Environmental Remediation of Contaminated Sites
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Lecture - 59
Thermal Processes and Soil Washing

Hello everyone. Again welcome back to the latest lecture session. So this will be our last lecture session right. In this particular session we are going to discuss 2 minor aspects let us say that people look at sometimes they are what do we say the thermal process and soil washing right.

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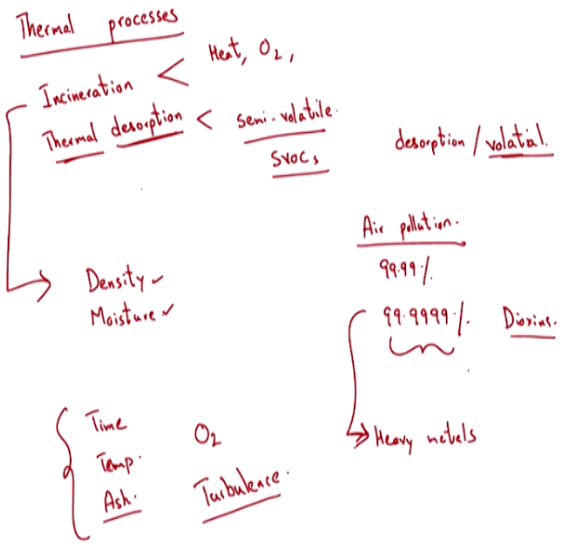

So we are going to look at the thermal process first. So again as we just mentioned let us say or we even looked at the pie chart let us say which give us an idea about the preferences for particular types of remediation techniques. Let us say thermal process or even soil washing let us say or not very (()) (01:06) now.

There are obvious reasons typically you know cost let us say right and such but obviously you know in specific circumstances or cases you know you would prefer to go for these process now right. So obviously as the name indicates let us say right a self explanatory obviously they are thermal process right. So typically we are concerned with let us say incineration and thermal desorption typically let us say right.

And incineration what is it that you need to provide obviously you need to provide a source

of heat or energy let us say right, you need oxygen and typically you would want to promote complete oxidation let us say right and typically you are going to be left with ash or such residue let us say right. So obviously energy let us say it is energy intensive process right that is one particular aspect.

So in thermal desorption though again keep in mind that we are looking at desorption right and based on providing energy let us say in the form of heat let us say right. So when a particular compound let us say is adsorbed on to a particular media let us say right and there is a particular reason for it and for it to dissolve let us say there should be some motive let us say here or some energy let us say since in this context.

So here you know we are going to supply that energy in the form of heat let us say that will promote the desorption of this contaminant from the relevant media let us say right. So typically we look at applications for semi volatile let us say or semi volatile compounds let us say right or SVOCs let us say that may be adsorbed on to different media let us say right and applying heat and passing steam or so on and so forth let us say.

You would want to bring about desorption and volatilization right. So here we are going to have desorption or volatilization and then followed by you know this particular process you can have or you know following this particular process you can have you know your oxidation or any other further treatment steps let us say right, but the major aspects as you can see in thermal desorption is that we are changing the phase again right.

But the impetus is that you know you are adding or you know you are putting energy or such right. So few more aspects to look at or consider with respect to energy let us say right. So what are you concerned with you are concerned with the density let us say of the relevant waste let us say right and moisture content let us say right yes and again keep in mind that the regulations are pretty stringent typically let us say for incineration.

And typically (()) (03:50) you know we have these what do we say removal efficiencies let us say or destruction removal efficiencies that are let us say 99.99% for the primary contaminant and 99.9999% 6s 9 here right for dioxygen or such that can be released from your particular and during your incineration or such right. So keep in mind that when you look at incineration as your particular alterative let us say right.

You are going to have to have very stringent air pollution control relevant measure let us say that need to be implemented right. Again very stringent air pollution control is need or has to be looked at let us say right. So again let us move on so we have particular or you know particular aspects relevant to air pollution right so that something to keep in mind. So obviously the relevant regulations are pretty stringent right.

So density, moisture content typically considerable aspects. So what are the typical aspects we look at let us say operational aspects, time required the temperature that needs to be maintain let us say and the ash content let us say and so on and so forth but these are the typically aspects let us say and obviously amount of oxygen amount of turbulence required let us say for what do we say more efficient combustion or incineration of the relevant material let us say right.

And again apart from these particular aspects you need to look at let us say you know any heavy metals out there and they are release right. So again they are regulated again in your particular air pollution let us say or air pollutants that are release let us say right. So you need to treat that particular air and you know there are relevant aspects out there and such, but again for obvious reasons cost or such reasons typically incineration are not chosen.

But there are some cases let us say where may be no other techniques work you know people chose this incineration and then moving on to thermal desorption as we just discuss let us say right typically use for SVOCs let us say right. Again this can be either in-situ or ex situ right. If it is in-situ you can pass hot water steam or so on and so forth to help the relevant SVOCs from the relevant soil media and so on and so forth. So I believe we have a few slides here let us go look at these aspects.

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DESCRIPTION

- Steam is forced into an aquifer through injection wells to vaporize volatile and semi-volatile contaminants
- Vaporized components rise to the unsaturated (vadose) zone where they are removed by vacuum extraction and then treated
- Hot water or steam-based techniques include:
  - Contained Recovery of Oily Waste (CROW)
  - Steam Injection and Vacuum Extraction (SIVE)
  - In Situ Steam-Enhanced Extraction (ISEE)
  - Steam-Enhanced Recovery Process (SERP)

So in this particular aspects we are going to look at let us say steam is forced into an aquifer through injection wells to bring about volatilization of semi-volatile compounds SVOCs right. So again the key is that we are looking typically at SVOCs why is that and why not VOC because they are typically more cost effective ways to look at or treating VOCs. And these are aspects that we have already discussed earlier.

