**Steel Making**

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**Iron and Steelmaking in India**

Let us continue. I have to talk for few more minutes regarding the layouts of various plants and the facilities that we have in the country. As I have pointed out already that we have a very strong secondary steel producer as well as primary steel producers, we have both integrated and mini mills. And, mini steel plants – we have basically induction furnace-based and arc furnace-based. Arc furnace-based facilities, which are basically DRI oriented or DRI based – they have both come up in the Western India, because you know that we have gas-based DRI production units as well as coal-based DRI production units. You have midrex process, which is a gas-based process. Then, we have SLRN or rotary kiln process, which is a coal-based process. So, mostly, in Western India, we have coal-based DRI units to good number of DRI plants with the not much infrastructure. They are just the money making units actually; nothing beyond that gross violation of environmental norms. These have come up in the Western Coast. On the other hand, we have the gas-based DRI processes mostly located in the Western India because of the availability of natural gas there.

It is also understood as I have pointed out that if India has to grow, India has to develop, it will need steel. And, perhaps from that point of view, 180 million tonne by 2020 is not too massive a figure. And, it is also started that because of the logistic problems, because of less capital inflow, because of problems with land acquisition, infrastructure, etcetera, perhaps we will witness in the years to come more or less similar weight of growth between the primary and the secondary steel producer. So, we will see parallel growth of the integrated steel mills as well as mini mills in the country. And of late, many steel plants are being launched, which has a capacity between 1 million tonne to 2 million tonnes; Balaji group, then Shyam group, Bhushan groups; Bhushan group is also expanding. And, there are umpteen number of steel plants, which are planned to be coming up in the Eastern Coast, particularly, in Orissa, Jharkhand and Chhattisgarh area.

Now, having said so, we understand that the primary steel producers in this country are going to be using mostly LD steel making process. In the future developments, we may see integrated mills coming up within slab casting or maybe strip casting, which is not yet certain, because strip casting is now a proven technology. And, I heard that Essar steel is already negotiating with Nucor, which is one of the pioneers in strip casting technology for setting up of plants. And today, I think I have mentioned during the course of this course that you have continuous strip traction technology, which is economically and energetically extremely efficient. So, newer technologies we will gradually see getting into the Indian market as well.

Certain variations do exist. As I have mentioned yesterday regarding the steelmaking technology, subtle variations also exist. In terms of ladle size, tundish capacity, nature of products, nature of secondary equipment, types of (( )) degassing treatment, some plants use ton degassing technique, some plants use circulation degassing techniques. So, although the subtle variations are there, the process route more or less is the same in all integrated steel plants. And, in the foreseeable future, I do not think it is going to change by large. So, we will have a primary steel making followed by lose it secondary steelmaking. But, the emphasis on secondary steelmaking is going to grow more and more in the years to come as we put in more and more stringent requirement on the quality of steel. And finally, we have casting technology; ingot casting hazards has been completely phased out.

SAIL of course, will not be growing; we have to see what happens to the SAIL plants in the year to come with a national orientation changing a little bit. And, we are thinking more in terms of these investments. Maybe some of the SAIL plants may go out of the SAIL umbrella in the years and that we have to really watch. But, at this moment at least no new SAIL plants, no new RINL ventures are likely in the horizon. Mostly, the private sectors – Jindals, Mittals, the Ruias, the SR group, etcetera – they are actually planning to set up more and more integrated steel mills. But, so far as mini steel plants are concerned, there are so many groups. NESCO is another group, which is trying to expand. So, these are not so famous industrial houses, but we will see such ventures coming up all over India – South India, Eastern India. But, maybe primarily it is the developments are going to be taking place either in the Western India, because of the availability of chick fuel or in the Eastern India. But, we have abounded low rate coal available to us.

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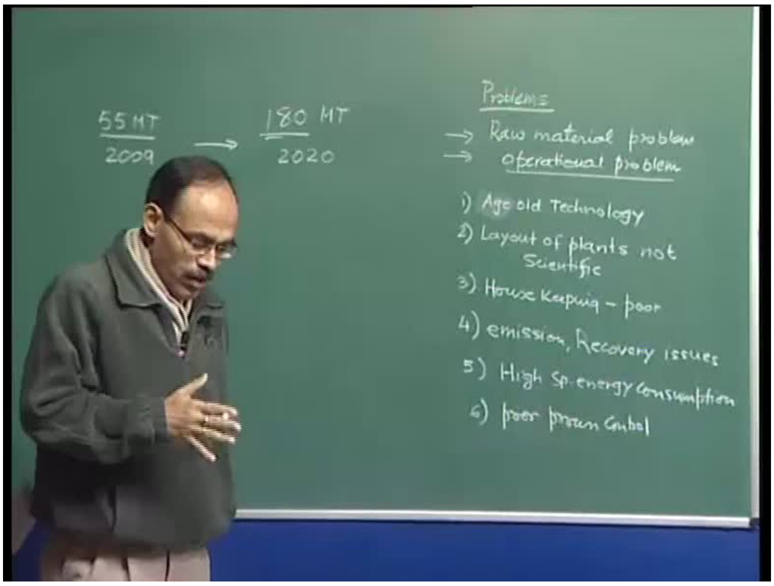


