Geoenvironmental Engineering (Environmental Geotechnology): Landfills, Slurry Ponds & Contaminated Sites

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Lecture - 05
Waste Minimization by Integrated Solid Waste Management (ISWM)

Good day and welcome back to this lecture. This is the fifth lecture in our series on the course of geo environmental engineering. And the second lecture in the module on a design of waste disposal facilities or design of landfills. So, in the last lecture, we looked at generation of solid waste. And how we are placing it on the ground and one of the messages which you might have carried from last time was that we produce thousands of tons, thousands of million tons of waste per year in a country.

So, when we are talking about the quantity of waste. Typically for example, if you just look at ash we are dealing with maybe a 120 million tons per year. And if you are looking at mining waste, we are talking about 1000, more than 1000 million tons per year.

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So, how do we solve this problem? Waste as you put it on land accumulates with time. So, I start with a small waste dump, and over the years 2 things happen. We will take them we spend it in over more and more land can we find that the more land is not

available. Then it becomes higher and higher because we do not have more land. So, the waste dumps from higher and higher and you will often see waste dumps which look like huge mounds.

How do we tackle this problem? And one question which I put up in the last class was can we become a 0 waste society. So, somebody said yes. So, the title of today's lecture is waste minimization by integrated solid waste management. So, to look at this problem and this is a huge subject. Integrated solid waste management can itself a 42 lectures on it. And we do not want to get drawn into trying to become waste managers our job is to design waste disposal facilities which do not impact the environment around the place where these are disposed.

But nevertheless some of you said that we can become anybody who wants to say we can become a 0 waste society or a very low waste society. Tell me 2 steps which you think would help us become a 0 waste society.

Student: Source segregation.

So, source segregation. I do not know how it will make the waste disappear, but source segregation is an attempt to minimize waste, but still you segregate the waste it is still waste.

Student: (Refer Time: 03:25) segregation (Refer Time: 03:29) authentic and then base to energy (Refer Time: 03:31).

So, if I segregate waste into say 2 components, of the biodegradable and non biodegradables. Still I have 2 wastes. Then what you are saying is, I can send waste for processing to a composting plant and to a waste to energy plant. So, by waste segregation and waste processing I can minimize waste, but can I become a 0 waste society because even when you burn everything there is ash.

Suppose I burn everything, I still have some ash and is the ash hazard inert non hazardous or hazardous well some ashes observed to be hazardous some ashes observed to be non hazardous, but in the end I still have this ash and this has to be put somewhere on the ground. So, it is going to consume land. The only way we can say that we will become a 0 waste society is if we do not have any end product to put in a dump.

So, we have not reached that situation, but we are definitely trying to reduce the quantity of waste.

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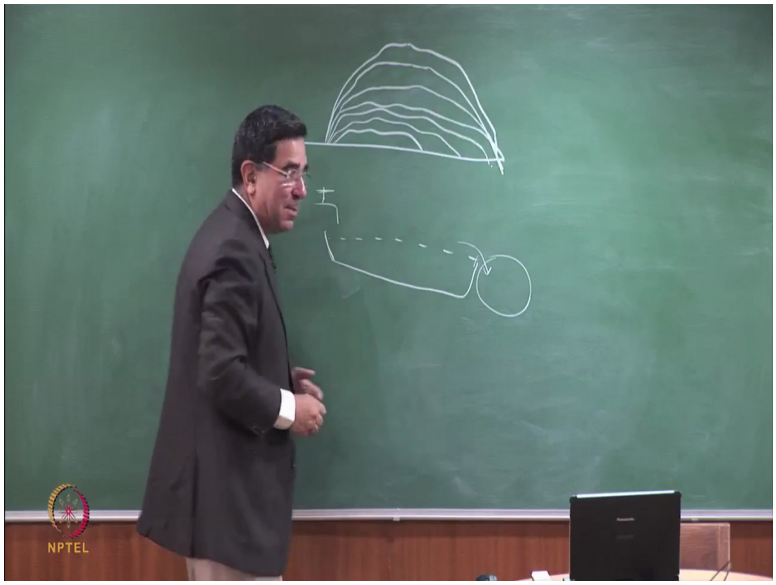

So, then what we are trying to says if I have a bathtub, which is full which is like the landfill capacity is full. And if the water is overflowing from the bathtub, I am looking for a solution for this problem. Now the solution is not to do a lot of engineering here water is coming out of the bathtub all the time you will say all right, get me a bucket, get me another bucket, get me another bucket, but that is not a solution to the problem. The solution to the problem is close the tap. So, waste minimization means please remember what is the important thing. The important thing is to close the tap. The important thing is to get as little waste out from your sources as possible. And if you do that waste gets minimized.