So we are not going to go about or discuss these aspects again but again if you have SVOCs and depending upon the relevant scenario you can try to promote volatilization by providing the relevant energy let us say right again let us move on. So the vaporized contaminants then what happens to them let us say you are providing steam let us say and you are desorbing the contaminants let us say right.

From the relevant soil or if it is dissolved in water let us say you are letting that you know change phase again you are volatilizing it. So then this particular gaseous phase is going to travel into the or be transported into the relatively to the vadose zone or the unsaturated zone right so that is what we are going to have and then removed by vacuum extraction as we have looked at in various cases let us say right.

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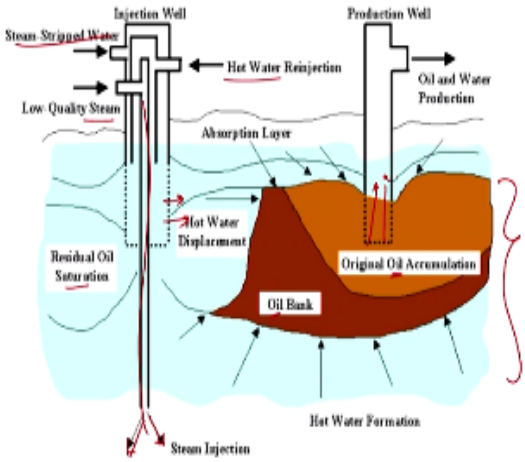
TYPICAL THERMAL TREATMENT PROCESS



So typical thermal treatment process let us say right I would not say remarkably typical, but yes this is widely used. So as you say you have different what do we say types of contamination out here specifically in this case due to oil let us say right and also you have some residual oil saturation out here. So what are they looking at they are looking at steam stripped water and steam and again hot water injection right.

It is not just one particular aspect. So steam infection let bus say as you can see right they are injecting steam out here and then hot water out here. So through hot water displacement or again due to the activity of the steam you are going to have what do we say desorption let us say and volatilization and then you are going to have removal from this particular layer out here.

Again you know for to not be tedious I am going to skip the relevant aspects, but we looked at these aspects as in desorption and so on and so forth in great detail earlier but again you get the idea out here right. So let us move on there are different techniques here right for hot water based on hot water or steam. So contained recovery of oil waste an example of which we have just looked at.

Steam injection and vacuum extraction this is what we discussed earlier. So again similarly we have in-situ enhanced extraction again the emphasis is on enhanced extraction or again steam enhance recovery process right. Again as you see the common aspect here is that you are either supplying either energy or energy in the form of heat here let us say right so that is the relevant aspect out here. So let us move on.

Again what are we typically looking at or you know where do we typically apply this particular kind of technique.

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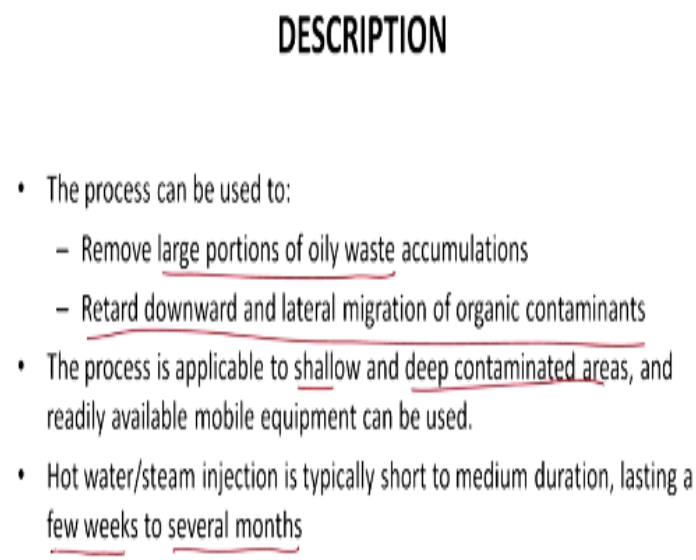

When we have large portions of oily waste accumulation keep in mind it is hydrophobic right semi volatile or completely volatile and so on. So in that case obviously they are going to look at a combination of both hot water and steam let us say. Again you are going to try to inhibit downward and lateral migration of the organic contaminants and that is the job of the relevant hot water that is being injected let us say right.

So again typically shallow and deep right. The limitations are based on let us say how deep you can dig let us say or you know have your setup such that you can inject the steam or the relevant hot water now. Obviously again similar to the other process like soil vapor extraction or such again we need to obviously consider the permeability, hydraulic conductivity and so on of the relevant soils and so on and such aspects right.

Again with respect to duration typically few weeks but rarely we also can go to a few months, but typically most people look at a few weeks let us say.

