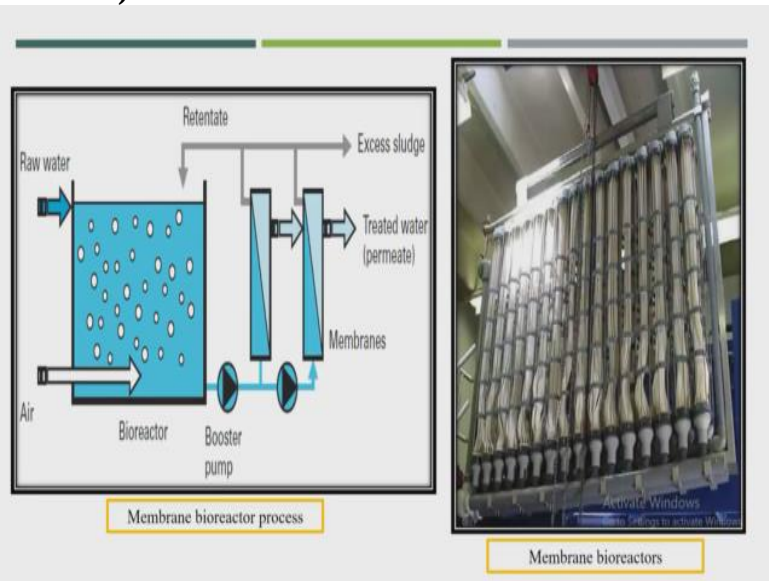
high advantage like a high concentration of biomass settling time, less sensitivity to toxic substances, removal of organic substances, and ammonia in a single process.

(Refer Slide Time: 41:17)



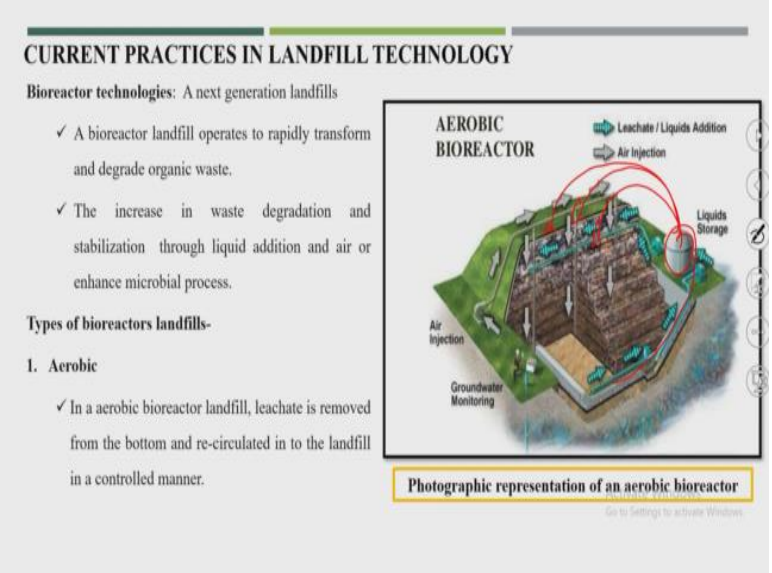
So, this also important and then this also could be a combination of the biological and physical process could be possible and the benefit of these membrane bioreactors like it lead to the growth of nitrifying bacteria. So, not only the carbonaceous pollutants will get removed out but also the nitrogen or nitrogenous compounds also will get nitrified. So, the advantages could be less sludge production, efficient for high quality, the effluent of high quality and high concentration of nitrifying bacteria could be possible, but the disadvantage is only that high investment cost.

(Refer Slide Time: 42:11)



So, this is the one small sketch of membrane bioreactor so, this is what membrane.

(Refer Slide Time: 42:24)



So, the current practice in landfill technology so now, because see, I did not talk much about the treatment process much because it is a very costly unit and the problem with this treatment of leachate is that you will not get the homogeneous kind of leachate every day or every time. So, even the operations of such kind of treatment plants also is not that so easy or so simple like these all these technologies are highly acceptable for sewage treatment or any industrial treatment.

Because homogeneous and you know, the particular loading, microbial consortium many things are known for operation of such kind of technology, but now leachate as I was talking about that, initially, the leachate will not be strong, or the BOD 5 will not be that large. But as the time after 4 years, 5 years, the leachate production, the quantity is also very large and also the quality is also very strong.

So I do not know how these kinds of biological treatment facilities will work. So like what here I am explaining though, the current practices, I think these practices are accepted in the US because their maximum waste goes to the landfill area. So rather than a collection of these leachates and treatment is a very costly process that is not that economical. So what they come up with one technology called bioreactor technologies.