So, in the context of today's lecture, suppose today we are producing hundred units of waste, can we do various kinds of things and reduce it to half it is value or 25 percent of it is value or even law. So, that is waste management integrated solid waste management and waste minimization. Our job will always be that whatever waste is coming out we still have to dispose it on land and you should dispose it in a manner we do not affect the human beings and the ecosystem around it.

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So, the objectives are to minimize waste and effectively manage the waste still produce. So, integrated solid waste management recognizes that we will not in the immediate future become a 0 waste society, but let us reduce the waste. So, what are the steps that we can take to reduce the waste? Are these 1 2 3 4 5 steps. So, first step is waste reduction at source. Please produce less waste as a householder as a human being, and that is a big step forward, how can we reduce waste? We can reduce waste by using materials more efficiently, and making differences in the packaging, and we will come to that later, because much of the waste is the packaging of the products.

After waste reduction we can try a resource recovery through separation and recycling. So, what was said was it was said we should do segregation, we should do segregation and we should recycle what can be used. So, in current tech context glass can be reused metals can be reused. So, all the stuff which the kabaddi wala from the house takes away is the recyclable stuff the paper is being taken away. So, we can do resource recovery through separation and recycling if we mix everything, if we mix the paper with the food waste we lost it. So, keep it separate and send it for recycling. It has it is implications on the number of streams for collection that you have to set up. It is not that simple that you keep it separated it is, do you have separate streams to collect it and send it to the separate units which are going to use it.

If you do not, if you are not able to recycle something after separation can we do some waste processing and help further resource recovery. What are the resources we are talking of the 2 resources which we are using from the environment at the moment. Now we are using energy and raw materials. And we want to recover energy and raw materials and materials, which can become raw materials for the processes because then we will need less raw materials and less energy. So, can be recovered energy through waste processing, can we transform the waste. So, that it occupies lower land than it would have otherwise and finally, we do waste disposal on land. So, these are the options that we have to look at.

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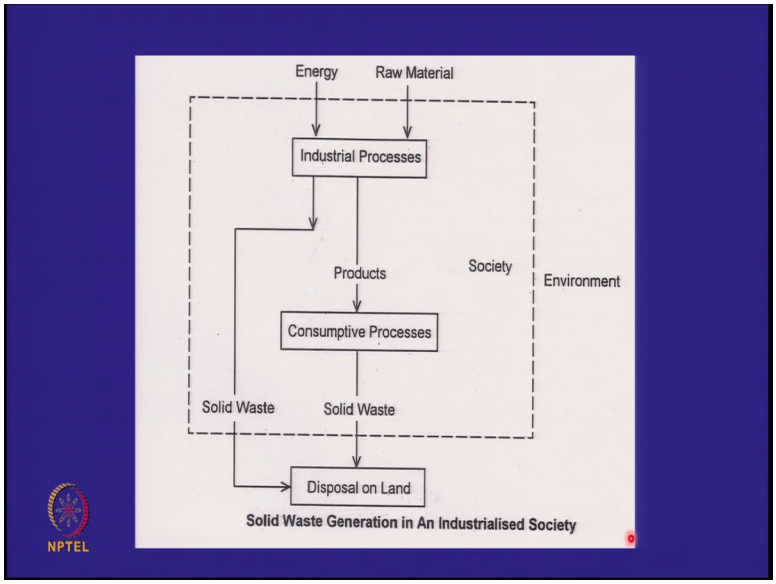

So, I we did this diagram earlier we are taking from the en environment energy and raw material and we are disposing the solid waste. If we are producing gaseous waste and if we are producing liquid waste, which we are, what is happening the gaseous waste is being treated and it produces solid waste. The liquid waste is being treated and it produces solid waste. So, all that is eventually permanently lying on the ground is the solid waste.

Just to recall electrostatic precipitators will reduce the smoke coming out or the particles coming out with the gases, but it will give you ash. Etp sludge is the output of treating wastewater. So, that the wastewater is not contaminated, but the sludge will have the

contaminants and all of them will come on land when I do integrated solid waste management.