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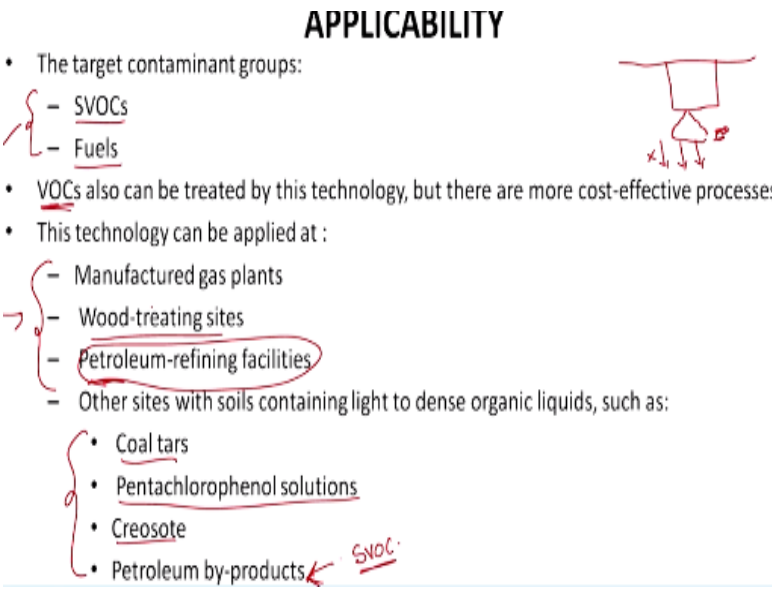

Again as we mentioned earlier or as I mentioned earlier typically for semi volatile compounds and for fuels again cost effective ways are already like soil vapor extraction or such are available for VOCs or their other techniques as we discussed and obviously these kinds of contaminants where do we come across them. Typically, in manufacturing gas plants wood treating sites and obviously petroleum refining facilities let us say where you have the underground storage tanks let us say.

As in you are going to have a subsurface, we are going to have underground storage tanks and you see considerable spills out there let us say right. So in this case either to prevent further transport out here or in this particular direction but typically in the downward direction you want to prevent that right and you want to have relatively safer removal let us say because you have the relevant spills occurring in petroleum refining facilities you know you can go with these kinds of process let us say right.

Again you know others sites with soil containing light to dense organic liquids but again not greatly use, but again they do use thermal process for remediating sites contaminated with coals tars pentachlorophenol solutions creosote and petroleum by products, but here the key is that they need to be typically semi volatile right. Obviously if they are remarkably volatile they would obviously want to stay in the gaseous phase.

Here you are trying to promote their volatilization right. So that is something to keep in mind so very generic performance data out here.

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PERFORMANCE DATA – MEMPHIS DEPOT, TN

- **Extent of contamination:**
  - The combined area for treatment included 49,940 cubic yards of subsurface material to a depth of 30 feet below ground surface
  - The treatment system recovered approximately **12,500 pounds** of contaminants.
- **Volume of media treated – 49,900 cubic yards**
- **Site geology** - the site consists of tight **loess (silt/clay)** above the water table.

So here they look at the particular depot let us say in Tennessee right. Area of a treatment was around 50,000 cubic yards and the depth is around 30 feet below the ground surface and they recovered a remarkably huge amount of what do we say contaminants here 12, 500 pound as in keep in mind that 2.2 pounds=1 kg. So now you get an idea about the amount of contaminants that was remove here right. So again as we mentioned 50,000 cubic yards and here it was silt and clay right.

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PERFORMANCE DATA – MEMPHIS DEPOT, TN

- **Clean up goals**
  - To treat chlorinated solvents to concentration below target limits
  - Carbon Tetrachloride – **0.215 mg/kg**
  - Chloroform – **0.917mg/kg**
  - 1,1,2,2-PCE – **0.0112mg/kg**
  - 1,2-DCE - **0.755 mg/kg**
  - TCE – **0.182 mg/kg**
- Soil sampling results indicated that the **in-situ thermal desorption system** reduced contaminant concentrations to below **0.01 mg/kg.**
- Before treatment, these locations had chlorinated organic concentrations higher than **1,000 mg/kg.**

Let us move on so what did they extract typically SVOCs and some VOCs but mostly SVOCs chloroform let us say is an SVOCs right and they were able to bring down the concentration to UC as you see typically less than 1 mg per kg let us say right and that is pretty good out there, but in general keep in mind that similar to any other desorption technique or such.

However much you remove let us say there is always going to be some adsorbed on to some contaminants adsorbed on to the relevant soil or in the water why is that because whenever you are introducing a new media steam let us say surfactants or you know in this surfactant case (()) (12:53) or such you are introducing a new idea let us say that will be an equilibrium with the other media let us say that is contaminated.

So when we say equilibrium some of it even a tiny fraction let us say even though it is only a tiny fraction we will still be in the other media that was originally contaminated that is something to keep in mind now right. So again you know different what do we say contaminants let us say or mixtures or contaminants are treat out here and they also looked at soil sampling results and they saw this in-situ thermal desorption system reduced the concentration to below to 0.01 milligram per kg let us say so that is something to keep in mind.

And before treatment looks like they have the concentrations to be as high as 1000 milligram per kg right again generic information let us say.

