Non-ferrous Extractive Metallurgy

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Lecture No. # 36

Energy and Environment Related Issues in Nonferrous Metals Production (Contd.)

Good day students during the last several lectures, I have been discussing issues related to energy and environment in general, and also sometimes with specific reference to nonferrous extraction processes. This will continue for another three or four lectures, because there are lot things I would like to communicate to you. Maybe, someday some of you would be in a plant which is dealing with nonferrous extraction processes, I would also like to tell you what would you do, if you are manager of such a plant. What procedures would you adopt to check environmental degradation.

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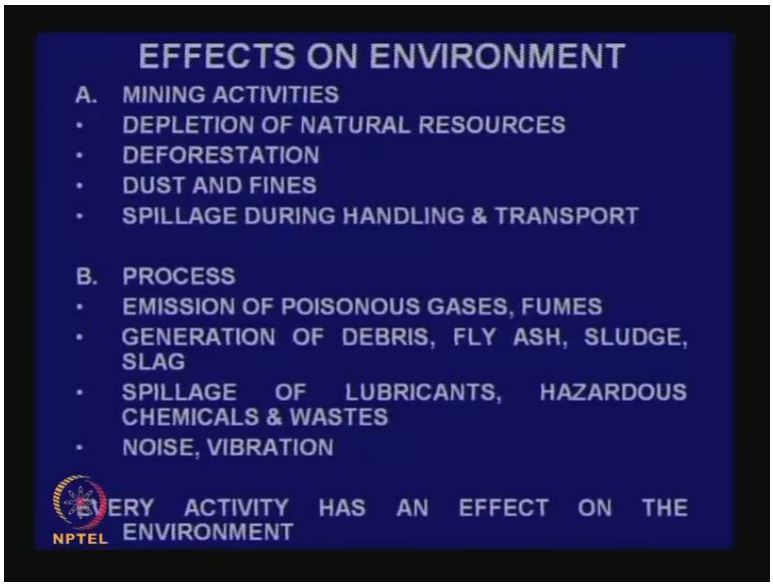

Now, let us come back for a quick review of the effects of extraction processes on environment, I mentioned this before, but let me mention them once again. Look at the slide, to start with, we have mining activities which is causing depletion of natural resources, deforestation, dust and fines, spillage during handling and transport. When we come to the actual process there would be emission of poisonous gases, and fumes, generation of debris, fly ash, sludge, slag all kinds of solid wastes, there will be spillage of lubricants, hazardous chemicals, and wastes many liquid form there would also be noise, and vibration which sometimes we do not take note of.

But noise and vibration - vibration also causes noise, create noise pollution; it causes discomfort, it is not good for proper work environment. So, they also go into the category of environmental pollution as we defined earlier. So, every activity from mining to processing has an effect on environment, there will also be effect of downstream processes, where after having produce the metal in the bulk. We go for making intermediaries or consumer products there would also be effect on the environment.

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So, every plant has to have an environmental policy not only, because the government and other regulatory authorities want them to, but hopefully the management should on its own have an environmental policy, because as I have mentioned earlier. Spending some money for combating environmental pollution, actually brings in benefit in the long run. And we have discussed, what are the benefits that come when the environment becomes better.

Now, the awareness is growing there are training programs, there is pressure from the government from the society from NGO's from national international international bodies. So, it becomes imperative, that every industry has an environmental policy. More so, for metal extraction process is which tend to be the most polluting. Now, a policy would involve the following: First of all, the management has to set objectives and target review, it is not enough to say we would be cleaner or our operations would produce less wastage or we will use less energy without sacrificing production; these are qualitative statements, this will not do anymore.

You have to have set objectives that if we are using so much of energy today will cut down by 10 percent within the next two years. If the air pollution values are so and so, at certain locations within the factory premises, and outside will improve our operation so that the values would come down to some specific values.

So, we have to have set objectives, these are the targets. That the environmental policy must list down, and this these targets must be reviewed from time to time; that how we said good enough targets, do we need to revisit the targets can you do better or in case we are not able to meet the targets, where the unrealistic in that case should we change them again. But more important, I think the thinking should be there in the first place which are realistic targets and which are not only realistic, but which are desirable targets. And the subject of review would be to see, if we have failed to meet the targets why we have failed to meet the targets? If you have done better than what the targets demanded, then you must make the targets stiffer; it is like the changing of the goal posts. As you go near the goal post, we say the goal post is to close so, move it behind.