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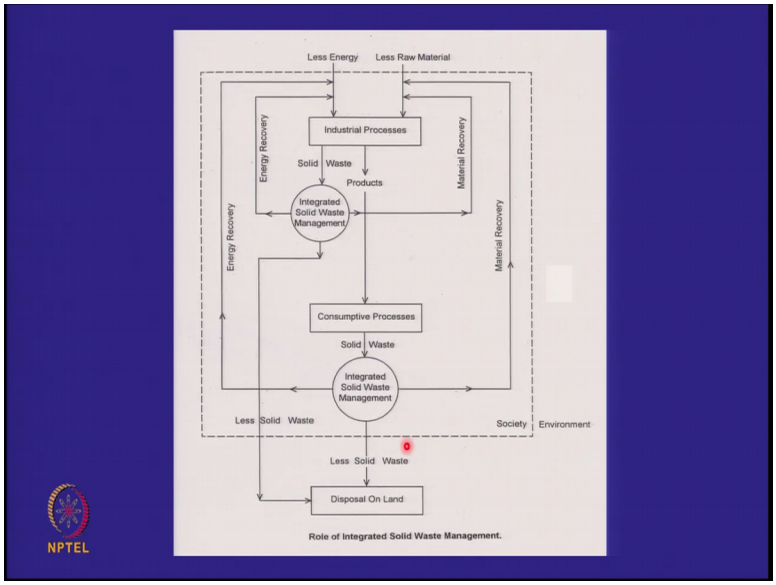

I look at the waste which is coming out from any process and I apply these principles, can we reduce waste, can we recycle it can we process it or can we transform it. So, if I am able to take out some materials suppose I am able to take out the glasses and the metals then what happens the glass industry now, gets an input from the recyclables. So, it has it uses less raw material.

Suppose, the waste which is coming out is paper and if I can burn the paper to recover energy, then the energy input to the industry from outside sources is reduced. So, integrated solid waste management means you look at all the alternatives and see how I can reduce the energy being taken from the environment and reduce the raw materials. Then I have the products, and then I have the consumptive processes.

Now here is where the municipal solid waste comes out. And here also we can apply the same principles, if I have municipal solid waste, what can I store separately what can I recycle for the materials and what can I recycle for energy recovery such that less energy and less materials. So, we get less solid waste to dispose on land the size of the landfill becomes less and we have less energy to be taken from the environment.

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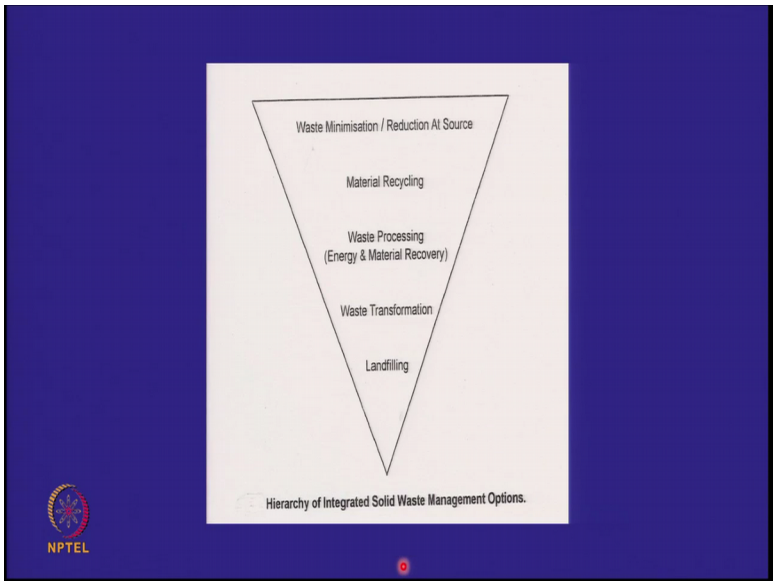

So, in terms of hierarchy, the maximum money should be spent if we are subsidizing or if we are catalyzing something. We are trying to invest as a government maximum money should be spent on waste minimization and reduction at source. The waste is not created then our problems are lesser.

If more investments have to be made they should be made in terms of material recycling and waste processes. Material recycling is higher in the hierarchy because here you are able to get the materials without putting it energy into the process. In waste processing you might have to put in a little energy so that you can recover the other things. Finally, waste transformation and land filling.

So, everybody agrees with this anybody has any alternate thoughts that no we could do it differently.

Student: (Refer Time: 12:25) processing (Refer Time: 12:28) different places like (Refer Time: 12:31) just slightly (Refer Time: 12:35).

So, the question is how many processing units where are they going to be located what is the optimal solution is that one big integrated facility or is it that small units are lying everywhere. Let me articulate that and we are not going to look at those solutions yet, but if I geographically or in plan.

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If I look at a city and the question being asked is there going to be one big facility with smaller facilities here, recycling waste processing land filling, or are they going to be different units spread around. Both solutions are being used in different situations. There is no one solution which is the ideal solution. So, you may have a centralized tsdf as I said treatment storage and disposal facility or you may have individual units all around it.

So, that will depend on how the plan area of a city and how large it is how larger the distances. If this distance is 5 kilometers there is one solution, but if this distance is 50 kilometers, then you have another solution. So, those solutions will be given to you by integrated solid waste management, where you can see how much of the transportation costs and how much of the processing costs.

