Iron Making
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Lecture - 38

Iron Making

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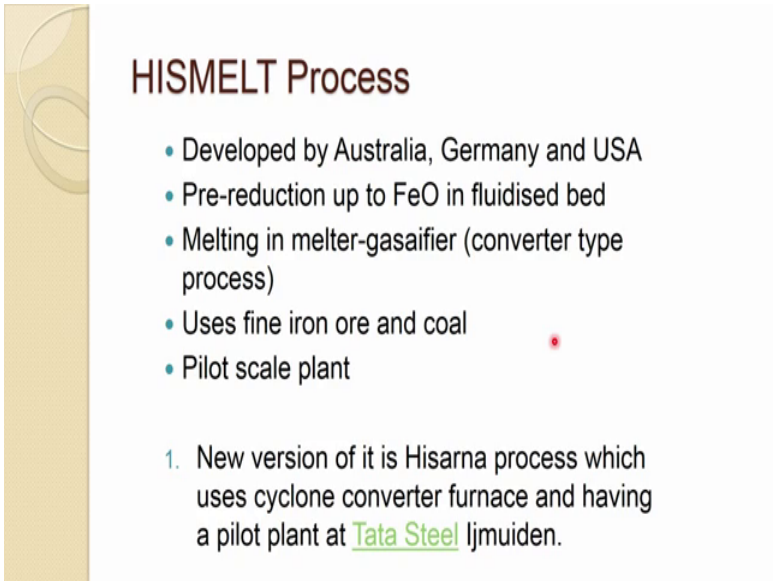

Another one is Hismelt process. So, these look at these.

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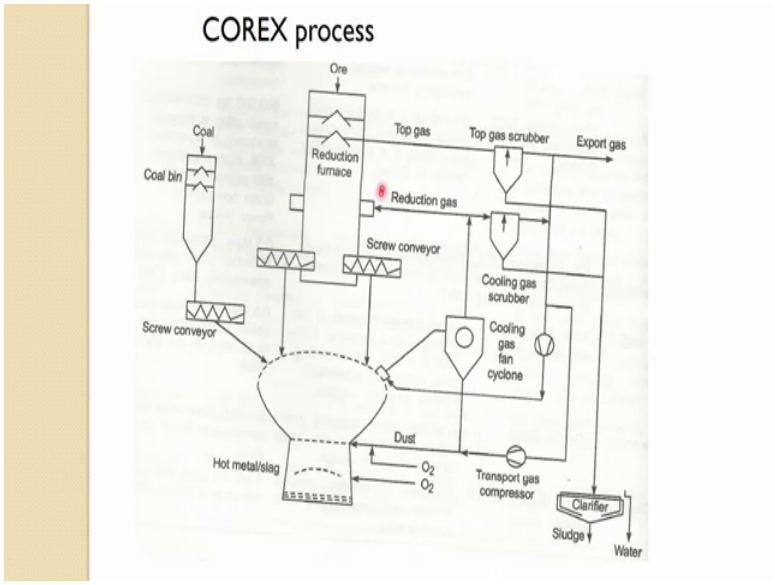

Certainly the corex process is a commercialized one and many plants are operating.

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Finex process on verge of commercialized one commercial plant one is there at the moment, but some other is also coming up soon.

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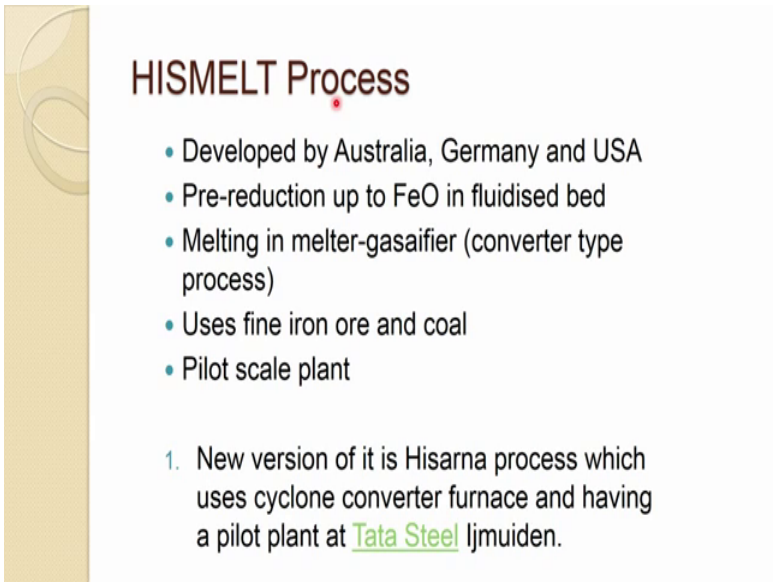

