Iron Making
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Lecture - 37
Iron Making

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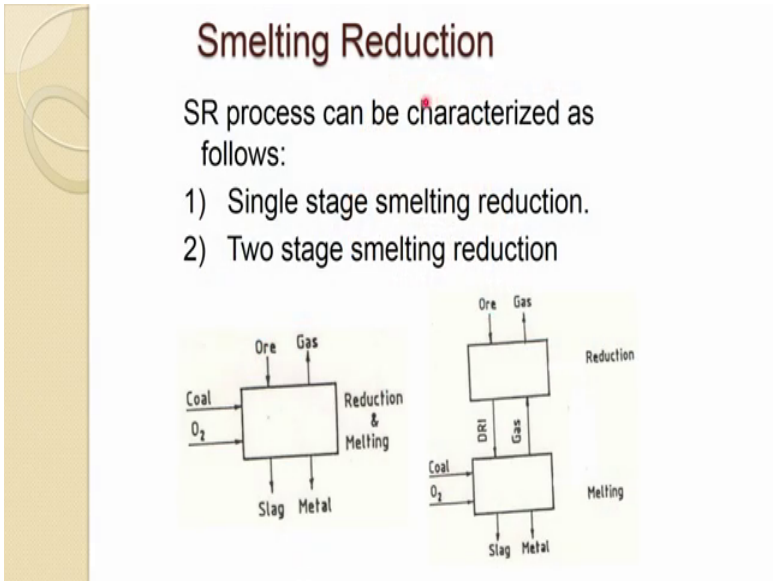

So smelting, reduction can be categorized or classified in three stages, one the single stage is smelting reduction and second is two stage smelting reduction and the single stage smelting reduction. It is shown in this figure. So, in this one coal and oxygen, is fed into the reactor along with the ore and the combustion reduction and melting occurs in the, in the same reactor and you separate out the metal and select and the product gases goes out. So, everything occurs in one reactor. So, that is why it is called as single stage smelting reduction.

How in the two stage? Smelting reduction you and the coal and the oxygen either you put and you fed D R I actually, it is a sortably. These are in, not exactly kept D R I would be having 94 or 93 percent sort of metallization, degree of metallization which we discussed before by substantially reduced D R I and this is also fed into the smelting reactor and where this smelting occurs, like an metal separated out and the product gas, which have the high (Refer Time: 02:05) and reducing potential. They are used to reduce the ore in the another reactors. So, this is a; so, this is like a two stage process. So, in the

first one, you have a reduction of a iron ore from the product gases, which are coming out, from this smelting reactor and in the second reactor that rigid D R I is fed along with coal and the oxygen and the smelting occurs and you get the liquid metal and slag.

So, this is the basic difference. In most of these, smelting reduction processes are in the second one and they starting at a started with the first one, but let down mostly second one was adopted, one of the previous example in the starting high smelt like there, but later on they have been, modified.

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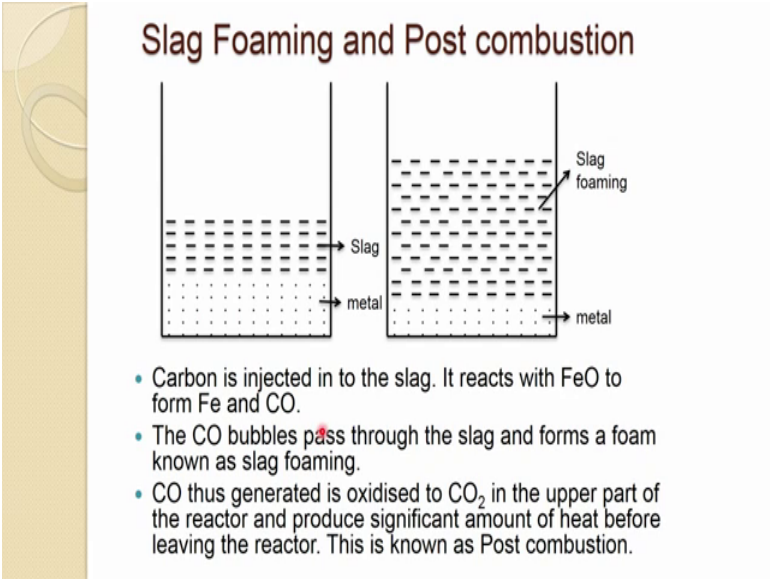

So, we said in the starting about, in the starting of the smelting reduction lecture, we introduced two terms slag foaming and post combustion in this. We will just talk a little bit about it later on. So, here we have that usually in the smelting reactor as you know most of the reduction occur in the liquid stage. So, so we have a solid iron, which is fed in, fed in and you have a slag metal, slag has a quite high percentage of iron oxide.