So, this is always happening in the industry. So, not only set objectives, but review the targets. Then according to the set objectives, and reviews we operate to comply with laws statutes, and regulations. Not only, we comply with what we have set for ourselves, they cannot be different from the laws statutes and regulations set by the government. Ideally your objective objectives should be to reach a situation which is better than that demanded by the laws and statutes, and regulations; that should be the minimum, but any sensible company would like to do just not comply, but do better than that. And to do that we have to have plans to reduce consumption, and wastages we should have a policy to recover, and recycle the material wastes; please ignore that e in front of r recycle material waste.

We must phase out pollution prone processes, that will be part of the environmental policy, that the processes which are pollution prone must be phased out, and upgrades technology. An example, that I have quoted earlier, and I can quote again in the copper metallurgy the traditional roasting reverberatory smelting processes were extremely pollution prone. Not only they generated pollution, they also wasted energy

So, the technology was upgraded to flash smelting, and in some other countries it has gone to the level of continuous copper smelting. The policy has to do something about rehabilitation of waste dumps in many industries for decades together wastes have been dumped, a policy has to be found to clear those dumps.

This is happening in many steel plants, where for years these dump they dumped at one place slag from the blast furnace, elsewhere slag from steel making furnaces. And I

remember when you go into steel towns specially once that the older like Jamshedpur, there were hills actually; hills were were slag dumps. And there were a railway tracks on top of the hill the ladles will bring in slag, and dump it. So, periodically the hill would become higher the railway tracks would go to higher level, and the hills went on rising and rising in height, but now they have taken policies to make use of what is there in the hill. So, that the hills gradually come down and disappear.

Today steel plants do not have these dumps in and around the works, but in many of our nonferrous metal industries, there are dumps. The synthetic rutile plants I mentioned which is rejecting iron which may not be they are may be a small dumps, I may not call it a hill. The red mud from aluminum industry they are not making hills, but they are in ponds, there are huge lot of them. So, we have to find something about rehabilitation of waste dumps. So, that we can reclaim the land, that they have occupied maybe we can find good use of them which will be profitable for the company. And lastly, the environmental policy must aim at developing awareness amongst the work force, because the policy should not be only the policy of the management. It has to permeate down to the work force.

It is very similar to the quality policy, that many industries have now adopted when we were students 40 or 50 years ago; there is to be in every industry something called manufacturing industry quality control, and repair. So, the products were produced they came to the quality control and repair section, they checked it whether they are fit enough to go the market, if the product was not fit enough. First they tried to repair it, if it was beyond repair, it was sent back to the works to be used as scrap Now, this quality control, and repair section was a very important section sometimes it accounted for one third of the work force or the or the or the materials that that they consumed, it is very important.

But eventually it was understood, that if you have a place where quality is being checked. The rest of the plant thinks quality is not their concern, they just want to produce, and let them do the quality checking.

So, the entire operation became error oriented - defect oriented. So, in the last 40 years things have changed; we do not check the quality at the end, this will be end of pipeline solution. The idea is to have a control of quality from the beginning itself. So, that we

ensure quality in every stage of the process, and we do not need an end of pipeline solution. For that there has to be awareness amongst everybody at every level in every step of the process. When we want to do something about the environment the approach is something similar, we cannot have end of pipe solution. That let anything that is happening, let everything happened and then we worry about control after things have happened.

We would have to ensure a concern for the environment right from the beginning, and that cannot take place unless the workforce is (( )) made aware.