Now, if we have to get to the figure of 180 million tonne by 2020 from 55 million tonne, 2009, we have to see that is it sort of a day dreaming or is it possible for us to achieve? And, in view of that, I think we have to now understand that then… GDP is very high. So, maybe we are in a position provided government makes land available, the market can generate lot of cash, we should be in a position to gear up our steelmaking facilities. But, the issue comes now that what are the problems that we need to understand? This journey is not going to be so easy. Despite the growing economy, despite the demand for a large amount of steel, I do not think it is going to be an easy journey, because we have lot of problems. And, I only search the problems or I will tend to list the problems; one is our raw material problem and other is our operational problem.

Yesterday, I have tried to briefly the last lecture; I have tried to briefly mention that we have an excellent iron ore; and amount of reserve is also pretty good; and we have good amount of coke also. But, our coke is least with large amount of coke ash – 22, 25, 28 percentage. And, what is coke ash? The coke ash basically is silica, alumina, etcetera; and, it contains lot of sulphur as well. So, iron ore is basically we have lot of fixed iron is very good. One of the finest iron ore from that point of view; but, at the same time, our iron ore contains lot of silica and alumina. We know that silica can be reduced in the blast furnace. Therefore, the tendency to produce a high silicon pig iron in Indian blast furnace is somewhat relatively high. And, this obtains to upset the good quality of iron ore; some beneficiation seems to be… – particularly when we will be talking about processing of low grade iron ores, because not all grades of iron ore…

The iron ore reserve is of 60 or 65 percentage iron. So, there are low grades iron also. Then, the beneficiation of iron ore particularly we are going to silica, etcetera. It is going to meaningful. So, if you have relatively more silica and we have 1 is to 1 proportion roughly alumina, the alumina will invariably go to the slag phase. So, you are forced to maintain a very high hot temperature. And, that high hot temperature – what it does? It causes thermodynamically creates more favorable condition for the production of high silicon pig iron. And, this high silicon pig iron upsets the economies of steel making as we all know, because high silicon pig iron means we have large amount of heat produced in LD convertor, we have large volume of slag. If we have large volume of slag, then we have large amount of CO to be added; if we have large amount of heat, which is evolved in the LD reactor, then the lining life is going to be drastically effected. So, high silicon pig iron has problem. And alternatively, if you do not wish to take that to the LD convertor, you have an external desiliconization. That is again deterrent to the production of the steel, because of the simple fact that external desiliconization will consume some amount of time and slowdown the pace of steel production.

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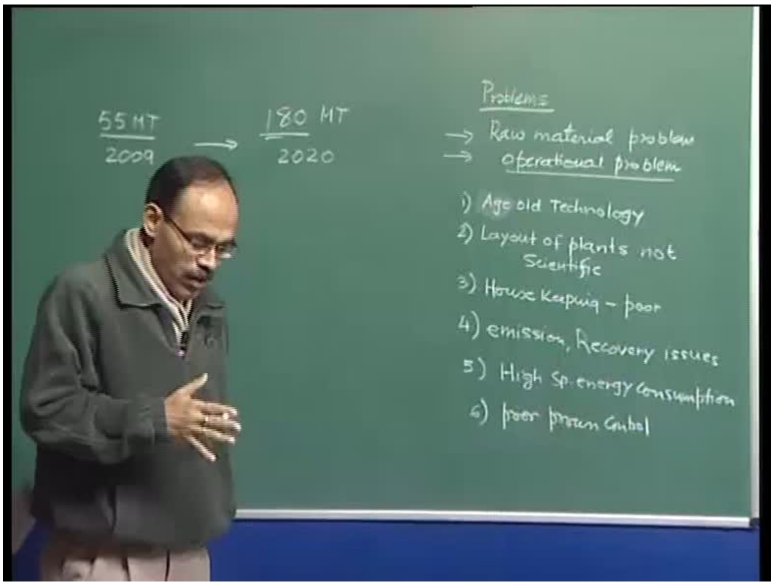