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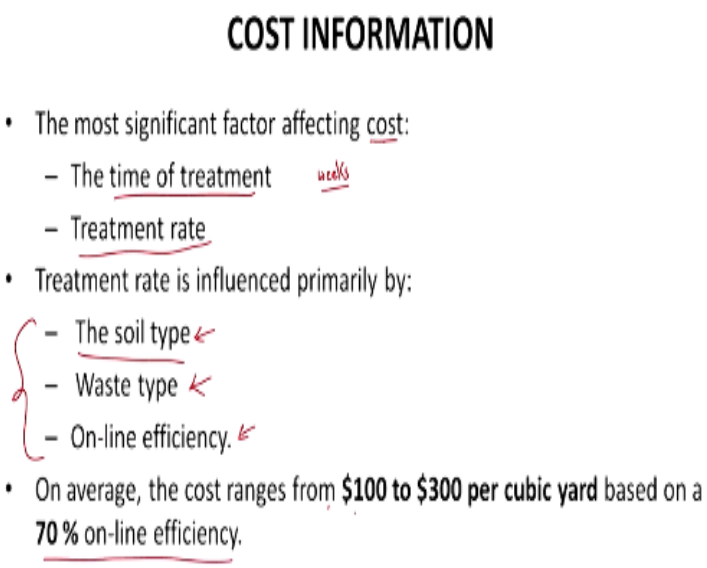

So let us look at general cost information out here and what are the relevant aspect at least In-situ team or hot water based injection system let us say that affect your relevant cost here right. So obviously time of treatment but that is why I typically mentioned that typically the relevant timeframes are weeks and obviously the treatment rate let us say right. Again aspect rate we have discussed.

Soil type as permeability, hydraulic conductivity or remarkably important aspect because the pressure and relevant aspects let us say are going to be depend upon the soil type obviously the waste type as in is it a mixture of contaminants let us say has it adsorbed or is it remarkably hydrophobic let us say or such or the efficiency of the relevant process let us say. And again depending upon the particular kind of online efficiency we have around 300 to 300 cubic yard.

I mean dollars per cubic yards and that is slightly on the higher end let us say ght. So let us move on.

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So now we are going to look at or briefly look at soil washing. Again it is self explanatory you are literally washing the soil if I may say so. So typically this is an ex situ process you are going to bring in soil out let us say from the relevant contaminate site. And soil washing typically is used in cases let us say when you know obviously it is ex situ right cases when you have mixture of contaminants, heavy metals, organic compounds and so on and so forth.

But again people do not typically prefer to go for such ex situ treatment, but in those cases let us say when you have or when you had to remove let us say you know highly contaminate sol from the site let us say you know obviously you can look at soil washing. So again as the name indicates you are literally washing the soil, but what are the relevant aspects involved here let us say again it is suppression or phase change let us say.

Earlier the contaminants was adsorbed on to the relevant soil and now after the relevant washing or treatment you are going to change phase into your particular what do we say solvent that you are going to use to wash your relevant soil here right. So let us look at the relevant aspects here. So contaminant sorbed onto soil particles or separated from the bulk soil and it is typically done in aqueous based system and obviously.

And obviously based on the particle size as in you have let us say clay again clay why are we talking about clay now. In generally clay has higher organic carbon or fraction of organic carbon let us say and organic carbon is the what do we say is the relevant aspect or factor that decides let us say how much of your hydrophobic contaminants is adsorbed onto soil. If it is (()) (16:18) of the relevant contaminant will be absorbed on to relevant gravel or sand.

As you can see clay relatively finer, sand gravel relatively bigger in size. So what is typically done is you know they are going to separate the relevant soil let us say by according to the relevant size let us say. As in the finer particles are going to be separated from the relative bigger or heavier particles let us say right or bigger typically size and thus I am saying heavier.

But also if you are looking at heavy metal base the contaminated soil let us say or heavy metal contaminated soil typically people also look at what do we density to separate the relevant aspects too or relevant contaminants too right.

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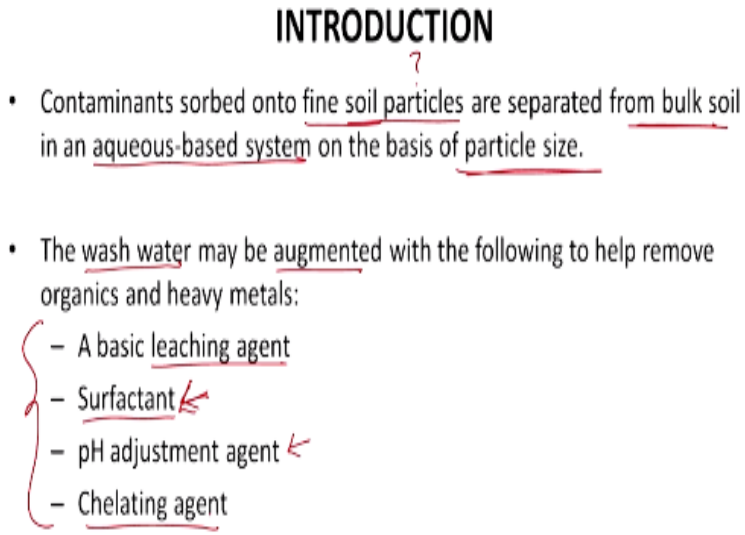

Again so typically fine particles are separated from the bulk soil and why is that because you

have the relevant contaminants adsorbed on to the organic fraction of the relevant fine particles let us say right and you are going to augment soil washing or the relevant wash water with these particles aspects what do we typically have a leaching agent because you want to leach or desorb the relevant contaminant.

Surfactant this is something we have looked at in our what do we say (()) (17:25) or surfactant application let us say right. You are more or less going to look at that in this ex situ case. Again pH adjustment as in depending upon the pH or changing the charge or such let us say or even you can change the relevant solubility of the contaminant right. You can bring about desorption.