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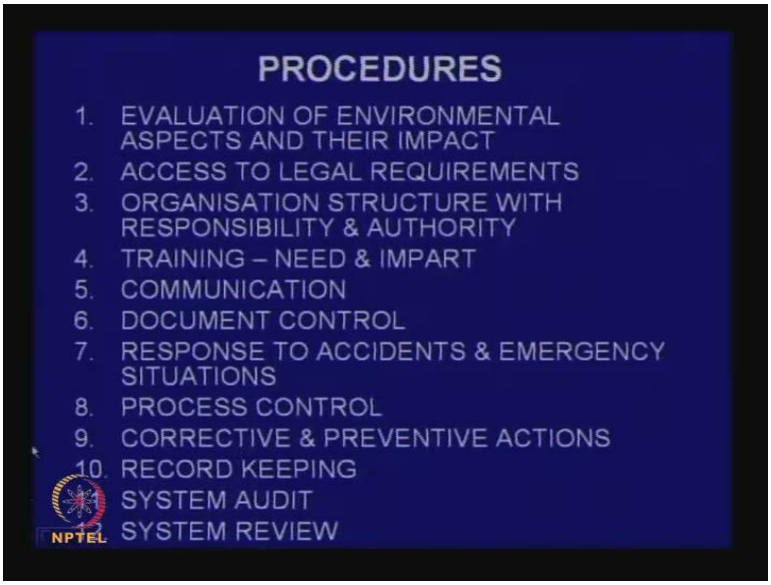

Now, when you have a policy, there has to be a procedure for implementation of the policy. And the steps in that procedure for implementation of a policy are as follows: There has to be an evaluation of environmental aspects and their impact, we cannot talk about a policy unless we have facts and figures. So, you find out the environmental issues, and what impact they are making, we need to have access to legal requirements, because we have to comply with legal requirements. All the literature has to be made available documents, statutes, laws - they would should not only be available, but people management as well as people down below must be made aware of these.

Next, there has to be an organizational structure with responsibility, and authority. If you want to implement something, it cannot be a wishful thinking (( )). You need to have a

structure people in places of authority with powers, they have to have all that is necessary in terms of incentives, and this incentives to enforce what needs to be enforced. If through awareness or through education, otherwise enforce very strictly using the authority given. So, we need organizational structure with responsibility, and authority. There needs there has to be a training, that you cannot impart something unless those who have to accept that know what is to be done.

So, down below from bottom to the top, there has to be training need need of training, and how to impart the training which would have to be based on communication day in and day out. And that has to come through commitment from the very top of course, the managing director cannot go and talk to everybody, but he has to talk to the colleagues one or two ranks below, they have to go and talk to people below them. Even the top can meet the rank can flying flies sometimes and talk. So, there has to be a lot of communication, and things cannot be only verbal; there has to be document control everything that needs to be discussed and communicated must be documented, and discussions or awareness programs will be based on the these documents.

Which means there have to be different kinds of documents; the documents you make available to the top management will be different from the documents, you make available lower down things may have to be written in very simple language for or the labor in the shop floor. They also then feel enthused, they become part of the big thing.

Let me tell you a story here, they wall were some stone cutters; cutting stone in a quarry. Somebody went and asked the stone cutter, what are you doing? So, the stone cutter said well I am an illiterate man, I cannot do anything for a living I am cutting stone just to make a living. So, that I get something to eat today maybe I save something for tomorrow. Here is a man who is doing the job, because he has to do the job. He goes to the second stone cutter; the second man says look I am cutting stone, and I am very good at it. You go anywhere, you find nobody can cut stones. So, beautifully and so efficiently, so fast.

So, here was a man doing the same job, but he had a pride in his work, he wanted to make him better than others. So, he he he was one step higher than the other fellow who simply resigned to an activity. Then this man goes to a third fellow says, what are you

doing? He says, I am building a temple; he is doing the same job, but he sees it as part of a big project in his mind, he is become a partner in a big project.

Similarly, when we talk about an environmental policy, we have to give to the work force a big vision; they should not do something just, because they have been told to do or somebody should not do it, because he thinks he can do it better than others. He or she in the work force has to believe that he or she is part of a vision, part of trying to create a company which will be cleaner company more labor friendly, more friendly towards the society more tuned to the future. It is not only for making profit. So, that vision has to be given through communication and through document control.

Now, to ensure that the policies etcetera are well taken, and well imparted the management also has to be responsive towards the people. So, there has to be response to accidents, and emergency situations which may or may not arise out of defective technology or environmental problem.

But there has to be quick response, there has to be strict adherence to process control, because no matter what technology you put in to an industry to control things. And very often you know things when they are in control is when your environmental problems are less, even when you are driving a car; the maximum pollution is generated during start up, and acceleration when the car cruise at a steady speed uniform speed it does not emit that much of polluting gasses.