Normally speaking today what is evident is that when you deal with waste they are all we are dealing with odorous compounds, it is better to put everything in one place. Because you can more intensively control, I thinks that the boundaries if you spread them at too many places and each place requires a environmental control stringent environmental control, but this is not the only consideration transportation costs and other things are major considerations which will which we have to take into account.

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How do we reduce waste at source? So, I talked about proper manufacturing and packaging of products for longer useful life. So, let me say again we come back to the example of shampoo, you are using shampoo. So, you buy a small bottle. In every 15 days you go and buy another small bottle. And then at the end of the year you have got as your waste, how many weeks in a year 52 and we are doing alternate week we are buying a new small shampoo bottle. So, we have got 26 small shampoo bottles.

My friend here he says I will buy my shampoo for one year in one go. So, he buys the large bottle, and the manufacturer who says I do environmentally conscious manufacturing says, I will give you more concentrated solution. So, instead of putting 4 drops of shampoo you can use one drop of shampoo right. So, he has a product which is manufactured and packaged for longer life and less waste. He may not have the money to buy it because he is getting is in a salary every month and for him to buy everything for a year, he may say no I do not have the money.

But the point is you can with proper manufacturing and with sensible efficiencies reduce the packaging. The other thing is you may go from toxic to nontoxic materials or you may go from artificial to natural materials some of the herbal compounds, some of the organic farming compounds. So, these may be producing less waste coming out of the system then we are very strong surfactants and detergents and other products which may be having a higher effect on the environment.

So, you may phase out the artificial materials by more natural materials. And you may do selective reuse of these materials as well again. Let us take an example you have a person who is making a packaging material. Now if the packaging material is recyclable is it better or is it worse?

Student: Is better.

Is better, so glass bottles are better than tin cans; you remember a time when all the beverages used to come in glass bottles.

Student: (Refer Time: 17:24).

And what used to happen all the glass bottles used to be collected back, why? Because you could just wash them and refill them now what is it we have got plastic bottles in tin cans, and do we give it back to the shopkeeper we toss it as if into the dustbin, as if by some magic they will disappear.

So, selectively reuse means use a packaging materials which can be used. And many countries are now making this last legislation, the packaging material will have to be taken back by the manufacturer, otherwise you have to pay a tax. Why should the municipality take care of the packaging material? So, maybe we will go back to glass bottles or maybe if you have plastic bottles, please take back your plastic bottles and recycle them wash them clean them and recycle them.

So, that is how you reduce waste at source. In some of the developed societies a huge debate is on the responsibility of the manufacturers. Then as I said resource recovery through recycling it is easier said than done, recycling is not that simple you have to keep each item separately, virtually the more segregated you are the more you can reuse. It now in a country like India where the kabaddi wala comes to your house you can take into each individual item he will take the glass bottle separately, he will take the tin can separately he will take the newspaper separately, he will he will take each individual, but in a in a more industrialized society, where everything is mechanized the tendency is you can keep them separate, but somebody is going to come and collect them a machine or a truck will come and collect them.

Now, if you have 10 bins. It is not only about keeping them separately you should be able to collect them and take them to different places for doing different things of them. So, the weakest link in the chain is, one the householder may not keep them separately is too lethargic or lazy to keep same things separately. The second is even if he does you may not be able to set up 10 streams for collecting different component of the waste because too expensive.

So, nevertheless, this is the area which requires the strongest funding other than waste reduction at source you do separate storage. So, now, some countries are 5 bin system, we are going we are trying to go from one bin to the 2 bin, briery size dry waste and wet waste, but there are some countries which are 5. I mean there is a hazardous waste which comes out from the paints, nail polish removers, lead acid batteries. They come out from the household the medicine. So, you have to have a hazardous waste bin. Then you have to have a recyclables bin the paper or the other stuff then you have a food waste bin. Then you have a metals and electronic metals bin, then you have an electronics bin

So, you have 5 bins. Adoption is not very high still in these various countries, but they are trying to go towards that system. Then once you are taking these you have to process these and remanufacture. It is not just you will take metal and it will get recycle you have to go through a process of removing the paint, making a new a can out of it or if you have a plastic bag, you can melt it and reuse it, but the recycle bag? How do you know you are using a recycle bag? What is the colour of a recycled plastic bag?

Student: Green.

Very ambitious, which is the color which is the easiest to manufacture, why it is the most difficult?

Student: (Refer Time: 21:17) black.

Black; so all the black tallies that you get for putting your garbage in it, progressively the color which is mixed with the plastic keeps on making the bag darker and darker and eventually the recycled plastic looks black.