Ash of course, is an issue of concern to all of us. And, our coke rate in the blast furnace if you go back, is also not quite encouraging, because the coke ash affect fixed amount and fixed carbon in coke; it is going to be less, more and more is the coke ash. And, that is why coke rate in our Indian blast furnaces ranges 700, 800 kgs per tonne of hot metal produced, because we are charging less fixed carbon and more ash possibly, which is reflected in the high figure of coke rate for blast furnace, etcetera. And again, we are talking of more slag; more coke essentially implies that the process is environmentally less friendly, we are producing more greenhouse gases. And finally, it will have large amount of slag, which will be produced, because silica, alumina, which are present in coke ash needs to be flushed. And, as a result of which, we have a downstream problem of waste disposal. So, these are some issues. So, as we go on to 180 million tones, the waste generated are also going to be much more. And, we have to see that when there is too much of crunch on the land, how do you really distribute or manage the waste, which is generated out of the steel plant.

More importance to me is the operational problems (Refer Slide Time: 12:35) in the Indian steel plants. I mean the technology in the Indian steel plant is very old. And particularly, I have mentioned in the previous lecture that electric arc furnaces if you go and see and these are 40, 50 years of olden. So many developments are taken place in the arena of steel technology. It is just unbelievable, uncountable. And if you go to the Indian steel plant, you will see that the technology has taken. A backs is there, where the owners are more concerned with the number of heats, amount of liquid metal without bothering much about the general safety, the energy efficiency, the cleanliness in the plant itself. And, these are issues, which have been totally ignored in the plants. So, there are lots of operational problems. And, these operational problems – I think I will say that leads to first one – I will say that age old technology (Refer Slide Time: 13:53).

I am not saying each and every plant in India uses old technology. But, by enlarge, my experiences been that… For example, one simple last thing I am going to tell you is that if you visit Indian steel plants, most of the places you will see that ladles and tundish – they are operated with stopper rods. And, more modern steel plants if you go and visit for example, Japanese steel plant, Korean steel plant, POSCO, etcetera, nowhere you will find they are using stopper rod. Stopper rod – you remember, this is to regulate the flow out of the tundish, regulate the flow out of the ladle. So, they are still persistently used in many Indian steel plants, but stopper rod technology has been literally phased out from modern steel plants, where we are now using slide gate technology. So, this is just a singular example.

Then, we have as a result of height, age-old technology, we have lot of problems in the plant. And, the layout of the plant is also not scientific. These are – housekeeping is extremely poor. We have emission recovery. These are big issues in Indian plants; high specific energy consumption; poor process control. These are all important issues. Layouts of the plant for example – I have talked about little bit about age-old technology; layout of plants not scientific.

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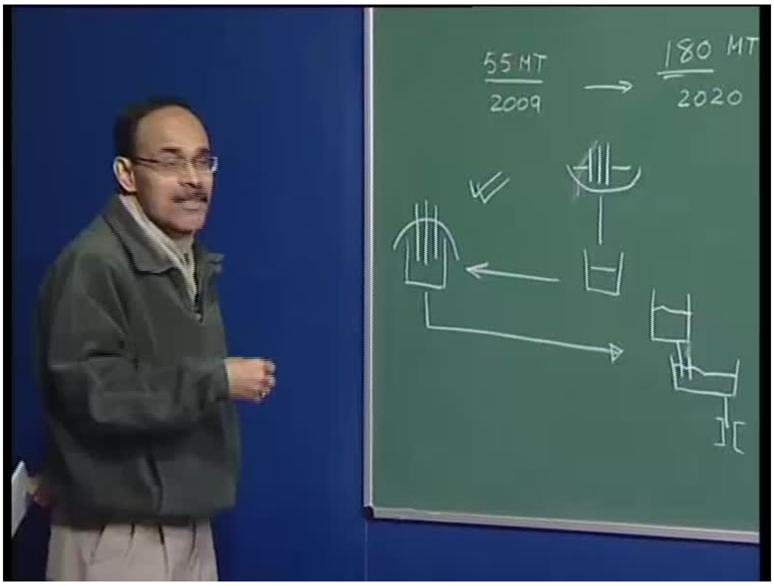


Many of the steel plants we will see. Because they are age-old, there is no synchronization of activities. You will see that the furnace is here for example; and, the material is taped here in the ladle; and then, it goes like this and you have a large station. And again, the material is brought here; we have casting. So, there is lifting by cranes; sometimes they move on rail; sometimes they are lifted from one place to another place. So, an electric arc furnace – then, it is taped; it moves in one direction; and then, it goes to the left or VD station; then, it moves in the reverse direction, because the plant is not scientifically laid out and this creates lot of logistic problem in running the operation very smoothly. And again, if you look at the overall layout, the scrap yard is at one corner; the control rooms are not properly located; control equipments are not functioning properly. And, these all creates lot of problem in terms of managing the available resources very efficiently.