Similarly, in an industry if things move smooth smoothly. So, the undesirable effects are less, but if things are bumpy that lot of production one day less production today, the quality is changing output is changing, then you create disorder you create more pollution also. To make things steady we need process control, and computerization that has been introduced today in many industries is ensuring that. The things go on smoothly you bring in raw materials of a consistent quality, the operational parameters remain constant, the product goes out with a quality that does not vary too much with time we need process control.

We need corrective and preventive actions that may be necessary, and we must have record keeping everything that is being done. All analysis of input materials, all analysis

of products, all data regarding the parameters that have been set for the process, they must be recorded.

Because in future, if you want to make further improvements or if you want if we are to analyze some undesirable effects, you cannot do so unless we have records, because we have to refer to the records and see what went wrong, and what needs to be set right.

Then there is called systems audit, and system review. I will discuss that little later by the word audit we mean a scrutiny an analysis of every step, and every detail with reference to a particular goal. Like if you want to do financial audit, then everywhere you find how the finance has been handled; if you want to do energy audit, then you go to every section you collect data to see how much energy a section has consumed in comparison to another section, and that comparison to another section.

So, that we can make a comparative analysis, and see if is anybody wasting energy; see if you go to a steel plant it is well known that maximum energy is consumed in the iron making section. We the figure is more, because we are consuming coke which is a form of energy.

Next would be rolling mills, in steel making less and if you go to the ore beneficiation section it is even less. Now, if you want to save on energy its only when you have this data through energy audit, that you would know where we should put on priority. In an office building, if you want to save on energy we do an energy audit in different divisions. And you can find out which division is consuming for too much, then we tell go and tell the division look there is a problem here, let us analyze.

So, unless you have the audit for the entire system we cannot improve the system, and after you have done the audit we have to review the function then with the whole system, that is what is called systems review.

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What are the environmental aspects that an environmental policy must take into account; there will be emission to the atmosphere discharge of waste water to water bodies. So, we cover air water then waste management, and disposal solid waste management and disposal. Then there is another category - special category called management of hazardous wastes which could be solids or liquids or gases. Hazardous waste substances means of particular nature, which have more adverse effects on humans, animals, plant or property hazardous. We talk about contamination of land are we introducing into the land something which is a contaminant, we need to talk about think about noise, odor, dust, vibration.

We need to consider use of natural resources particularly energy sources, can we minimize can we go for alternative resources, and likely breach of legislature procedures are we sticking to the legal requirements.

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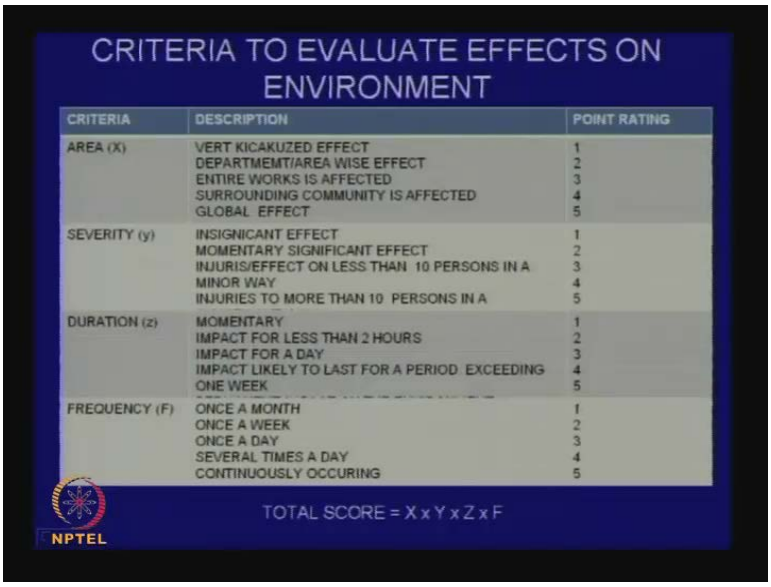

Now, here I come to an extremely important subject. This you may need, if you are in any plant, and so you better try to understand. How do we said criteria to evaluate effects on environment; there are environmental problems gasses, water, solids - we know they are bad, how do we know how bad, because unless we measure we do not know how to go about remedies.