So, remember that in all probability the transparent or the white plastic is the original plastic and the recycled plastic is black. So, you can recycle it, but how much can you keep the color away from the plastic, and all these materials can be recycled.

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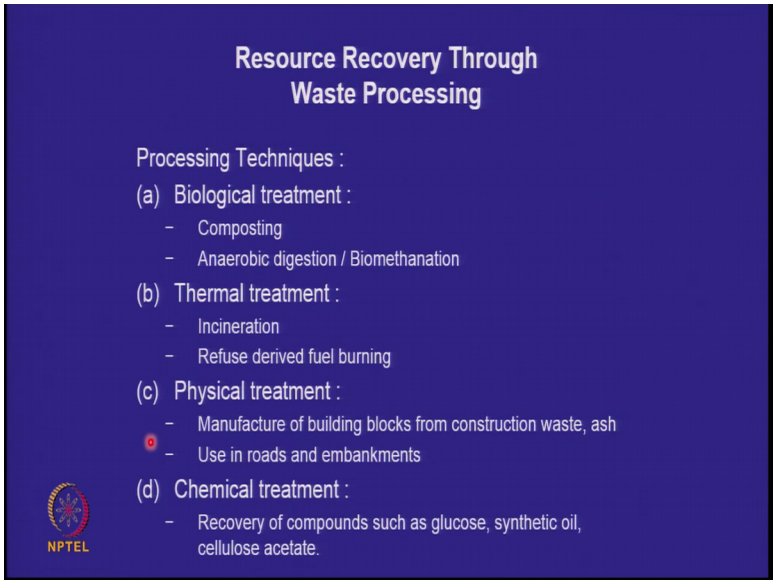

And of course, if I want to do further recovery, I mean our food waste I cannot recycle food, but you can send it. I mean the hostel food where does it go the food waste from the hostels all the food which is leftover; if the food is left, there 2 kinds of waste. One is the excess food. So, in the excess food can always be sent to a underprivileged, you can work out a mechanism that it can reach the underprivileged people, but if the waste which has gone into the dustbin where does it go.

It can go to a piggery, a pigs can eat it or animals can eat it, but then again you need a separate collection and transportation and delivery system. You may be here and the pigs may be 25 kilometers away right. So, anyways after recycling and reuse you can do re processing. So, you can convert your municipal solid waste into compost by aerobic processes and anaerobic digestion. You can do biomethanation, a methane can give you energy you can do thermal treatment, you can burn it you can from the municipal solid waste you can take out the paper and the plastic and the rags for refuse derived fuel, which can be used for energy recovery. If you have ash, if you have construction and demolition waste and you use it from building blocks, can you use the ash in roads and embankments. If it is not hazardous instead of using earth which you will dig up from

some farmers place can you do that? And you can also do some chemical treatment for recovery of compounds.

So, all these resource recovery processes require more investments in terms of giving energy and materials to make this happen, but in the end the recovery bills do outweigh the investments which are made.

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After this we may want to we may still have some waste left and we might want to transform the waste. For example, you might want to shred the waste to make it into smaller you have large sized waste, you can shred it or you can grind it. You can do size separation through screening, mixed waste is coming to you to a site, you do screening. The waste which is more than what is the signs, how many mm is this or how many centimeters of this?

Student: (Refer Time: 24:25).

So, let us say this is 4 inches, 4 inches how many mm.

Student: (Refer Time: 24:30).

So, anything about hundred mm maybe it will be only C and D waste which was mixed wrongly. So, we can do screening and from the screening you can transform the waste by getting separate fragments. You can do volume reduction your waste is very loose you

can send it through compactors to reduce the bail them and to make them into denser arrangement. You can stabilize the waste, the waste is hazardous you can mix it with sainly cement, and lime such that the toxicity goes down because the cement will react with the matrix. And when you do a leaching test that much hazardous material will not come out and you can also do encapsulation; that means, you are very toxic waste you can embedded in the middle of a brick or into a glassy matrix. So, that it does not come out.

So, waste transformation is the next step after waste processing. And then finally, of course, you will do the disposal online. So, for the solid waste that cannot be recycled a processed, you see every waste when it goes to a plant do not think it vanishes. Suppose waste goes to an incineration plant and they will burn it. Firstly, the incineration plant Paulo will say, I cannot take all the waste I will do pre processing. So, he will do pre processing, he will remove the construction in the demolition debris which is mixed with all kinds of stuff, he will take the final fraction he will burn it ash will come out.

So, some of the waste will get processed and reused, but there will be rejects. So, from each plant you get rejects the rejects have to come for disposal to the land. So, waste does not vanish, if you send it for processing. Some reject still come back to you all the time. So, for the solid waste that cannot be recycled a process you will dispose on land and for the residual waste after all types of processing have been undertaken; that means, all the rejects coming out of the various plots. And this is an interesting table, we will come back to this first. So, there are 2 components of the waste which is disposed of on land that waste which cannot be used for anything.