Beside these two there is no other process has the commercial plant. Now Hismelt is a promising one this is started by a C R A Australia long time ago. And then Germany and USA also joined later on in the development of it. So, this is again also based on the fines iron ore and coal.

So, pre reduction up to FeO in fluidised bed melting in a melter gasaifier converter type process uses fine iron ore and coal and pilot scale plant is there and this Hismelt. So, they have a pilot scale plant in a Australian greener the these also taking law they has been now taking where Tata steels and others and they are putting a sort of new version the process called Hisarna process which uses cyclone converter furnace and having a pilot plant at Tata steel ljmuiden.

So, both the process have a quite a lot similarity because this is a upgraded person of it which is using the cyclone converter furnace which was using one of the smelting reduction process, but it is not commercialized.

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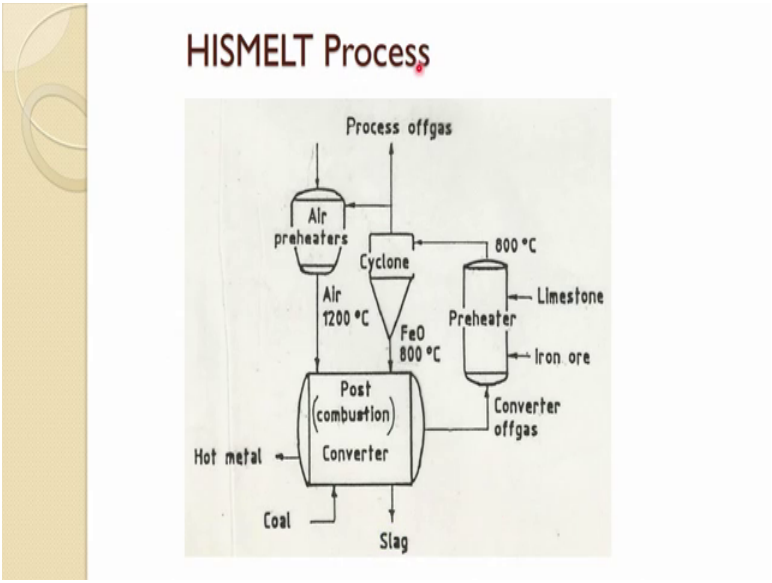

So, on Hismelt process you have a this converter type of reactor as you mention about it.

So, you fed free the coal and of course, the gases also goes into sorry the air with oxygen actually comes into this and hot metal slag comes out pro the off gases which are coming out from the converter this goes for the pre heater of the to pre heat the iron ore and limestone and then goes to the cyclone.

So, most of the reduction upto FeO stage is occurs into this and these fines later on fed into the converter. So, in this post combustion is post combustion occurs it is very integral part of the process and. So, this is a sort of flow diagram of Hismelt in similar type of you can say for Hisarna.