Plant layouts are in general, except for few modern plants. More or less, I am talking about mostly the mini steel plants or the arc furnace-based steel plants, where an extremely primitive layout is there in the plant. And, what happens is for example, if layout is not scientific, in that case, what happens is for example, you try to process steel to this and at one point of time, you find that because of transportation, etcetera are holding, your temperature has dropped to such a level that you require really reheating in the LF. So, you have to shuttle between LF time and again in order to bring the metal of the correct temperature in the continuous casting brig.

Housekeeping for example, is extremely important. Why? For example, in most of the steel plant if you go, you will find that it is smoke, dust, the cleanliness level is very bad. Now, if the housekeeping is no good, in that case, it is very difficult to attract new engineers and asking them to make their career in steel plants; because I have been visiting many steel plants and I have been telling people that unless you are able to create a congenial atmosphere, unless the environment in your steel plant is good, no engineers from NIT and IIT are going to make a career in the Indian steel plants. So, this is extremely important.

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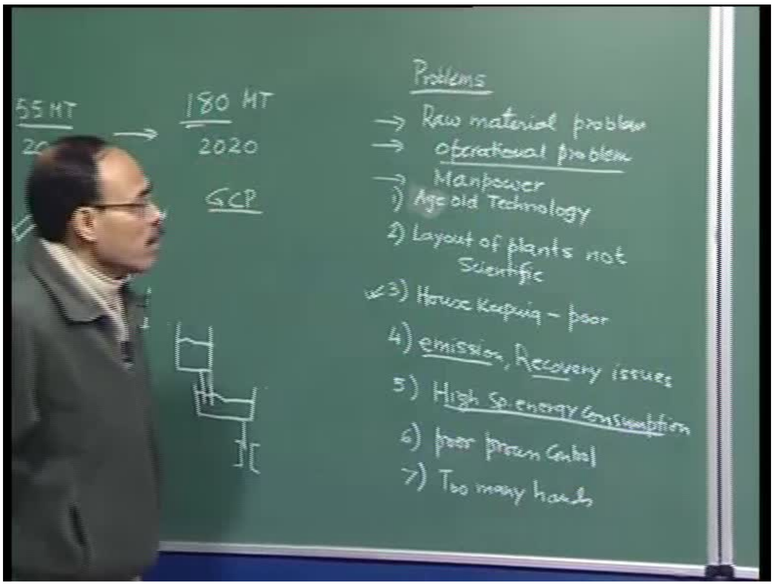

If you see outside steel plants, they are so clean; many of you may have seen videos; and there are few peoples. And, this briefs me 1 – too many man hands; the work force is too large in our steel plant. So, coming back to the housekeeping, we require it should look like a modern steel plants – modern steel plant extremely clean, very little amount of gases and dusts or smokes. And, you go to steel plants, you find scrap is everywhere, dirt is everywhere, broken pieces are everywhere. And, you do not feel like what they are at all. And, if that is the scenario, in that case, this is going to cut a very solid figure as far as new recruitments are concerned. And, it projects on the other hand, many people from foreign countries have come, seen Indian steel plants; they have interacted with me on diverse plants and have told me Indian steel plants are 50 years behind in terms of how this is.

Emission recovery – emission means rampant emissions in Indian steel plants. If you go, you will see that they are all red powders, everywhere there is dust. And, if you go to the LF station, you go to the electric furnace; during the furnace stepping, everywhere there is so much of smoke and dust that it becomes horribly difficult to work efficiently under such conditions. And, these are certain tasks. We have extremely GCP (Gas Cleaning Plants). Many a places, many a times, I have seen the gas cleaning plants, which are essentially attached to the LD converter, electric furnace, ladle furnace, etcetera are not at all functioning. And, the dusts, etcetera from these furnaces are being released to the environment in a callous manner. Again, recovery of heat from the spend gases is also very important issue, which you have not been able to give sufficient attention. And, all these things – layout of the plant, age-old technology, emission recovery; ultimately, high specific energy consumption…

Poor process control in many of the plants I have seen. But, they do not have for example, flow meters, which can record the amount of the flow; oxygen going into the furnace itself. And, as a result of which, they tend to over blow oxygen. And, if they over blow, in that case, the slag becomes more and more richer in iron oxide. Sometimes it is 25 percent, sometimes it is 35 percent with excessive amount of oxygen blown. And, if 35 percent of iron slag contains so much of iron oxide, in that case, you can imagine what is going happen to your yield. Therefore, first, process control put to adequate process control is necessary. For that, you will have to have sensors and gadgets. You all see is to be functioning all the time, they should be giving you good and reasonable results. And finally, we have too many hands. Of course, we have to look at the society. But, even China, which is a socialist country, there the number of hands per tonne of steel produced is far less than ours. In our steel plants, we just have too many people. The liability on the management is also high in terms of their health care cost, another recurring cost. And, as a result of which, the profit really is not that much.