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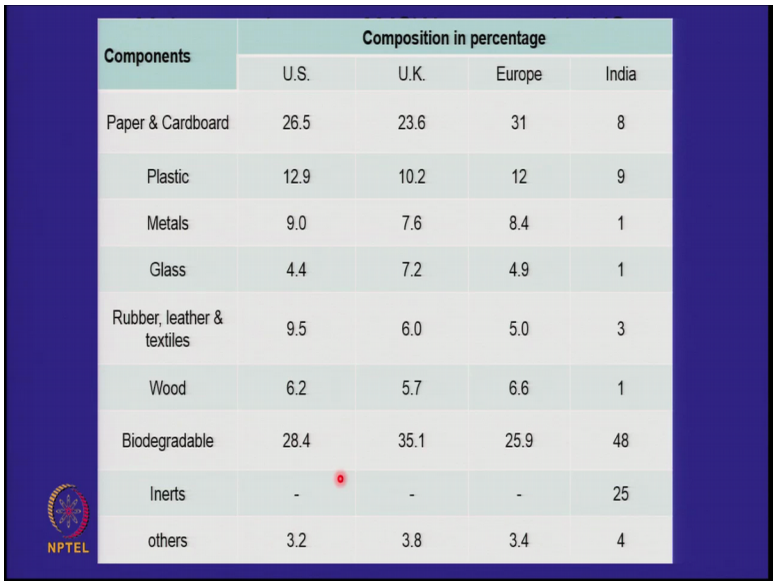

Components	Composition in percentage			
	U.S.	U.K.	Europe	India
Paper & Cardboard	26.5	23.6	31	8
Plastic	12.9	10.2	12	9
Metals	9.0	7.6	8.4	1
Glass	4.4	7.2	4.9	1
Rubber, leather & textiles	9.5	6.0	5.0	3
Wood	6.2	5.7	6.6	1
Biodegradable	28.4	35.1	25.9	48
Inerts	-	-	-	25
others	3.2	3.8	3.4	4

So, the waste is very intricately mixed and you can see the components on it, you know, but you know you have a tea bag mixed with your food waste mixed something else I mean unless you actually go into it cut the tea bag and remove the stuff, you know you have you have your waste which is in a plastic bag, and the plastic bag is closed from the top and dumped into them. Unless you to shred the plastic bag you cannot go inside to remove wastes inside it is complex the more you mix the waste the more useless it becomes it is no not possible to get the constituents back again from it.

So, there will be waste which cannot be recycled or processed. All industry will say this is not good enough for me. And those which can be recycled and processed there will give you residual waste that will also come to the land. So, if I look at the type of waste which is coming out in different countries, this is the components you know in this is municipal solid waste paper plastic metals glass rubber leather and textiles wood biodegradable inerts other. So, first remember inerts is not like true inerts it is like construction and demolition waste.

So, if I see India here, and if I see us UK Europe you find lot of paper and cardboard here, but not here and the answer to that is the kabaddi wala system the household collection individual collection system our paper goes to that. Plastics are similar nobody wants these fine glass specially these thin bags, they are very little recyclable value. Anything which are the recyclable value will be taken away. So, metals also you find in

India they go down. Glass also in India your beer bottles or your any other bottles they go down.

So, rubber leather and textiles I think is underreported in India we think this is higher this would also be about 5 to 6 or 9 percent in India especially the garage which are there wood is also had. In fact, these figures are probably a little under reported, but nevertheless we will take them at this value, but suddenly you find because there are. So, many other things in the waste of other countries the biodegradable component is a little low right, whereas, in India the other components have been reduced by the kabaddi wala. Therefore, the biodegradable components are high.

So, Indian waste is the wet waste it is called the lot of food waste in comparison to other countries. And if you have a lot of paper and cardboard and plastics, you can burn that it will give you energy. If you do proper control for dioxins and everything, but if you have low quantity, then it may not give you energy unless you segregate. So, and the other thing which you see very high in India is the construction and demolition waste. In the developed world there is a separate stream for collecting this, and this is a well set out industry you will recycle your C and D waste. You have C and D waste processing plants where as in India we are just starting; so at the moment almost all the waste which comes as about 25 percent construction and demolition waste.