And again chelating agent too as in you are going to add a (()) (17:46) let us say that is going to make the relevant contaminant more soluble let us say right. So these are different ways to augment your wash water right.

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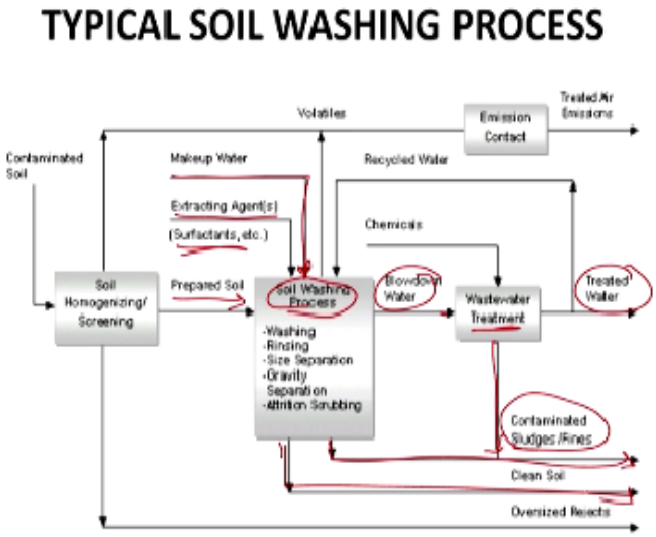

So again what is the general soil washing process you can go to the FRTR website to look at these aspects right. So let us look at what we are putting in let us say. We have contaminated soil and what exiting the system let us say treated air, treated water because you are obviously going to use water to treat the relevant soil let us say right. And obviously you are going to have some contaminated sludge or fine that needs to be further treated.

So typically clean soil and you know your relevant sand or gravel that was rejected let us say right. So let us look at the process here. I have my contaminate soil and its homogenize let us

say right. You want a homogenous mixture and that is what you do and during that time any volatile compounds obviously are treated here right any volatile compounds are treated out here.

And now separated the soil based on the relevant size let us say and thus the oversize particles are rejected out here right or sent out of the system now and then these fine particles obviously now go through the soil washing process. What do you add typical extraction agents as we looked earlier obviously including some surfactants typically aqueous based system.

So thus you are going to obviously have water here. So obviously when you have water you are also going to have the blow down water that needs to be treated in a waste water treatment plant and thus you end with treatment water. So here you are going to again have the contaminated sludge or such based on the type of treatment technique for the relevant waste water let us say.

So again here you are going to have the clean soil going out clean soil from here I guess right. These are the general aspects as you can understand now right. So again let us move forth.

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DESCRIPTION

- Mostly based on mineral processing techniques
- Soil washing is a water-based process for scrubbing soils ex situ to remove contaminants
- The process removes contaminants from **soils** in one of the following ways:
  - By dissolving or suspending them in the wash solution (which can be sustained by chemical manipulation of pH for a period of time)
  - By concentrating them into a smaller volume of soil through:
    - particle size separation
    - gravity separation
    - attrition scrubbing

So description we covered most of these relevant aspects mostly based on mineral process technique yes. So as I mentioned typically based on ex situ right and again what are some of the process let us say right. So what is the one aspect obviously dissolving or suspending them. Suspending them let us say based on surfactants dissolving based on let us say addition

of water, chelating agents or let us say or adjusting the pH and so on and so forth let us say right.

So these are some of the aspects and the concentrating them into smaller volume as in earlier I had gravel, sand and clay. And now I want to do not want to treat all this huge volume of soil. Thus right obvious cost and such so I want to cut down on the relevant volume how do I do that obviously based on particle size separation. Now there are different ways obviously gravity separation and attrition scrubbing too.

Attrition scrubbing again that is self explanatory. Again typically based on particle size separation they again there are cyclone based relevant systems and such there are different ways to look at particle size separation let us say right.

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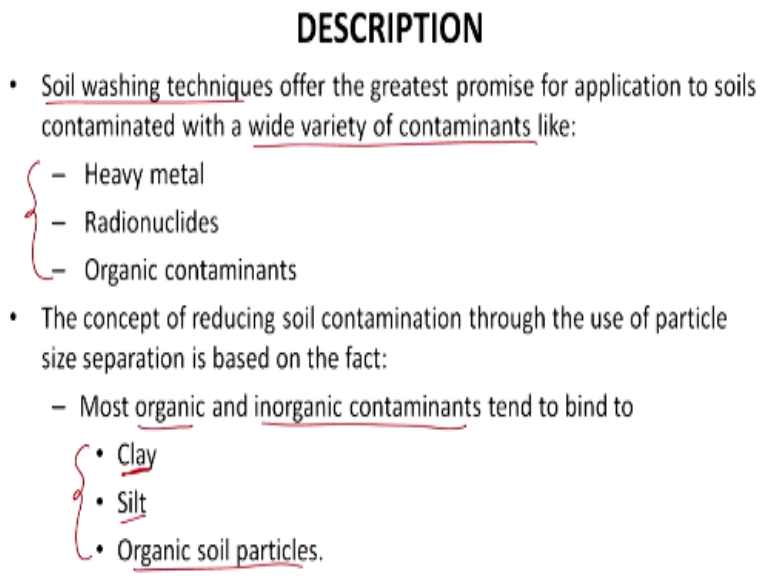

Again let us move on so again as I mentioned earlier techniques are worthwhile let us say when you have a wide variety of contaminants like heavy metal radionuclide and organic contaminants you know out there in relatively high concentration let s say only when the concentrations are very high typically would you want to go for soil washing let us say. And again what is it that we are looking at as this is something covered earlier organic.