A German philosopher once said, and that has been repeated by many people; that you have to first define, then you have to measure. Once you can define, then only you can measure; and once you have measured, then only you can analyze. And when you have analyzed you can control, and when you can exercise control you can improve things. So, there are 5 steps: You must define, you must measure, you must analyze, you must control, and then you improve.

Now, in my lectures on energy and environment environment, I have been trying to go through the steps I have we have defined things about measures, I have not discussed much we have talked this and that and everything, but how do you go about measuring.

A simple way of doing that is by looking at the response that pollution is bringing in the work force or amongst the experts instead of analyzing how many diseases it has made or how much how much damage it has done to buildings, animal, plant ,etcetera, because that will very difficult to estimate quantitatively. So, we have an indirect procedure, and

this procedure is shown in this table; this is what many plants actually practice to measure the effect of the pollution, that is there in their plant.

Let us see how they go about this. There is an elemental subjectivity mind you, there is an element of subjectivity, but then when a good number of experts are giving their opinion discussing among themselves. Then the subjective opinions begins to become for more meaningful. If you look at the procedure, you will begin to admire the inherent worth of it. We first said the criteria of the effect on environment. What is the area? That is effected by the problem, we have in the plant.

Suppose we have an operation which is generating whole lot of dust, we have to find out how much of area is effected by that dust generation. Then, what is the severity; they would again be defined in the next column, but see the first the main criteria - area affected severity of the pollution effect duration is it happening only for a day, for a week or more, and then frequency. How frequently does it take place? This has been devised in a very famous industry, I would name it because they may have changed by now, and I like it. Now, let us see let us see now, these have been further identified area very localized effect, there is a spelling please I will have to change this, very localized effect is happening in a very small area.

Departmental or area wise effect slightly bigger entire works is affected, surrounding community is affected; there is a global effect. Like if you generate CO 2, there is a global effect, but if you are generating dust from a container it is a very localized effect. There could be something which has effect on the department some may be on the entire works, and these are given different values, localized effect one departmental or area wise 2, 3, 4, 5; these are arbitrary.

You could say why not 1, 4, 9, 13, 18 you could do that, but it is a question of grading, and after lot of discussion they have said this is good enough. Like you know even in academics you give A, B, C, D, and certain values are assigned. As we got severity again they put it to five categories, insignificant effect - momentary significant effect.

Injuries effect on less than 10 persons in a minor way injuries to more than 10 persons in a… It should be in a minor way. Duration momentary impact for less than two hours, impact for a day, impact likely to last for a period exceeding one week.

Again these are given values 1, 2, 3, 4, 5; 1, 2, 3, 4, 5; finally, a frequency how frequently does that operation take place. Once a month, it is given; one once a week, it is more serious; once a day, even more serious; several times a day more serious continuously occurring. And after we have picked up a certain activity, we give these grades then the total score is X into Y into Z into F; please remember it is not plus it is multiplied.

Why it is multiplied? If it was plus, it will mean that if this score here was not there, it will simply disappear, but multiplication in multiplication no term can be ignored; it will have an effect. So, we multiply everything all this course X into Y into Z into F will give you the total score. Now, the higher the score the bigger is your problem, the idea should be to minimize the total score which is everywhere, our goal would be to go from 5 towards 1, 5 towards 1, 5 towards 1, 5 towards 1; we must find methods of minimizing each of them, because they are multiplying each other. I do not have to time to take up a particular example, but you can do it for yourself, in any operation you consider this can be applied. Maybe you will need some modification here, and there depending on what you are concerned with.

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Now, let let me come to a general topic again about waste management; waste management means several things means avoidance of wastes recycling, and reuse of wastes minimizing adverse impact of disposal of these wastes on the environment, three

things if possible avoid generating the waste. If you are not able to avoid the waste is generated find a method of recycling or reusing the waste.

Suppose you are not able to generate waste, and you are not able either to recycle and reuse, but then we must find to keep the waste in a manner that the adverse effect of disposal on the environment would be minimum. Take the case of nuclear wastes; now nuclear reactors would produce spent fuel; there would be other wastages which are radio active in nature, we cannot reuse them. So, we have to finally, dispose in a manner that they will be safe from the point of view environmental degradation.