Many of the steel plants that they are in India make enormous amount of profit. It is because of one single fact that it is not because of technology, it is not because of very efficient management, but it is because of one single fact that they have captive minds. And, from captive minds, they are able to get the basic raw materials at an excessively cheap price and that gives them the age over others. So, plants, which are operating in India – there are few many of them; I do not want to name them here. They have the captive minds. And, from the captive minds, they get raw materials at a very cheap rate and as a result of which, the final product they roll out is relatively low price with respect to others.

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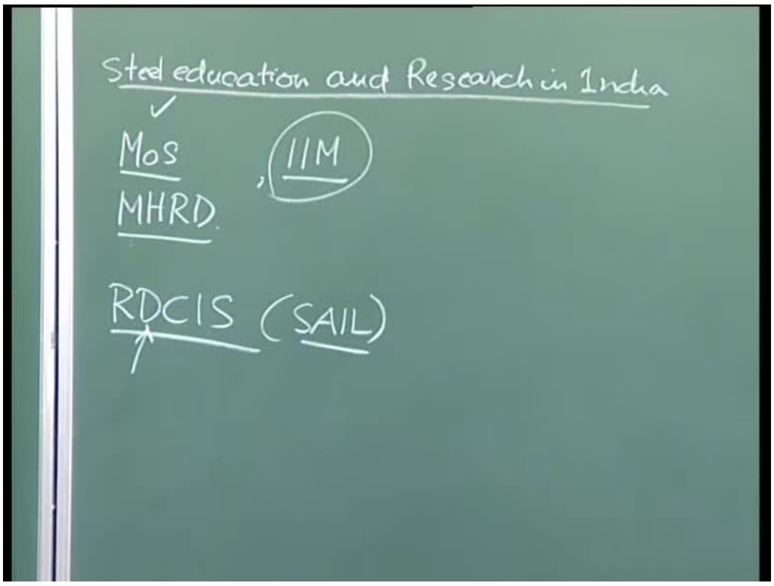


Now, having said so much, the other important issue is that what we have recently seen, is an issue of man power. So, raw material problem, operational problem, and then we have manpower problem. This is very important. And, in this context, I wish to spend a few more minutes on the topic of steel education and research in India.

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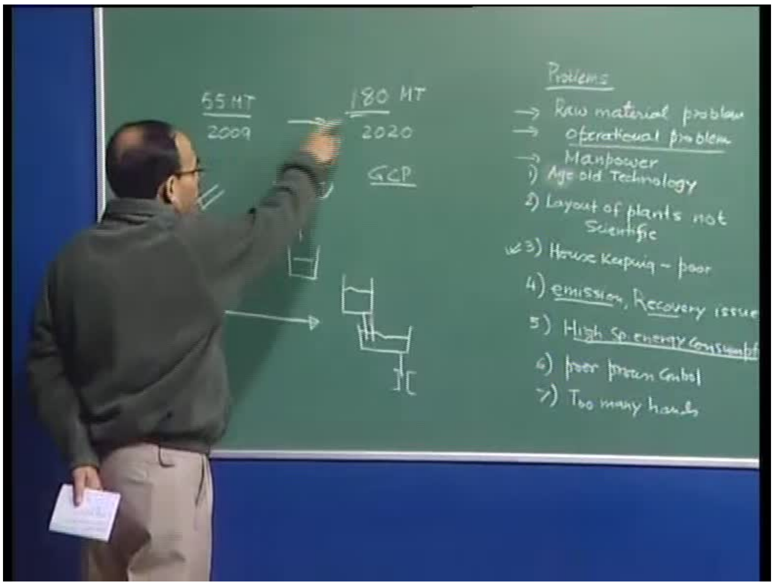


Now, when you have so much of steel produced, so many new steel plants coming up, you will certainly require metallurgical engineers; particularly, people having interest in steelmaking. Impossibly, we will not be hiring graduates from Chinese to run our steel plants. So, we require qualified manpower; we require people, who have a lot of interest in steelmaking.