Let us say and you know depending upon the type of inorganic contaminants the relevant contaminants bind to the relevant organic carbon fraction which is typically present in clay and silt and other organic soil particles let us say right. So now you want to separate it or change the media let us say or phase let us say right.

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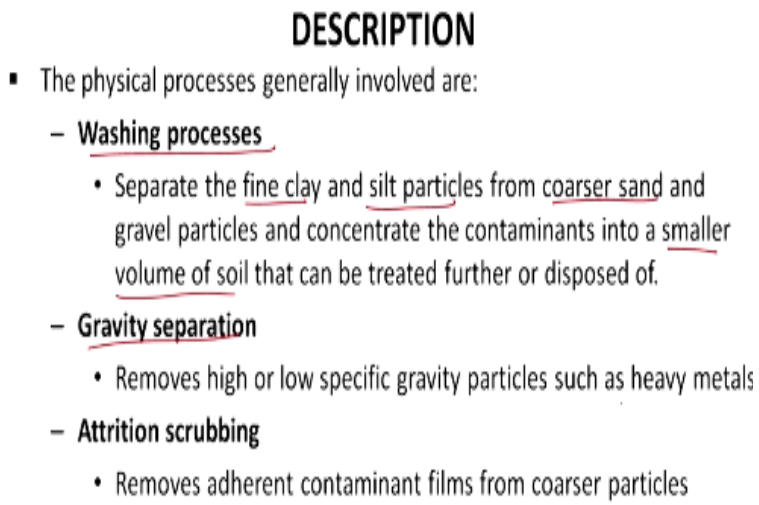

So let us move forth. So again what are the process that are involved obviously as I mentioned earlier washing process where you know separate the fine clay and silt particle from the course of sand right and then you are going to get a smaller volume that is then treated further let us say and again one of the techniques is gravity separation, remove high or low specific gravity particles such as heavy metals let us say.

This is something we discussed let us say compound let us say such as heavy metals again the principle here can be based on the density or you know the gravity separation that is something to keep in mind. So attrition scrubbing as the name indicates let us say remove the contaminants from of coarser particles by attrition let us say right again different techniques to promote that.

So sequential washing as in you can wash or you know have a mixture of relevant enhancement to the relevant wash water at one time or if you have a mixture of contaminants which is the typical case let us say for soil washing based what do we say process let us say you are going to first wash it with one particular type of contaminants and remove that not contaminants pardon me one particular type of enhancement or surfactant let us say right.

And remove that contaminant from the relevant soil then the other one and so on and so forth. Why is that obviously let us say you know you cannot different types of incompatible chemicals or surfactants you know working on soil at the same time let us say right. So that is one aspect right.

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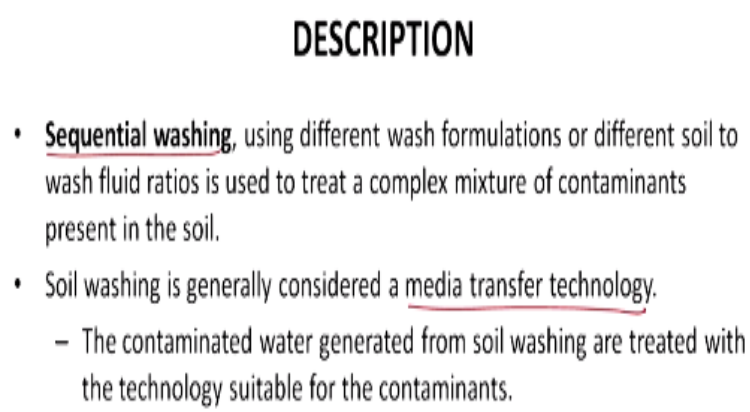

Again as I mentioned earlier it is media transfer as in changing phase from one media to the other right.

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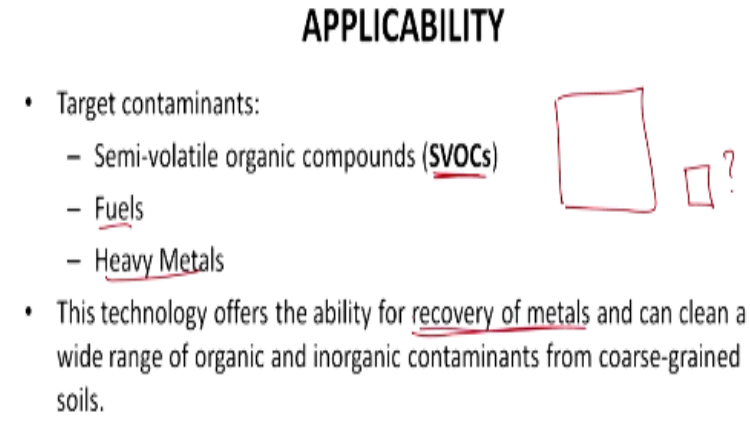

And as we discussed earlier typically worthwhile for again they say SVOVs because if it is VOCs in condition (()) (23:04) obviously you know they are going to volatilize and fuels and heavy metals right and again the issue here is that you are having a huge volume of contaminate soil and then a smaller volume that you treat further and how are you treating it you are not degrading it right.