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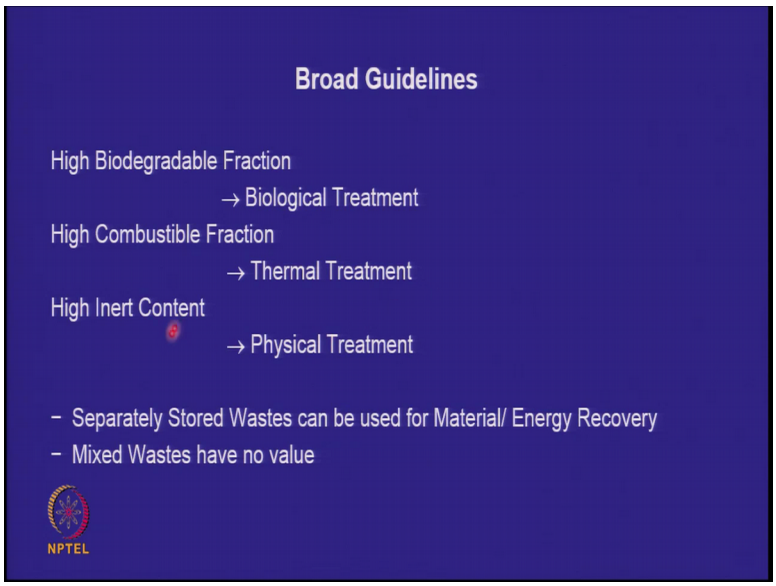

Any observations on this table anything you had like to discuss? Any clarifications? If you have a high biodegradable fraction, the optimum route is to do a biological treatment. And the optimum route is basically composting here. If you have high combustible fraction, the optimum route is to go for energy recovery by thermal treatment; that means, incineration you burn the combustible material. If you have high inert content do physical treatment, make building blocks make embankments.

So, you these are the broad guidelines which we have. And the important thing is if the waste has been stored separately into the separate fractions and if you have the streams to collect that, we can use it for the purpose; however, if all these components become mixed with each other. All these components become mixed with each other then it has no value. And an important example is that about 25-30 years ago oh the first waste to energy plant was set up in Delhi by oh international funding, but nobody realized that this that the technology that they were using was coming from Europe and the US, but the nobody realized that we have no energy content. And you know this error can be made if your sample size is not large. Typically, if you want to find the energy content of municipal solid waste what should be our sample size?

In soil mechanics what is your sample size if you want to do liquid limit plastic limit, how many grams.

Student: (Refer Time: 32:12) 30 grams.

Well later I take 100 grams, be on the safe side. 100 grams will come in in my hand now I am trying to make you visualize you want to characterize municipal solid waste, what should be the size of your sample, in terms of volume or in terms of weight, the 100 grams, you want to take one kilogram is that a good size to,

Student: (Refer Time: 32:44).

anybody 100 grams was for soil 200 grams for a tri axial test, 2 kilograms for a proctor test that is the kind of sample size that we are talking, about how much for a municipal solid waste.

Student: (Refer Time: 33:02).

Well I would like to take the municipal solid waste which is at least one cubic meters, one meter by one meter by one meter. Why? Because it is very heterogeneous, it might have a huge boulder it might have a broken piece of your window a broken piece of your chair. So, it might have large size material. So, if you take hundred grams and go and do the energy content your reading is not likely to be correct. So, one of the reasons at that time I think there was an error was that the sampling was not large enough to represent the energy content of total waste. So, plant was set up and it never was able to recover energy.

Student: (Refer Time: 33:41).

From it: so it is important to understand that if you store things separately and if your energy content is good you can get energy out of it. Mixed waste really has no value. Can we unmixed it the question always there is can we unmixed waste, yes I can grossly unmixed waste. I can do screening I can do magnetic separation, I can do air separation, but I cannot intimately unmixed it. I cannot remove the tea from the tea bag and say my paper is here and my tea is here or the thread is here.

So, unmixing is difficult

Student: (Refer Time: 34:22).

Separation or sorting of mixed waste is tedious. It is expensive and often non executable.

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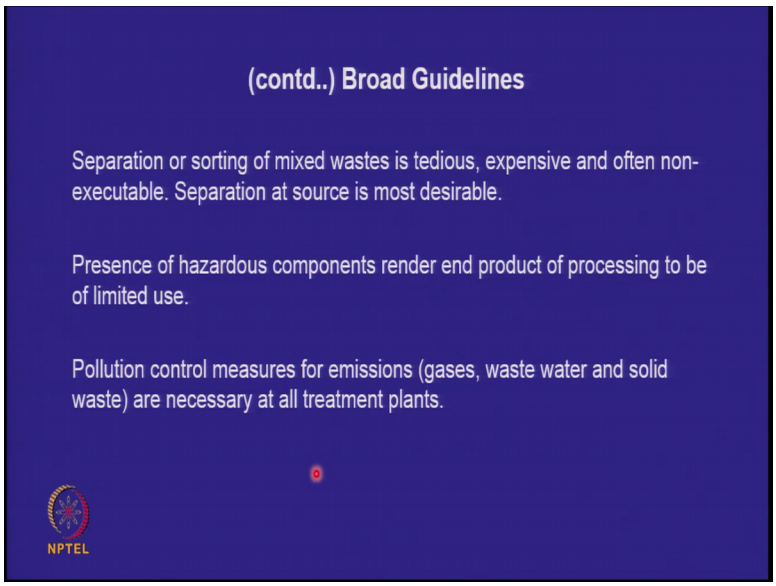