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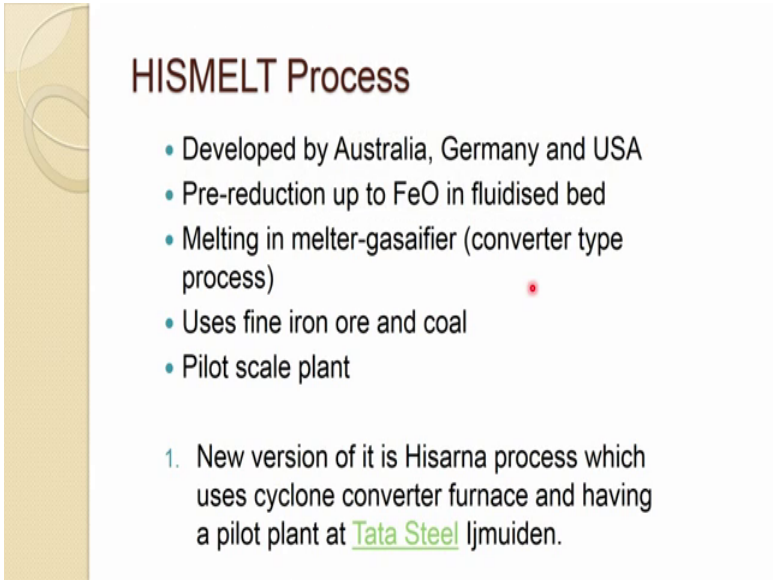

But it has a cyclone converter furnace. Um, But still they are in the development sort of stage not commercialized yet.

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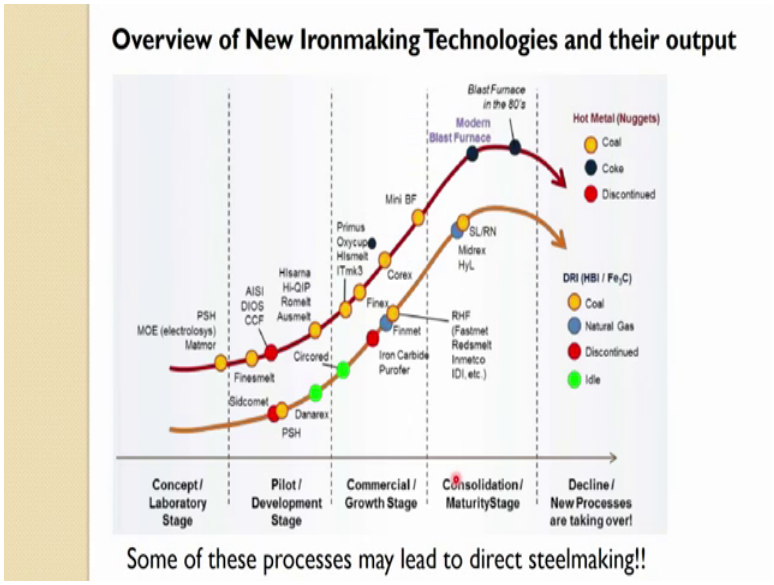

So, in brief we look at the overview of new iron making technologies and their output and this figure summarized in a very good way. So, conception and laboratories stage this electrolosys process PSH can and the process based has come up to the pilot and development stage Hisarna which we talk Romelt, Hi QIP, Ausmelt, Danarex and all these the process which are related to these are smelting reduction and blast furnace

related. So, they produce the hot metals and they processing the bottom one are related to DRI or H B I or sponge iron this produce the solid iron. So, this two curves are representing different in hot metal and solid iron.

So, in the hot metal one is smelting reduction AISI American DIOS, CCF these are the process and Finesmelt on the other end for DRI sidcomet PSH Danarex these are there, but now really none of these sort of operation yellow once these are coal based and blue ones saw the natural gas and in this one the black one source the coke using the coke into it and yellow one source the coal uses. So, some of these processes have been discontinued the red marks mostly red and green sort of iron discontinued.

So, commercial level and the growth stage these are the process which can which has the very high potential especially Hismelt Hisarna Itmk3 Japanese one Primus Oxycup and of course, the there was a iron carbide purofer discontinued finmet R H F these are the processes which are more growth growing stage and it divides a commercialization.

However corex and finex they are commercialized process mini blast furnace is operated in many of the countries again the advantage of this mini blast furnace is like smelting reduction process DRI with which separated when you need a small investment in localized demand to meet, you need a small processes and in the same way the mini blast furnaces were developed and they also working in a country they are in existence especially in Brazil, China, India.