You are changing the relevant phase let us say. So this particular technique of what do we say let you have or you know bring about recovery of metals based on the relevant treatment

technique that you have down the line right. So that typically adds to the you know increase the cost effectiveness of your relevant process let us say right. So let us move forth.

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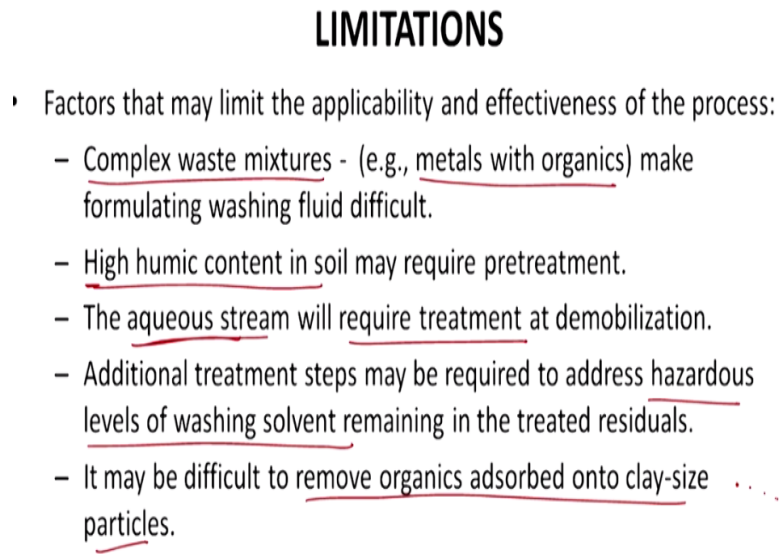

So what are the limitations obvious limitations as in when it is remarkably complex let us say when there are way too many metals and organics you know at the extreme end. Then obviously it gets difficult let us say right because even then even in such a case or in such a case even sequential washing or such will not help and high humic content in soil. So if soil have humus or such or humic content if I may say so right and not (()) (24:12).

So humic content again why is this or it is similar to natural organic matter if you can think of this. So this can bind heavy metals let us say or act as media for high content of organic compounds or such or hydrophobic compounds to be adsorbed on to right. So you need to typically look at that particular aspect let us say but the soil that is high in humic content is relatively present only in the top layer or the first few feet let us say right.

Again aqueous stream will require further treatment let us say obvious aspect that we discussed earlier. So again to address hazardous levels of washing solvent again that is something to keep in mind you are going to use different surfactants or washing agents again they need to be what do we say looked at let us say right. And again you are going to have to remove the organic adsorbed on to the clay size particles this will be an issue when the particles are much, much, much finer let us say right.

So in those cases let us say obviously getting the desorption to be relatively more effective is

sometimes tricky now right and obviously one other aspect in this context is that similar to your surfactant extraction or surfactant based extraction. You know surfactant they are typically in the groundwater you did not add toxic surfactants let us say you add bio degradable surfactants.

But here let us say here it is ex situ so typically people you know can have the option to go for surfactants or washing agents that are toxic if released out there let us say or exposed to human let us say, but you can you know you can remove them obviously right, but the issue here is that even residual levels of these toxic surfactants let us say can cause issues down the line when you dumped the soil if not dumped you know or you know replace the soil in its original location or such so that is again another aspect to keep in mind let us say right.

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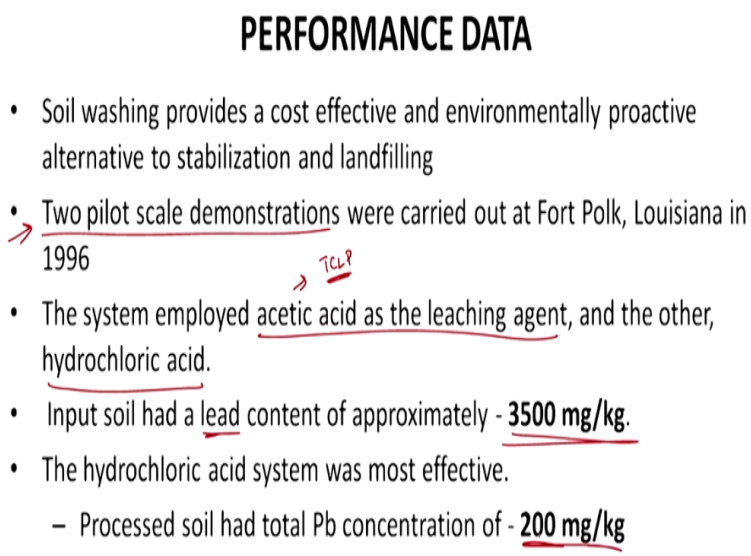

So performance data let us say right. So again 2 pilot scale demonstration again many such what do we say cases are out there at least a few full scale what do we say process too where let us say remarkably contaminated soil let us say right as in the spills was what do we say detected relatively early right. The contaminant has not been transferred over a wider area or it has not dispersed. So in that context obviously excavating the soil and washing the relevant soil is a better process and that is what people have looked at least in quite a few cases.

Here we are going to look at very you know few or some data with respect to the pilot scale demonstration so let us say. What did they use they used acetic acid as the leaching agent if you keep in mind let us say in the TCLP test let us say or if you can recollect in the TCLP test you have acetic acid as the relevant leaching agent right that is some aspect out there and for

the other they used HCL let us say right?