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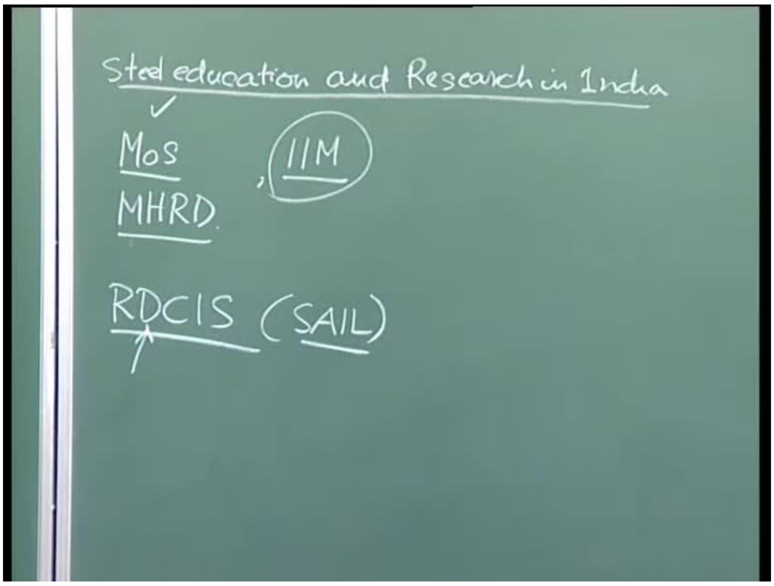


Now, as we are aware, that we have a full-fledged ministry of steel and mines that takes care or controls all steel-related and mines-related activities. We have a cabinet minister;

we also have MHRD (Minister of Human Resource and Development), which looks after the overall higher education as well as education in this country. Recently, under the ages of the ministry, we have Indian Institute of Metals. This is not Indian institute of Management, but Indian Institute of Metals. The head quarter is in Calcutta. So, with the intervention from MoS, IIM has constituted a committee; or, Ministry of Steel asked IIM to constitute to a committee, look into the issue of manpower shortage in steel plants.

Remarkably speaking, I have seen that in one month, there is a unique example, I could locate one single person working in three different steel plants. He was first working in x; then, after 20 days, I visited another plant and I found that the person has moved to the second – another steel plant. Why? And then, finally, by the month end, he has moved to another steel plant, because he was getting more salary; they are not takers. And, as a result of which, what happens is, it is the same person, who goes from one plant to another plant. And, at the grassroot level or at the graduate trainee level, we have not been able to recruit too many people for our steel plants, because of simple fact that we do not roll out that many engineers today, who has requisite expertise and knowledge of steelmaking. And also, on the part of the students, as you are aware, that student do not show much interest to make a career in steel, because it is not as attractive as nanomaterial; it is not as attractive as biomaterial; it is not as attractive as a InfoTech. But, maybe it is an age-old field. And also, the plant condition etcetera – I have been deterrent for the students to take up a position in steel plants.

Although so much of proliferation of education has gone under the ages of the Ministry of Human Resource and Development, you have so many deemed universities coming up, so many engineering institutions coming up. Remarkably speaking, there are very few; you can just count them in fingers in the last five years, engineering universities or institutions have open, which have metallurgical engineering as a discipline; I think last five years, I remember, there are one in Orissa; then, NIT Bhopal has started the program in metallurgical and materials engineering. And also, you may have noticed that earlier while the education is basically a metallurgy-oriented, say 30-40 years back, today, the orientation in most of the engineering colleges are materials-oriented.

Earlier, we used to be taught metallurgical thermodynamics. Today, the thermodynamics course is restructured as thermodynamics of materials, where more thrust is given to defect thermodynamics. Chemical thermodynamics, Gibbs-Duhem equation, ellingham diagram, etcetera are possibly been kept aside to some extent. And, as a steelmaker, we would like to see that there is emphasis on chemical thermodynamics; there is emphasis on chemical thermodynamic softwares and so on, so that the engineers can carry out in a small or relevant calculation on a daily basis. So, the curriculum has also gradually drifted towards the material science. There are been new areas, which are coming up, emerging areas; and thirdly, we have too few institutions catering to the needs of the metallurgical and materials engineering. And, statistics is almost 1000 to 1200 metallurgical engineering graduates are produced in a country like ours. And, although steel plants have lot of job openings, lot of vacancies, they do not find employable graduates at the end of the day.

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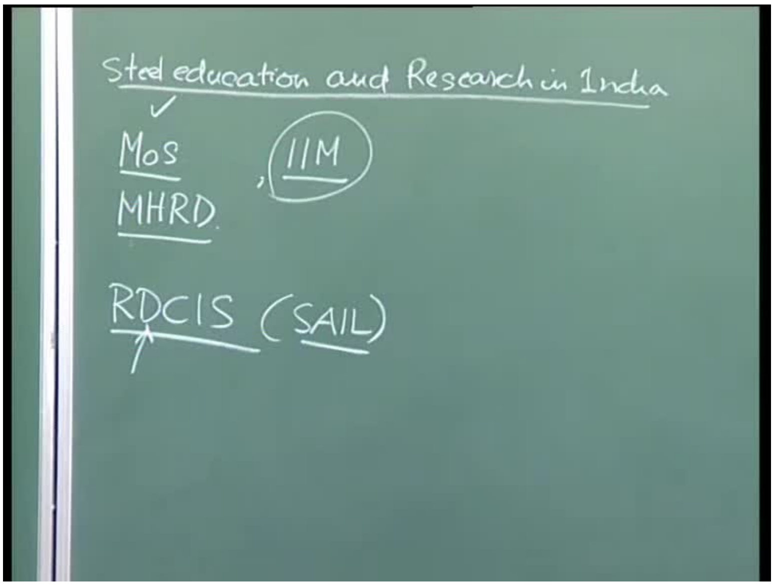