Then a quite mature stage is the process which are (Refer Time: 07:26) modern blast furnace and blast furnace in at stage those are the one which are released to quite matured stage now and then you have a S L R N, Midrex and HyL these again are commercial matured processes which are there. And so, this summarizes most of these processes; so, this is already matured one, these are commercialized one many of them and some are on the verge of commercialization and so, some of these processes may lead to direct steel making hopefully.

So, this about the alternative route of Iron making.

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And we will talk a little bit about the energy and environment related issues in integrated steel plant. So, I will touch upon a briefly on these one because this is also a small part of this course and one. So, done this learned about it with the growing global part problem which is happening. So, we also have the responsible to understand about the energy and environmental related issues which integrated steel plants are facing and we should probably contribute in reducing it.

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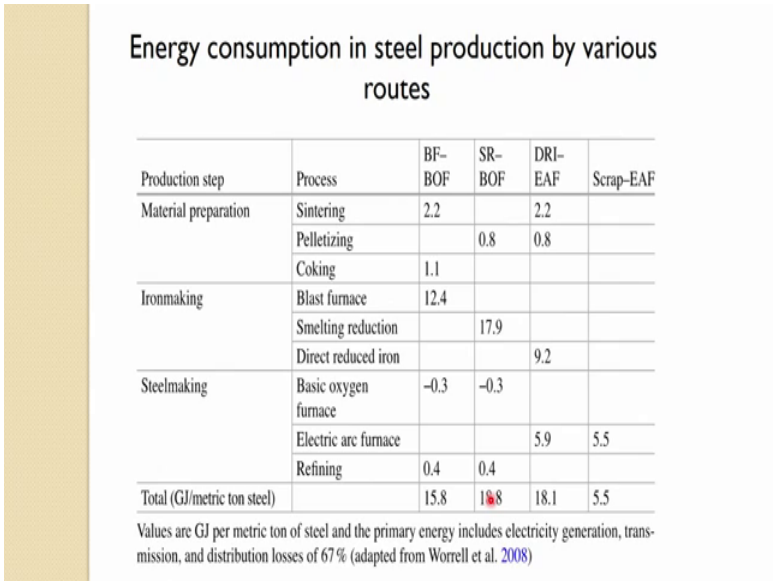

So, we will start with a energy consumption in steel production by various routes; now they are quite a lot argument that blast furnace is quite energy intensive if you look at these table. So, production step process a blast furnace basic oxygen furnace to make the steel smelting reduction you get the hot metal hot metal basic oxygen furnace DRI where you have a solid iron melting it in electric arc furnace. So, by that route you make the steel making another is you already have the a scrap and melting at electric arc furnace and making a state.

So, these are the four rule; so, this is any way because it is just a involving already scrap into electric arc melting it. So, it does not take care of that scrap formation how it arrived. So, certainly it would be having a very low energy. So, material preparation like a blast furnace due to the sintering so, and coking coal is using. So, you can see its takes about 3.3 gigajoule per metric ton of steel and then blast furnace takes about 12.4 quite high and it steel making event you get some energy bag. So, minus point 0.3 refining you give it.

So, total is come to a about 15 gigajoule per metric ton of a steel they are known to use the smelting reduction approach to produce a steel. So, pelletization it takes some of these and then smelting reduction is takes a very high this very high energy of course, some coal based in steel making refining some you have to use it.

So, it is about 18.8 gigajoule and if we go with DRI and electric arc furnace; so, solid iron. So, that is again some other operation that take almost 3 gigajoule per metric ton of a steel and in reducing of it takes 9.2 and then melting of it which is about 5.9; so, 18.1. So, if you look at these main three routes of a steel making blast furnace BOF is still competitive in takes quite low this energy.

So, it will have not address the issue related to energy in this way and that is one of the reason also these processes though they are in to existence is long are unable to compete with the blast furnace BOF route. So, this gives the you sort of summery of the various routes of a steel making and how much energy is used in this various processes.