So, separation of the source is most derive desirable, but that depends on the person who is producing the waste. And secondly, it depends on who is going to collect the separate streams the municipality is therefore, must have the separate systems for collecting and working on that; that means, if I want your construction and demolition waste separately I must be able to get it from you and my stream must go to a C and D plan.

The other issue is that if there are some hazardous components. If you mix your hazardous components into your non hazardous waste, you render it hazardous. So, presence of hazardous components renders the end products of processing to be of limited use. Let me see; I will look a composting to my biodegradable fraction of municipal solid waste. Now the compost must meet my standards set up for applying of fertilizers and composed to crops to grow crops which are going to be consumed by you and me.

So, the compost must have heavy metals within a limit and certain other things within some limits. Now if you all if you by mistake mix up the waste and make a compost of mixed waste, it may not meet the standards. So, it may meet the standards in the industrialized world there are separate standards for compost which can be used for flowers and gardens which are not going to enter the human chain, whether we the compost which can be used for crops which are going to be consumed by human beings. So, maybe the compost might meet a lower standard, but the very stringent standards you then should be very clear that there should be no hazardous component to it.

And the more processing devices that you set up, the more is the odour issue that you are handling. Always has a smell. You go to any area you go to an industrial area and you start getting a particular smell in the indust in the air. And that that is the smell because of the gases coming out of the chimneys, and you go to the waste dump and that smell will be all pervasive. Now you say I will send this for waste to energy, I will send this for composting wherever you send it you create more odours, whenever you send it you create more odour, and then you have to do the odour control.

So, pollution control measures are necessary at all treatment plants when you keep on hearing about some residents being up in arms against the waste to energy plant in okla or the composting plant in the newspapers, every now and then. Why because they are bothered by the odour. So, ideally these should be far away typically odour will travel 3

to 5 kilometres from a facilely. Either you should have very stringent odour control mechanisms which are expensive or you should be far away. So, these have to be taken into account.

So, all that we are saying is that this integrated solid waste management is very important. It can be done at the household level which is the best.

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But then you are dealing with tens of thousands of people and making them you know fall in line. It can be done at the community level; you may say all right I will not do. So, much at the household level, I would like to do composting at the community level or waste to energy of my society. I will do bio mechanization and take the methanol. Or it can be done at a central level in a city or it can be done at a central level in the city.

So, for the big cities a lot of demand for centralized facilities, which should be a little away from the city, and we should do everything in a mechanised manner, but in the smaller cities one can look at household and community level initiatives. So, the ultimate integrated solid waste management system comes in looking at the alternatives at all these 3 levels and then arriving at the solutions for your integrated solid waste.

If you invest in all this, then the amount of waste reaching the land is lesser. So, let us land area is used. And the height of the dumps becomes smaller. So, we will carry on this discussion about integrated waste management by looking at some recent initiatives

which we have started. We look at some examples where this is working beg beginning to make an impact and the waste reaching the sites is reduced, but for today we will stop at this juncture, and I will be happy to take any questions that you may have at the stage.

So, we started with the thought that can we have a 0 waste society. So, after this discussion how many of you think we can have a 0 waste society, where is your hands. We are a class of 15; let me see how many hands think. One of us thinks that we can have a 0 waste society, wonderful. How many of us think that we can have a low waste society low waste? So, 14 out of 15 think that we can have a low waste society. And what is low if today we are producing 100 units of waste, our target should be that that 100 should become 50 in the near term and perhaps 25 in the long term. And by that time maybe some treatment techniques would have come a low cost low energy treatment techniques where we can actually make all the waste disappear. And then we can have a 0 waste society as one or some of us are optimist about it.

But you know you keep on reading about these experiments that people live together for 365 days in a dome and they wanted to see whether they can live without energy and without raw materials from outside. How many of you saw the movie the Martian? In that Martian also he has to set up an ecosystem, where he has to sustain himself without energy and without raw materials from outside. That is the dream that will be a 0 waste society and there will be no waste.

Till that time environmental geotechnology or geoenvironmental engineering we will continue to remain a important subject, and we will discuss that in the next class.

Thank you.