What is done today? I mentioned earlier, first of all that will be taken into into glasses, in molten glasses you dump all that. So, the when the glass freezes everything is locked in there; that glass will have to go to several layers of steel containers - those containers would finally be dumped in the sea or deep in land under the rocks or whatever. You do the best you can to see that the waste does not pollute, where it is kept. Unfortunately in the industries today's nobody had still now not everybody has the awareness or the technology or the training or the mindset to do this. Obviously, it is going to cost little extra to do this, but it has to be done for the good of the society also for the image of the industry for the good of their own team.

All this comes under environment management system audit, and environment management system review. So, when there is an environmental policy, the environment management system is put in the place, that how will the whole thing be done. (( )) First of all the chain of authorities, then documents with them as to what is the policy what are the activities? Then how will the activities be implemented reviewed from time to time all that will come under environment management system. Once, it is in place it has to be audited, periodically one has to go and see, and there has to be and the systems review time to time; that is the system that we have designed is it good enough. And once we think this stays now, then we do the audit.

What is happening where? Is something happening somewhere that should not happen or is a section doing better than the other section, if they are doing better why they are doing better. If they are some section is not doing well, why they are not doing well? All will come in the the purview of audit.

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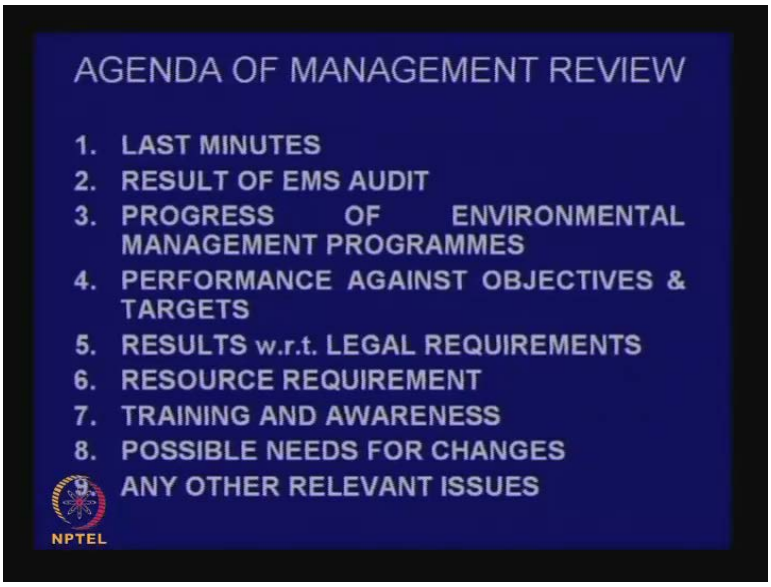

How does the management proceed in this, and one day you may be in the chair to do this. You have certain motion policies, procedures, implementation, but the management has to review from time to time, and the agenda for management review will go like this. First of all last minutes, what were the decisions taken last time, what are the actions that were recommended by the audit section. So, what was the result of EMS audit? What all did they recommend? What was the action planned? So, then we come to third progress of environmental management programs. How are they progressing, including the original activities as well as those recommended later on.

Performance against objectives targets, every section was given a target what has been the performance as against the target, we have to measure, we have to grade them. We have defined things, now we are measuring them. And then only we will control, analyze, control, and improve.

So, the systems review is the process of analyzing, and then only management will have to take decisions for control and improvement. We look at results with respect to legal requirements are we meeting them? Are we meeting the resource requirements that for implementing anything, we need certain resources do we have them; people, technology, materials is there sufficient work in the area of training, and awareness generation possible needs for changes any other relevant issues.

So, this management review system will do this periodically, if not every month every two months; always with reference to what happened last time? What were recommended to be done subsequently, an examination where they done subsequently is anything new to be done. If, so what all inputs will be required possible needs for changes, and while discussing some other relevant matter can come in. This is how an environmental policy is taken forward, in any industry a nonferrous metal industry will not be an exception.