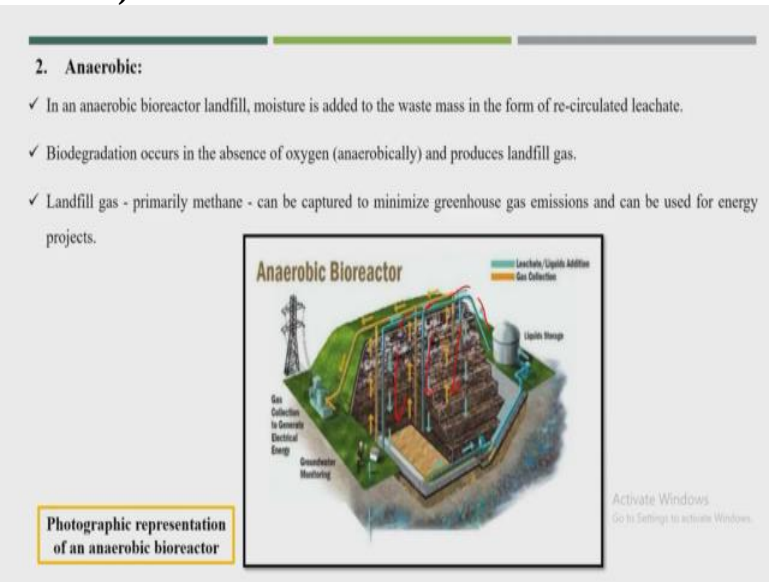
These they are called is a next-generation landfill. So bioreactor landfills operate to rapidly transform and degrade organic matter the increase in waste degradation and stabilization through liquid addition and air or enhanced microbial activity. So, there will be 2 types of

bioreactor. They propose that one could be aerobic. In aerobic reactors, the leachate is removed from the bottom and recirculated into a landfill in a controlled manner.

So, what is the idea? So now in the previous treatment process, the task was to collect the leachate and store it for the treatment process. Now in this case, whatever leachate is getting collected, this leachate is getting collected is stored and now because the idea is that in the entire waste material should get aerobically degraded whatever the organic matter so because of aerobic degradation, you required moisture also for the growth of microorganism.

So, you put it onto the again recirculate into the biomass and also you put up the inject the air to maintain the aerobic condition and you know that in the aerobic condition the degradation will be very, very fast could be possible, so, that the entire waste material will get degrade and also the leachate is also getting consumed for the degradation process and for the growth of microorganism, air injection in the waste mass using vertical or horizontal ways to enhance aerobic activity, but I think again when you are saying aerobic one. So, you require the energy to inject the air into the landfill area.

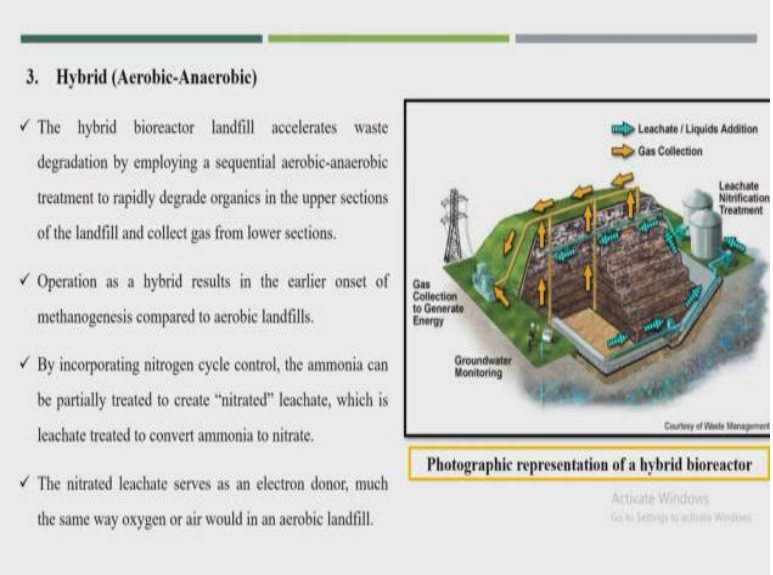
(Refer Slide Time: 46:17)



Then this thought came why not you go for anaerobic one simple anaerobic the operation is same leachate store and again leachate stored and again you dispose recirculate into the biomass and now because already the landfill is a with the final cover is a closed landfill. So, the entire mass will be under anaerobic conditions. Then the same anaerobic bioreactor moisture is added to the waste mass in the form of recirculated leachate.