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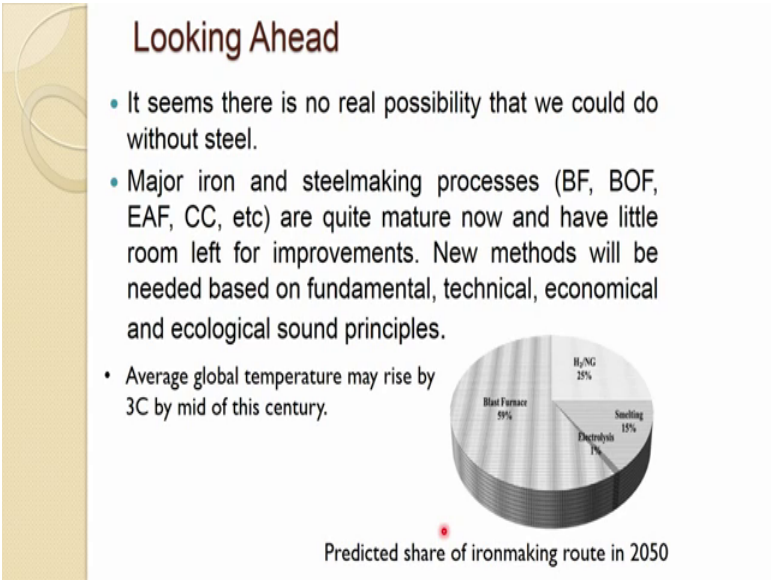

Now, we look a head; so, it seems there is no real possibility that we could do without a steel is very true at the moment no other material is available which can replace steel in (Refer Time: 13:27) major iron and steel making processes blast furnace BOF, EAF continuous casting etcetera are quite mature now and have little room left for improvements.

New methods will be needed based on fundamental, technical, economical and ecological sound principle ecological sound principle is involved in that. And these because from its energies do it in most of the reduction is coming through coal in one way or another. So, which is producing the green house gases and that is where the global part thing is coming.

So, average global temperature it is predicted by mid of this century mid of 3 degree Celsius and there is a sort of a prediction of iron making route by 2050 that blast furnace still would be dominating may be about 60 percent.

DRI, natural gas, route reduction may increase and may go to 25 percent smelting may occur 15 percent and new one process looks promising electrolysis may got 1 percent. So, electrolysis efforts have been done to produce iron, but this would be possible only if electricity is generated by other where not using the coal or in clean way it can be generated in renewal will way on like that.

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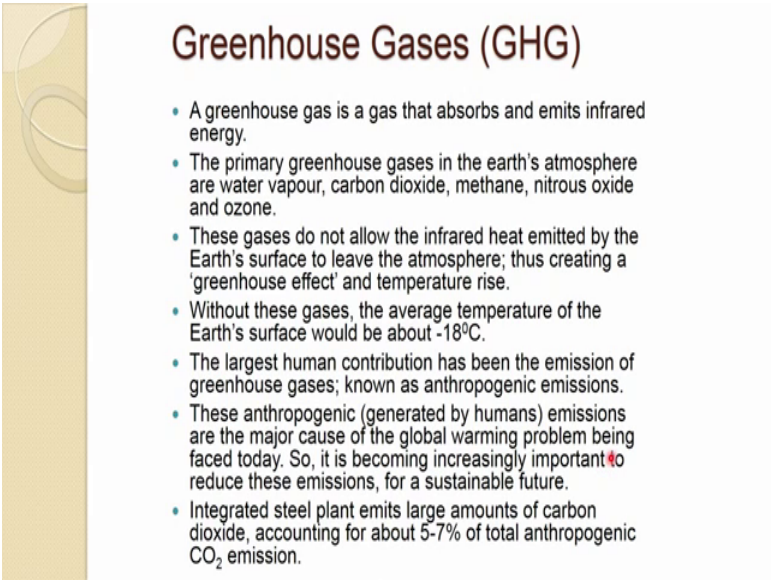

So, lots of talk about a greenhouse gases emission by stirring the trees. So, like due to know what does it mean we talk more about it. So, a greenhouse gas is a gas that absorbs and emits infrared energy. The primary greenhouse gases in the earth atmosphere are water vapour, carbon dioxide, methane, nitrous oxide and ozone. You know already the ozone layer is there around the earth and that is the one actually which is keeping us bit warm. So, it absorbs and emits some.