So, these three problems that too few metallurgical engineering graduates and passing out; and then, we have metallurgical engineering curriculum, which is getting left sided towards materials education. And also, in emerging areas, these three have really put a punch on steelmakers' ability to recruit more and more people. So, the task force now mostly comprises of B Sc graduates, diploma holders, who are given some training rather than BE metallurgy or graduates in metallurgical engineering, because that too many number of metallurgical engineering graduates willing to war in a steel plant are not simply available. So, this is going to be a serious concern for us in the years to come; we do not have too many engineers.

And also, here I would like to blame the steel plants also to some extent. They might recruit the metallurgical engineers, for example, but the environment in the steel plant in this country is unfortunately not that creative, because graduate engineers if recruited, we cannot expect him to just to press a red button and a blue button, tap the heat and be content with it. So, he has to apply his mind and he needs a creative environment and steel plants. Who only think in terms of number of heats a day unfortunately has not been able to give that creative atmosphere to the new recruits. And as a result, young engineers going and working in the steel plants get really the solution, because they do not find much creativity. There is not much scope of improvement, because the management does not nurture excellence; they just look at the quantum of steel that is being produced. So, there are many issues; not just it is a very complex problem. Ministry of Steel is there; MHRD is there; we should have by now and usaging that we will need steel by 2020, lot of steel. And, we should have been able to by now reinforce our steel education and research program in the country, so that we have a smooth production.

In most countries, we have iron and steel institute; where is such an institute in this country? We do need now. Maybe time has come that we have a separate institute, which will roll out people with requisite qualifications in iron and steel technology, who should be in a position to occupy the position of graduate engineers and so on. So, despite a minute full-fledged Ministry of Steel, despite a Ministry of Human Resource and Development, what I see, that steel education in this country has been ignored for quite some time. And today, the number of graduates produced having interest in steelmaking. You see this is a really perpetual problem in the sense that when we were students, there were lot of seats of excellence. And, extractive metallurgy in this country are iron and steel technology; be it IISc Bangalore, be it IIT Kanpur, IIT Kharagpur, IIT Chennai, IIT Bombay and lot of IITs also. But, today, the number of experts, the number of professors involved in teaching and doing research in iron and steel as dwindle, remarkably, you can ask that why it so important; because when we have professors teaching and doing research in iron and steel, it is they who induce, create the interest among the students. It is they who supervise the graduate students and these graduate students at later stages become leader in their field. So, the professors have a proactive role here. And unfortunately, in the last 10 years or so, a number of professors doing research and teaching in steelmaking as reduced to an alarmingly low level.

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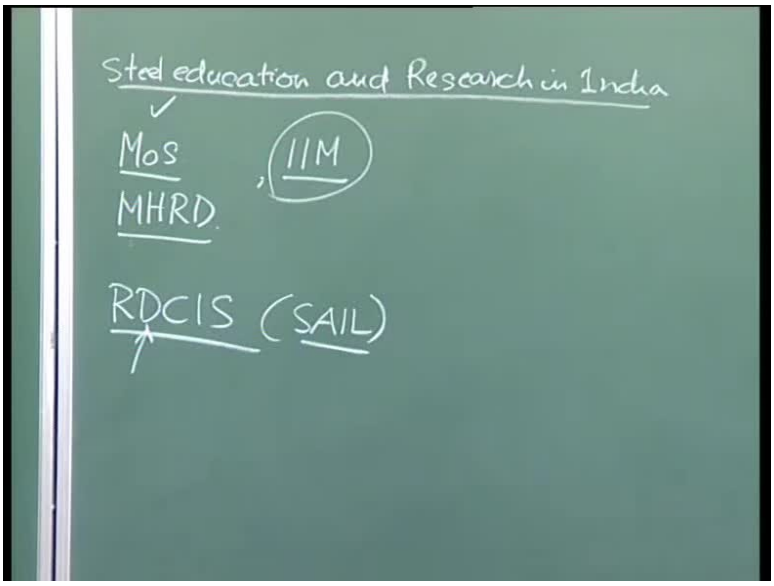


And, my quote of the day is like that the steelmaking professor has become like a Panda; Panda is an animal. I think world wildlife organization has declared it to be an endangered species. And, I think the professor of steelmaker in this country has also become endangered species. And, I think a very viable steel program parallel to the material science program is available only in Japan, which spends. There are lot of universities where there is still research going on; where people, who takes lot of interest in steelmaking. And, at the same time, Japanese doing excellent in terms of electronics, another exotic and advance material. But, unfortunately, our vision has been somewhat distorted. And, as a result of which, the education program has suffered tremendously. I have been mentioning that it has its own problem now, which we are going to see or experience in the years to come.