So, carbon is injected in to the slag and it reacts with F e O to form F e plus CO that we have seen before in the reaction and when the CO is forming. So, CO is a gas and it has to bubble out through this slag. And it is a very intense reaction remember, because in some of that we mention 80 percent F e O and some 20 to 80 percent of very intense reaction takes place a lots of CO generation, happen in that actually. CO has to bubble out and that gives a sort of foaming reaction. So, it expend, it makes the slag has foam 1.

So, that is called as the slag foaming that level rises of the slag and a metal also encrypt into this droplet. So, that is called the slag foaming.

So, one way it is insulating, the metal from heats and other thing. So, acts as a insulated, keeps a temperature. So, this phenomena is slag foaming and in other hand, if, when the C O, which is forming in this intense reaction. So, CO as you know it is, has a high (Refer Time: 05:27) value. It can be formed, because oxygen also in the reactor, which is a closed reactor. Let us say; so, oxygen is also introduced in this. So, CO react with the oxygen and keeps CO 2 and that is a very exothermic reaction, lots of heat is produced and this heat actually that is bond.

So, CO is bonding here and that heat is being utilized to about the melting purpose in the reactor. So, the heat, which is getting produced by burning of CO at the top of the reactor, but inside the reactor is known as the post combustion. So, in one ways, you are combusting the gases and utilizing the energy of these to heat up the, (Refer Time: 06:14) of over a metal or, or a describe any of these thing.

So, you are utilizing that heat and that is why it is termed as post combustion. Mostly, it is in a single reactor, it occurs and one good example also, it still making the basic oxygen for lesson like that your post combustion, under the things occur. So, this is the meaning of post combustion and slag foaming and especially smelting reduction processes. These are quite common in smelter a reactor. So, CO bubbles pass through this slag and forms the foam known as slag foaming C O. Thus generated, it is oxidized to CO 2 in the upper part of the reactor and produce significant amount of heat before leaving the reactor.

Because that is a exothermic reaction. So, this is known as post combustion. So, now, I hope you are familiar with the terms of slag foaming and post combustion and these phenomena are quite common in most of this smelting reduction.

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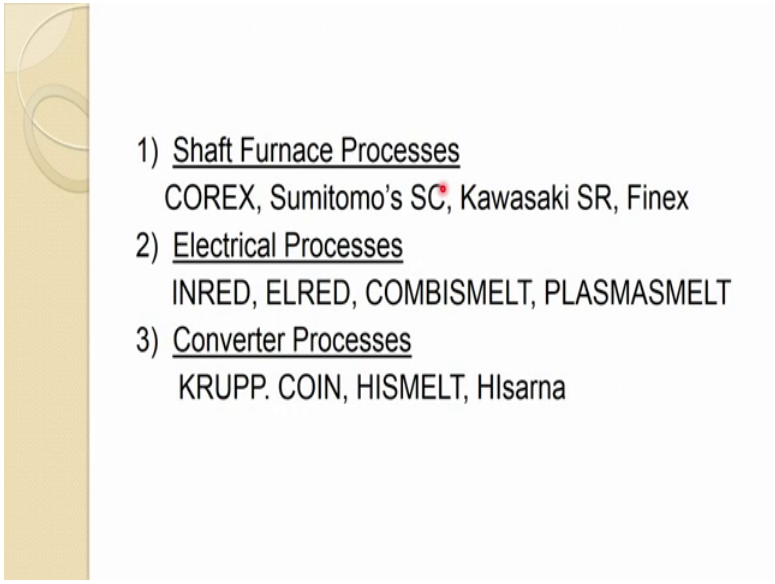

So, now, that is smelting reduction process can be divided into different categories; those process said, which are based on shaft furnace. These are like COREX, Sumitomo's S C, Kawasaki S R, Finex. So, these are based on this shaft furnace base electrical processes. Some processes uses also electric, as an energy source like INRED, ELRED, COMBISMELT, PLASMAMELT. These processes and some other they use electrical (Refer Time: 08:08) other. And the third type is converter processes, where you have a single sort of converter in which, the smelting occurs. So, KRUPP. COIN, HISMELT and Hlsarna. These are the processes, these comes under these.

So, only few processes which have been commercialized, we would be again just talking a little bit about those process, and leaving the other processes. So, COREX is, is a quite commercialize process, which has many plant all over the world.