Input soil had lead content heavy metal contamination based on heavy metal contamination remarkably high as you can see right and the hydrochloric acid system was relatively more effective they say and it had lead content after treatment of 200 milligram per kg let us say right.

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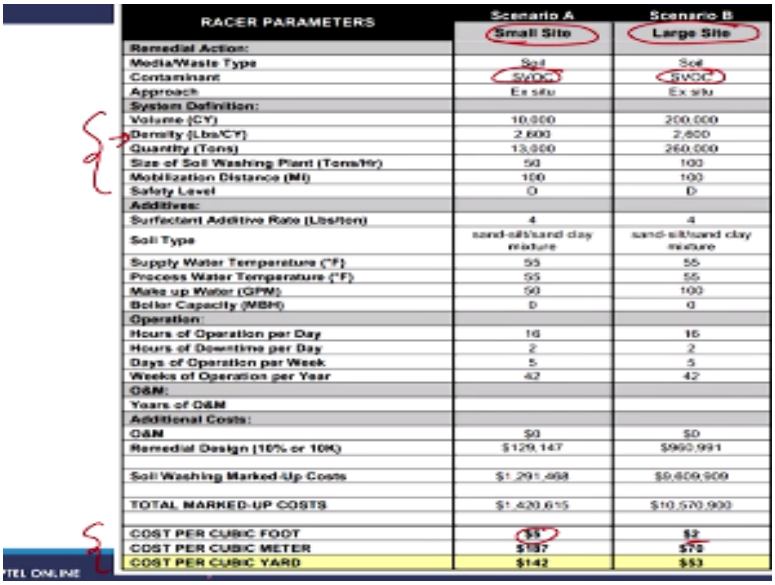

RACER PARAMETERS	Scenario A Small Site	Scenario B Large Site
Remedial Action:		
Media/Waste Type	Soil	Soil
Contaminant	SVOC	SVOC
Approach	Ex situ	Ex situ
System Definition:		
Volume (CY)	10,000	200,000
Density (Lbs/CY)	2,600	2,600
Quantity (Tons)	13,000	260,000
Size of Soil Washing Plant (Tons/Hr)	50	100
Mobilization Distance (MI)	100	100
Safety Level	0	0
Additives:		
Surfactant Additive Rate (Lbs/ton)	4	4
Soil Type	sand-silt/sand clay mixture	sand-silt/sand clay mixture
Supply Water Temperature (°F)	55	55
Process Water Temperature (°F)	55	55
Make up Water (GPM)	50	100
Boiler Capacity (MBH)	0	0
Operation:		
Hours of Operation per Day	16	16
Hours of Downtime per Day	2	2
Days of Operation per Week	5	5
Weeks of Operation per Year	42	42
O&M:		
Years of O&M		
Additional Costs:		
O&M	$0	$0
Remedial Design (15% or 10K)	$129,147	$960,991
Soil Washing Marked-Up Costs	$1,291,468	$9,609,909
TOTAL MARKED-UP COSTS	$1,420,615	$10,570,900
COST PER CUBIC FOOT	$5	$3
COST PER CUBIC METER	$137	$78
COST PER CUBIC YARD	$142	$53

So generic cost information as in you have a small site and relatively site and typically SVOC based on SVOC comparison and you know obviously different aspects such as density relevant aspect right. You know density obviously is going to increase the relevant cost (()) (27:35) is going to affect the relevant cost let us say and again different aspects. So one aspect is that as we come out here let us say let us look at this set of data now.

So for the smaller side you see cost per cubic foot is relatively higher or considerably higher and same case for obviously based on you know cost per unit volume is relatively higher in you know the relatively smaller systems let us see. So typically you know if you have one particular unit let us say and it is better to or you know you have one soil washing unit nearby let us say.

It is better to you know transport the relevant soil to that particular unit and pay the relevant operator rather than you building the relevant unit and try to you know wash the soil yourself or the relevant operator washing the soil himself or herself why is that because of cost as you can see let us say right. So that is one aspect to keep in mind. So I guess with that I am going

to end my session and my class.

So a very quick recap of some of our objectives here so the first objective was to familiarize ourselves with some of the laws that you know we have out there with respect to hazardous ways and relevant remediation and such and second aspect was to understand if the site is contaminated you know why do I need care let us say because there are risks associated human health risks let us say and we know now to calculate them.

So based on those risks we know to the extent to which we need to remediate the relevant site. So typically when we look at site we have you know contaminated soil or contaminated groundwater and in some cases contaminated gas too and we looked at various techniques let us say right at least you know we had considerable or relatively in depth overview of some and summarize what do we say overview of some right.

But you at least have now have an overview of most of the techniques out there that are widely used for remediation of contaminated sites now at least the objective from my side is that let us say you know such dissemination of knowledge let us say at least in India let us say where you know remediation is in it is an nascent stage let us say will allow for you know what we say more informed people to take worthwhile nations or let us say you know if you have the relevant knowledge at least you can push for remediation.

You know let us say there is myth or mental block out there that thinks that once the site is contaminated you cannot get things done or you cannot get it back to its if not (()) (29:55) to a better state let us say right, but as you can see now you know you have lot of techniques out there and lot more techniques coming up let us say that are used worldwide you know and often too right that are at your disposal let us say right.

So I guess with that I will end my particular course and before I end I guess I will have to thank my advisor Dr. (()) (30:16) and you know who was instrumental in providing some of the material for this course and thank you.