Research in iron and steel, for example – indigenous research in iron and steel is very poor. Although we have a full-fledged research, (Refer Slide Time: 36:05) RDCIS, that is, under SAIL, has set up a huge research center. But, we really have not been able to come up with a new technology. Many developmental works – yes, we have been able to do, we have been able to improve some of the existing processes, but not a new technology. So, looked at from such point also, we do not have a sizeable or a meaningful R&D activates in steel in the country. I think Chinese in that front are doing much better than us.

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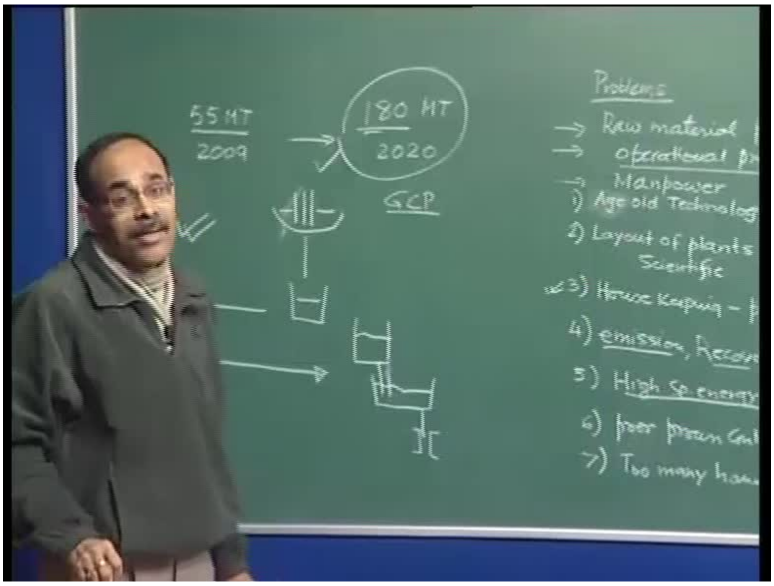


Lot of Indian steel plants today I go and see, they are buying for example, Chinese technology. Chinese coke ovens are being installed in JSW; whereas, coal injection in blast furnace, entirely Chinese technology. But, where is equivalent Indian technology? We have not been able to come up with that. And, I think we have altered somewhere down the line and that is why the scenario – although we have painted a rosy picture, but the scenario in terms of manpower, in terms of research, in terms of the general conditions of the plant really do not look that attractive. So, this I think is the last lecture of this course. And, now, I have come to the an end and I do not wish to go beyond this. But, I think there is lot of challenge.

The last statement that I am going to make as far as the discussion is concerned is that we require very knowledgeable people now to contribute in the area of steelmaking. I have mentioned earlier also that the technology is 150 years old; it is near-perfect technology. So, just by merely attending the shop floor or going on a daily basis, we will not be able to contribute. Even the knowledge of the subject has to be very good. We have to be equipped with modern subjects, modern tools, knowledge of computer, knowledge of fluid mechanics, knowledge of kinetics – all these are necessary. And then, possibly we can see that we can improve the casting rate; we can improve the yield further. We are already talking about 90 to 94 percentage of yield in steel plant. So, it is a near perfect technology that we are dealing. But, in our country, the mindset has to change; the owners and the government has to change their mindset.

And, product – for example, steel products – they are completely dirty products that we today produce. And, these products and government of course is going to bring in some regulations. There are so much of inclusions that really you cannot apply them in strategic application. Today, it is fine. But, if you put inclusionless steel, loaded steel for making bridges, you can imagine after 50 or 100 years down the road what is going to happen to the fate of all these things. So, these are very important issues. And, as a budding engineer in a steelmaking engineer, you should be concerned about it. My objective as well as personal (( )) objective in this course is to expose you to the subject and give you a modern outlook; and, bring it to a point, where you should be able to think yourself what are the ifs and buts, what is the subject, what are the loopholes for the problems, what are the scope. And, put everything in the perspective of India, because India has to grow, India has to develop and India will need more steel.

Thank you.