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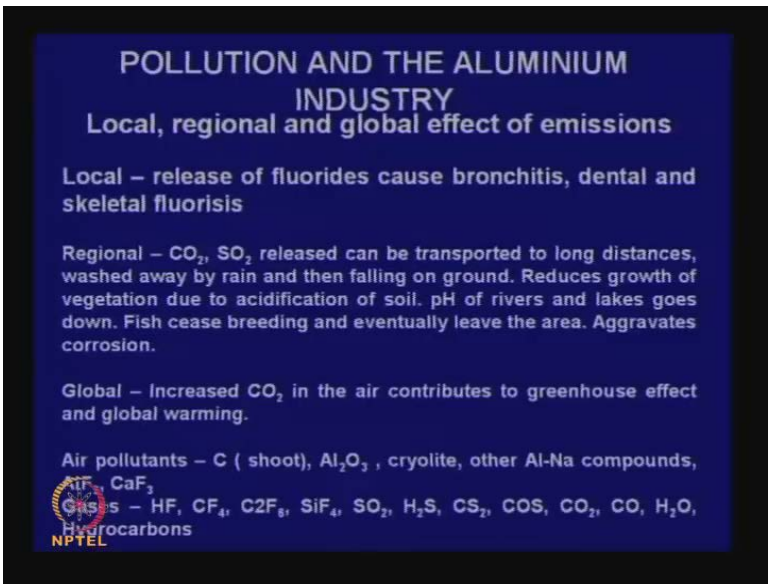

I will discuss now one particular industry, which is the biggest polluter in nonferrous metallurgy, and that is the aluminum industry. The subject assumes greater importance, because this is the flag ship activity in a nonferrous sector in our country. No other metal come anywhere near the quantum of production as compared to aluminum. And the sector has to grow; it has to grow, because we have bauxite deposits in plenty, we have the skill, we have the knowledge, we have the work force, we do lack power which is the need of the hour so far as an aluminum industry is concerned. Hopefully that would be solved, because without energy the country cannot progress not not just aluminum industry, the entire country cannot progress.

In any country GDP is proportional to per capita energy consumption. So, if we want our GDP to grow our energy production, and consumption have to grow as well. So, from the point of view of nonferrous metals production aluminum assumes the most important

position. Now, if you want to talk about pollution in aluminum industry, we would again have to discuss the effects, in terms of local regional and global effect of emissions, because their management, and their implications are different.

What are the local effects, local issues release of fluorides that cause bronchitis dental, and skeletal fluorisis. So, population around aluminum plants, smelters would have the problems of bronchitis; they will have dental problems, the skeletons will become weak - the bones would become brittle.

Then there is a regional - regional means say several kilometers around the plant site, pollution effects will come from CO 2, SO 2 released, and these gases can be transported over long distances swept by air or washed away by rain rain waters will make them fall to the ground, these are acids you will have CO 2, SO 2 will pour acid - acid rain will go to the ground, it will reduce growth of vegetation due to acidification of soil; P h of rivers, and lakes go down goes down and then fish fish cease breeding, and eventually leave the area. Acids also aggravate corrosion of structures, buildings metal structures everything; this is a regional effect, it can go to quite a distance from the plant site.

Then there are there is global effect the increase CO 2 in the air; the CO 2 coming from from the electrolytic plants, this will contribute to green house effect, and global warming. The entire world is affected by every contribution to global warming, no matter from where it is coming it may be small, but it certainly is a contribution. We also have not only CO 2 or SO 2 in air, there are air pollutants shoot alumina particles - cryolite particles; other aluminum, sodium compounds fluorides. Then there are gases hydrofluoric acid CF 4, C 2 F 6, SIF 4, SO 2, H 2 S, and whole lot of them hydrocarbons, they are all going into the air.

So, they have they contribute to local problems, regional problems as well as global problem. Now, aluminum industry is a big polluter; and the industry is trying to find solutions, but they have not found solutions, yet for all the problem One thing that is not mentioned here; is that you know we have carbon cathode, and carbon anode time to time, the metal is going to the cathode which makes the lining of these electrolytic cell, but the soderberg anodes or the other anodes where we are generating CO, CO 2 they get poisoned by fluorides, and they have to be thrown out from time to time.

This is a problem, because all the poisoned electrodes are there in a dump people do not know what to do, because we simply cannot crush and grind and put it use it for land filling. You cannot, because there are fluorides in them, they are poisonous substances. So, industries simply sits with the dump still not knowing what to do with it, we do not have a proper process for handling that waste dump.