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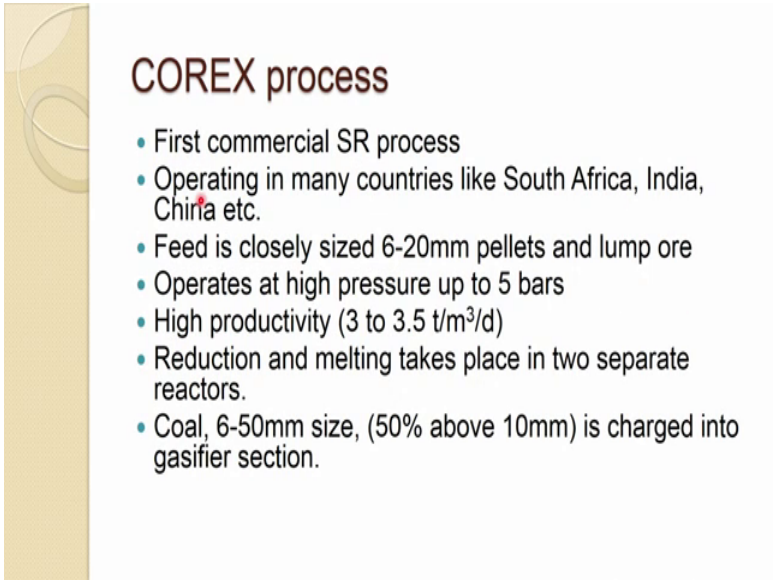

Now, so, first commercial smelting reduction process operating in many countries like South Africa, India, China etcetera, feed is closely sized 60 20 mille meter pellets and lump ore. So, remember, in this one, you have to feed as pellets or lump ore. So, it does not take fine and this is, the difference in this model operates at high pressure up to 5 bars, takes a quite high productivity, reduction and melting takes place in two separate reactors. So, it is a two stage process coal 6 to 50 mille meter size, 50 percent above 10 mille meter is charged into the gasifier section.

So, there are some requirement of the charge, which should be in the sort of range and. So, at this processes sends it to this charges, but (Refer Time: 10:05) you can see it uses coal and pellet. So, without the using, the coke.

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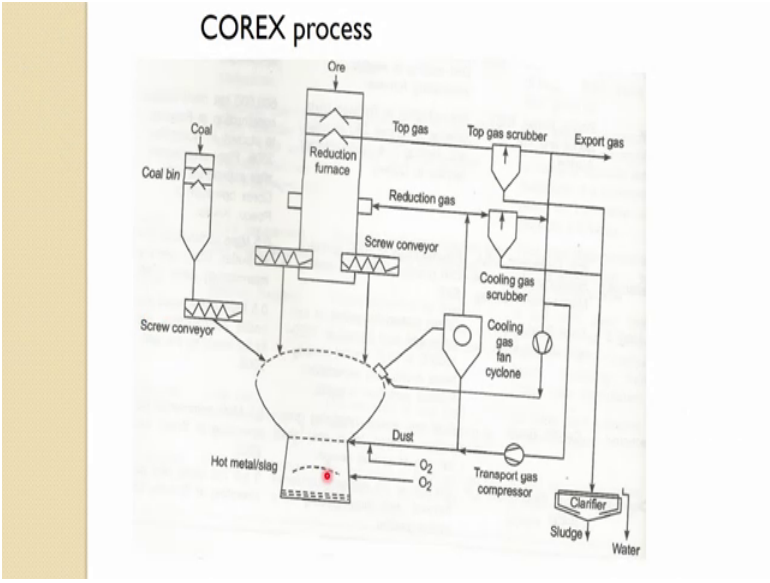

So, the flow diagram of this process is like this. So, you to introduce the oxygen and the coal; so oxygen from the bottom, coal from the top, and the dust also, which generating into edge. You can put away little and smelting occurs in this reactors depending, how much post combustion unit you can, put the oxygen amount accordingly, because otherwise, even this energy is used for the reduction of the furnace or reduction of the iron ore.

So, iron ore is, fed, into this, reduction chamber in that reactor like a sub furnace type reactor and reducing gases, which are coming out from the melter gasifier. This is known as melter gasifier. So, the reducing gas, which are coming out after removing dust and other thing are fed into this, reduction chamber and they ore get reduced and these reduced, ore are fed through this screw feeder into the smelter gasifier and this hot.

So, since you will heat even of these reduced gas is also being used into this and then this smelting occurs into that that one and, because oxygen is used here most of the smelting, reduction processes use oxygen; so there off cases a very high calorie value. So, top gases mostly, they are used in the plant, for all the power requirement, but still they have a very high calorie value.

So, they are used for power generate and export the electricity or gases for other purposes. So, this is a typical diagram of the corex process and as I said, this is one of the most popular commercialized smelting reduction process. Now, nowadays, which is

having a few plant in some of the country; however, the productivity is not as high as the blast furnace, another process is FINEX smelting reduction process.