So, these gases do not allow the infrared heat emitted by the earth's surface to leave the atmosphere thus creating a greenhouse effect and temperature rise without these gases the average temperature of the earth's surface would be somewhere like this. So, ozone is playing a very important role in that now because if these other gases also come into pictures. So, temperature certainly is going to rise and that is where the greenhouse effect is coming into picture and we produce lots of carbon dioxide iron integrated steel plant.

So, the largest human contribution has been the emission of greenhouse gases known as anthropogenic emissions. So, emission which are created by human usually termed as anthropogenic emission. So, these anthropogenic emission are the major cause of the global warming problem being faced today.

So, it is becoming increasingly important to reduce these emissions for a sustainable future. So, integrated steel plant emits large amount of carbon dioxide accounting for about 5 to 7 percent of total anthropogenic CO 2 emission. So, we are contributing quite

a lot in this beside there is a of course, good power of plant and manufacturing industry are doing and, but carbon dioxide is that is the major product which is industries are sending it into their atmosphere beside a of course, a little bit this um, but this is the major one and in this was a lot of efforts are being made to reduce this carbon dioxide emission in the steel plants.

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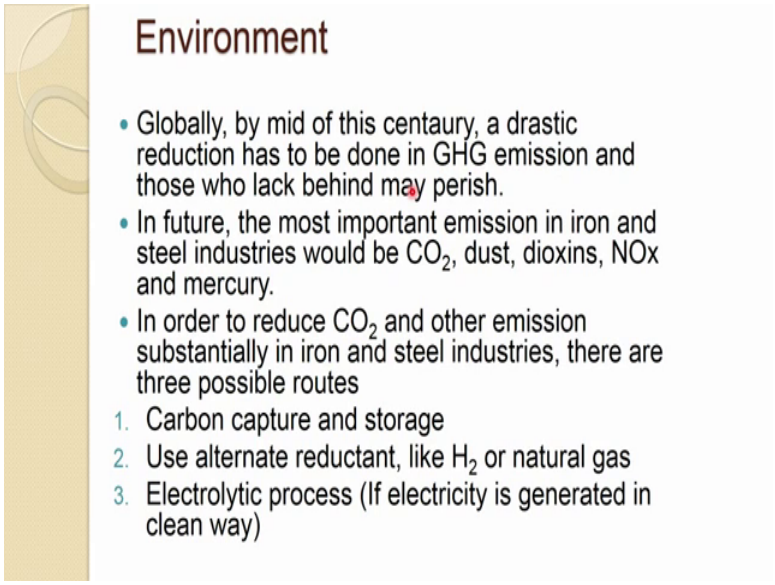

So, globally by mid of this centaury a drastic reduction has to be done in green house gas emission and those who lack behind may perish. So, very stringing rule have been made and recently the perish code is there on environment. So, if industry do not follow these they will they have to shut down.

And in fact, many of them are shutting down due to the violation of this green house gas emission rule. So, in future the most important emission in iron and steel industries would be CO 2, dust, dioxin, NOx nitrous oxide, mercury. In order to reduce CO 2 and other emissions substantially in iron and steel industries they are three possible routes carbon capture and storage use alternate reduction reductant like hydrogen or natural gas natural gas still has a problem reforming again getting a CO 2 like hydrogen is possible one or electrolytic process which we checked talking in the previous slide if electricity is generated in a clean way this is the important aspect of it.

So, beside that in fact there is a another possible like CO 2 coke oven gas and BOF gas they have a. So, combine them then you can make a same gas and by using the pressure

drop reaction you can convert it into the useful liquid product hydrocarbon petrol and like that. So, that way one can also again capture the CO 2 or carbon essentially.