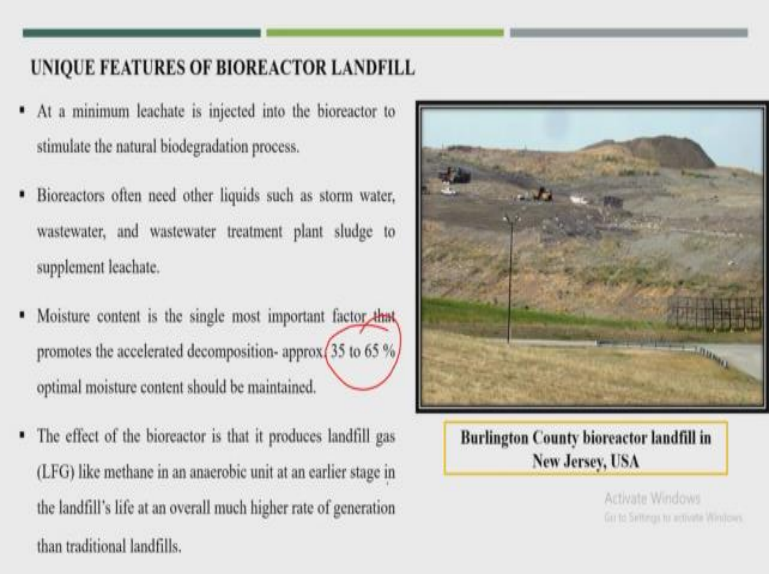
And biodegradation occurs in the landfill area in the absence of oxygen to produce landfill gas and primarily that gas will be the methane gas and also possible that because in such kind of sites or such kind of bioreactor will be able to collect these gas and can utilize that methane gas.

(Refer Slide Time: 47:21)



And there is another type is a hybrid one. So, both could be possible like aerobic, anaerobic. So, in this case, it could be possible that in the top area mostly the top area will be in aerobic conditions and the bottom area will be in the anaerobic condition. So, because the top area can be air can be injected very easily as compared to the bottom area is not costly also. So it is possible that the top area will degrade so fast compared to the anaerobic area. So, I think this is also one technology we can use.

(Refer Slide Time: 48:13)



So, this is one landfill site in New Jersey. So they consider that as a bioreactor. At minimum leachate is injected into a bioreactor to stimulate the natural biodegradation process. The bioreactor is often used other liquids such as stormwater, wastewater or wastewater treatment plant sludge to supplement leachate because see in us the biological waste also is not that high.

So their biological waste goes to only 20 to 30%. So obviously, the leachate production also will be not high. But when you talk about India, I think your leachate production itself is a very high so but in that is why they required other kinds of liquids like stormwater, wastewater treatment, even sludge also they are adding because it consists of a lot of microbes also. So that which can enhance the degradation into the bioreactor facilities.

The moisture contained in the single most important factor that promotes the accelerated decomposition of approximately 35 to 65% optimal moisture content should be maintained for the proper degradation process. So, see entire these bioreactor systems, the major important factor is, is to maintain the moisture for the degradation process. So, actual the problem in the landfill area what will happen that because the upper portion will be always dry.

Because is open to the atmosphere, only the bottom portion will be in the anaerobic one and slower there because the anaerobic slowly, slowly degradation could be possible. And suppose, there is no rain in there is no precipitation for supposing after 3 months of the rainy season, almost remaining that 6 to 7 months or 8 months there is no rain. So, how the degradation will be fast at that particular time?

So, the simple thought that leachate you collect you collected in the 3 months in the rainy season collect it, and again you supply to the remaining 7 to 8 months to get wet the entire mass because once it will get wet the degradation will be very fast into the waste material. The effect of bioreactor is that it produced landfill gas like methane in an anaerobic unit at an earlier stage in the landfill life at an overall much higher rate of generation than traditional landfill.

So, as I was talking about in the traditional landfill are not designed properly landfill area or even this normal landfill, sanitary landfill also methane concentration, you will not get it

initial 2 years, 3 years or 4 years. So, but because of bioreactor because the entire model in the anaerobic condition, so you will be able to achieve more landfill gas so that the these gas can be collect and can utilize.

So here we will finish that. But I think before finishing again one last comment onto for landfill. The waste only again, I think is again I think again I am repeating that waste which is not biodegradable, not recyclable, not utilizable anything should only come to the landfill area so that you need not too much worry about the leachate and wherever I think the small facility will create for landfill area, go for proper lining, proper leachate collection system.

Maybe we will not be able to treat that leachate because it is a very costly system. So at least plan for such kind of facility where this entire leachate can recirculate onto the same area. That is the best way of operation of the leachate collection system and followed by treatment. Thank you.