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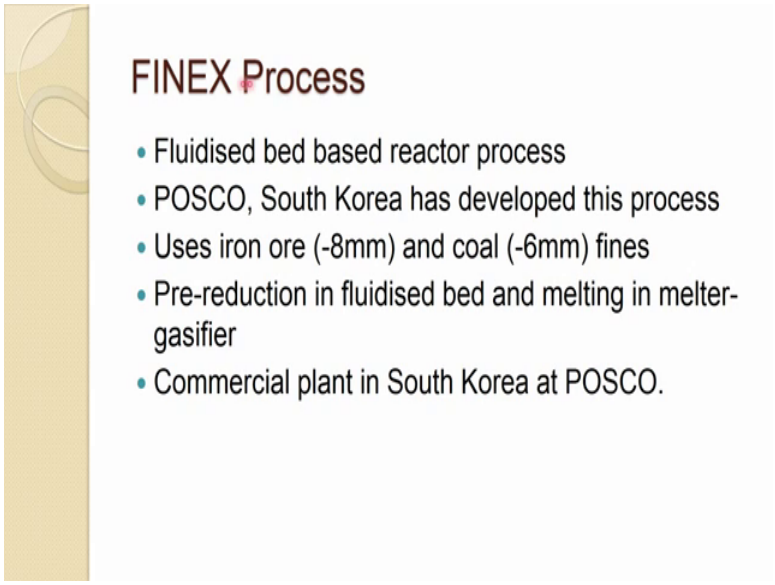

So, fluidised bed, this is a fluidised bed; so this one, because this is shaft bed packed bed sort of sort of one. So, here or is not fluidised and these, those pellets are getting reduced and being fed into a smelter specifier, melted specifier in that one. So, this in the form of pellets; however, in FINEX one, it is a, it is a fluidised bed, bed reactor. So, usually you can use the iron ore fines in this. So, size of this ore would be low.

So, POSCO, South Korea, still company actually has developed this process. This essentially, what they did is, they studied the COREX process. They bought the COREX plant and they modify that process and introduce the fluidised, bed and that is how they came up the finex process. So, uses the iron ore as a mentioned, so less than 8 millimeter. So, it can use the fines and the same way, the coal fines also. So, major advantage of this, is using the fines, because lots of fines are generated from mining till the melting operation and those becomes a problem, then you have to use the agglomeration technique pelletisation and simply plant and extra investment in, in iron making, processes.

So, this eliminates a agglomeration plant also, altogether beside the coke carbon, because it is using coal. So, no coke requirement pre reduction in fluidised bed and melting in melter gasifier occurs. So, again this sort of (Refer Time: 15:15), process. So, pre

reduction in one reactor, which can have a series of it and melting melter gasifier and commercial plant in operation, in is, in operation is South Africa at POSCO, sorry, South Korea at POSCO.

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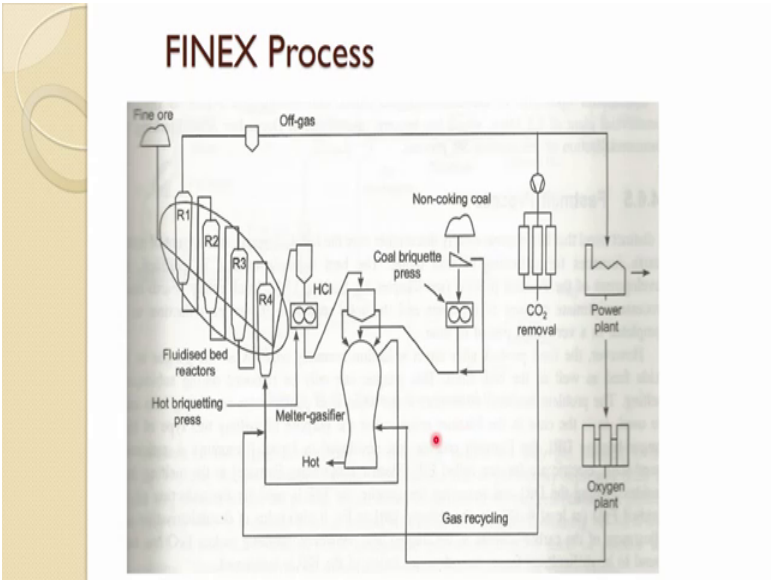

So, this is a flow chart of the finex process, where again melter gasifier is there through, put the oxygen and other gases. Essential, features are more or less same in most of this melting um, processes um. So, this off gases actually introduced, into the fluidised bed reactor, which are in the series and by the time. It comes out from the R 1 that is, you get almost, quite reduced, iron ore. Now, because iron ore, it is find in nature. So, it has to be briquetted difficult to, put it directly.

So, hot briquetting is done, of the, of this one is comes and through that the hot briquetting machine and this hot, hot briquette are fed into the melter gasifier and this is similar to the COREX, process. This melter gasifier, no need to describing it again and, these recycling sort of gases goes, again for the reduction purposes and even some off gases and because here also one using oxygen, which has a very high amount of (Refer Time: 17:16) value energies. So, use it for power plant and other purposes, it has the (Refer Time: 17:22) some CO 2 removal plant.