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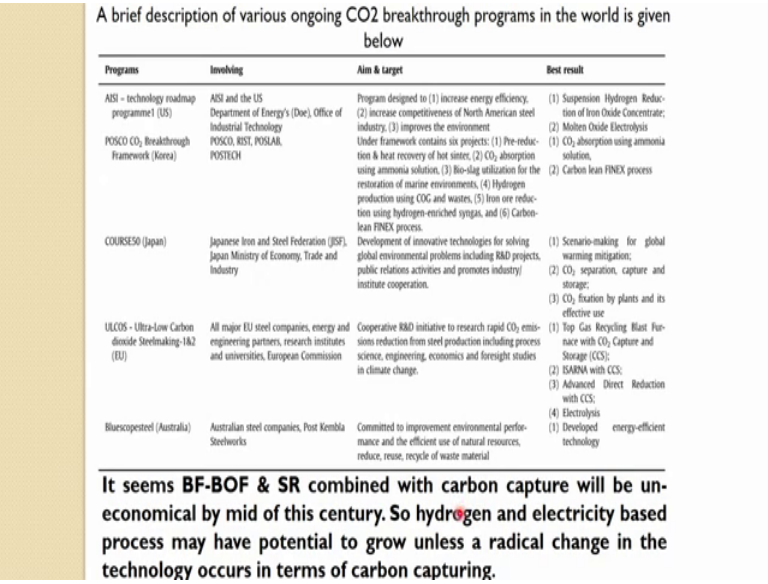

So, this lots of efforts worldwide that go going on to reduce the CO 2 and the steel plants and there are various technologies which are being developed. So, this figure can you saw the brief description of various ongoing CO 2 breakthrough program in the world. So, there is one American AISI technology roadmap. So, in this one mostly that increase the energy efficiency competitiveness in North American steel industry improves the environment.

So, that uses the suspension hydrogen reduction of iron oxide concentrate. So, mostly by hydrogen reduction in molten oxide electrolysis there is a POSCO South Korean steel making plant CO 2 breakthrough program they have and under these they have a 6 projects and the name of most of them is CO 2 absorption using ammonia solution carbon lean finex process.

So, bio slug utilization for restoration of marine environment hydrogen production using coke oven gas and wastes iron ore reduction using hydrogen enriched syngas; we talked about this syngas with can be a combination of C O G and BOF gas and you can produce this syngas and carbon lean finex process COURSE50 that is again ambitious program of Japanese government and it is in many stage of that is by iron and steel federation of Japan.

So, development of innovative technology for solving global environment problem; so, scenario making for global warming mitigation, so, CO 2 separation capture and storage CO 2 fixation by plants and its effective use. So, first stage they have many stage in this because by 2050 they their aim is to reduce 50 percent of that emission.

So, various phases are there of this one first phase is over and second phase is starting which is more related to it industrial trial. I will call this ultra low carbon dioxide is steelmaking European plant reduce the emission. So, cooperative r and d initiative to research rapid CO 2 emission reduction from steel production including process science engineering economics like that and this one top gas recycling of blast furnace with CO 2 capture and storage technique Isarna this hisna with CO 2 capture and storage technique advanced direct reduction.

Again with capture technique electrolysis they are also trying to explore this and the last one is by bluescopesteel Australia. So, Bluescopesteel of Australia; this Australian initiative to reduce the environmental problem. So, and that one efficient use of natural resources reduce reuse recycle of waste material to develop a energy efficient technology. So, currently in a summarized with bisects it seems that blast furnace BOF and smelting reduction combined with carbon capture will be uneconomical by mid of this century.

So, hydrogen and electricity based process may have potential to grow unless a radical change in the technology occurs in terms of carbon capturing. So, this is some of the important aspect related to environment especially with respect to iron and steel industry. And one should be aware of it their many challenges still iron and steel industries are facing. And lots of research can be done experimentally and mathematically also in a modeling way. So, I hope you have enjoyed this course.

Thank you for listening and taking this course.