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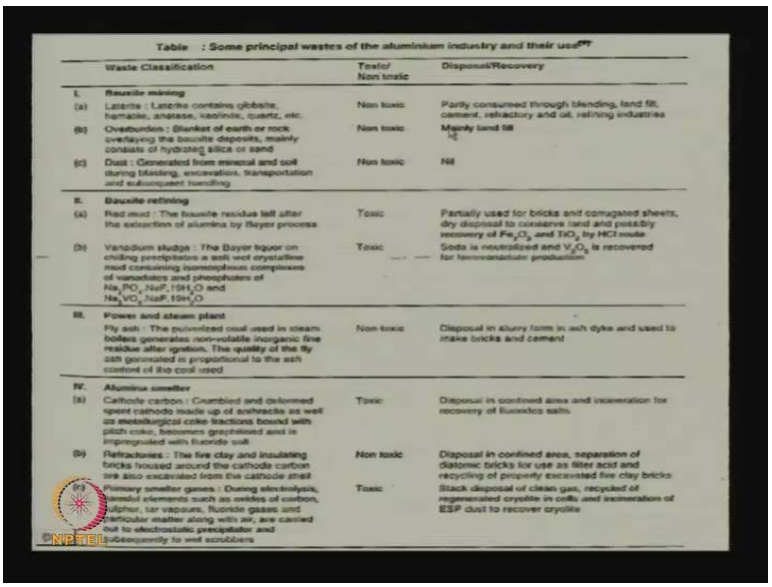

Now, it is bit difficult to read. So, I will quickly go through this, and end the lecture here. You just listen what all things, it actually gives some principle wastes of the aluminum industry, and their use people have looked at it and found there are uses for it. In bauxite mining laterite, which contains all kinds of minerals the overburden that has been taken out from the top there is dust all these are coming from bauxite mining. Fortunately, they are nontoxic means they would have go to respiratory problems and other problems, but no serious health damages.

They can be partly consumed through blending land filling, they can use they go for cement making refractory oil, and refining industries etcetera etcetera mostly land filling we can use all that. After we have removed the top, then for bauxite mining we end up with red mud the bauxite residue left after the extraction of alumina by therefore, this is toxic; it is partly used for bricks, and corrugated sheets dry disposal to conserve land and possibly recovery of FE 2 O 3, TI2 by HCL root they are being tried.

Dry disposal means we do not allow too much of liquids to go with the red mud, but then there is a problem that they can fly around. So, they keep them slightly moist, then we have vanadium sludge, the bayer process liquid on chilling precipitates a soft weight crystalline mud; that is toxic soda is neutralized, and V 2 O 5 is recovered for ferro vanadium production. So, vanadium recovery is being tried. Power and steam, plant you know generate a combined power, and steam where the steam goes for the autoclaves. This is nontoxic, fly ash is nontoxic is disposed in slurry form to ash dykes and used into to make bricks and cement, people are finding used for fly ashes.

But there is a problem here, in many country's say in Europe, Poland, and all they do not allow use of fly ash bricks for making houses, because they are radio active. They are allowed for making roads, and other things not at all for houses not where too much of too many people are coming in that environment. In our country, we still do not have that restriction.

In the smelter, there are toxic things coming in cathode carbon as I said the cathode not the anode, I mentioned you along if the cathode carbon crumbled, and deformed spent cathode made up of anthracite. As well as metallurgical coke fractions bound with pitch etcetera etcetera, it is a toxic and disposal in confined area, and incineration for recovery of fluorides also.

At the most the whole thing can be burnt carbon is burnt away the fluorides also recovered. It is the cathode that that is disposed anode it gets consumed. So, there is no problem with that. Refractories also give nontoxic the dispose dispose in find in confined area, and then we have primary smelter gases which are toxi,c you can only think of stack disposal of clean gas recycled or regenerated cryolite in cells and incineration of ESP dust to recover cryolite.

So, the gases that are coming out you might try to recover cryolite cryolite from that. So, there are all kinds of things coming out of in the aluminum industry solutions have found partly some time holy for certain things, but there lot remains to be done. We will continue with it in the next lecture. So, thank you.