Steel Making

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Module No. # 01

Lecture No. # 19

Modern Steelmaking II, Electric Arc Furnace

In the last lecture, I have said about stainless steel making in electric arc furnace. I have also said, the different types of stainless steel which are to be manufactured for different applications. I have also said, because of the limited availability of high quality stainless steel scrap, it has become important to use high carbon ferrochrome, required to decarburize iron chromium melt, because most of the stainless steel applications for most of the applications, they require carbon in a very low range.

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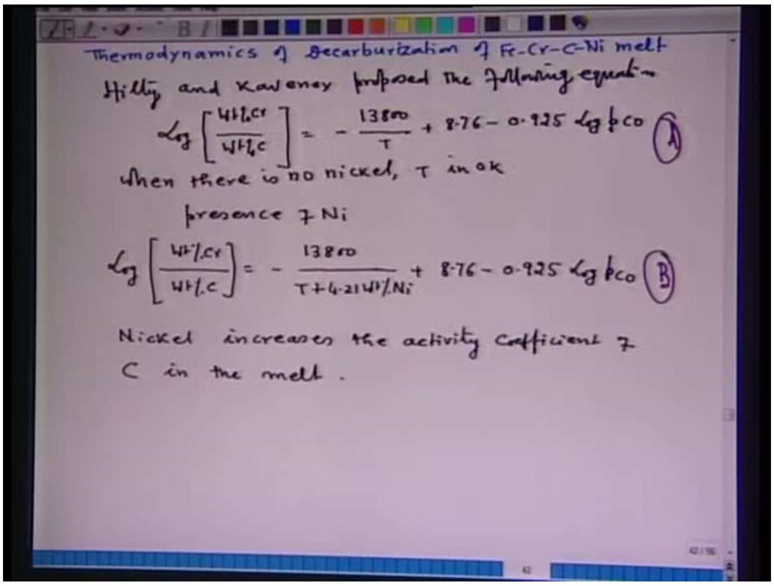

Thermodynamics of decarburization of Fe-Cr-C-Ni melt

Hilty and Kaveney proposed the following equation

$$\log\left[\frac{wt\%Cr}{wt\%C}\right] = -\frac{13800}{T} + 8.76 - 0.925 \log p_{CO} \quad (A)$$

when there is no nickel, T in °K

presence of Ni

$$\log\left[\frac{wt\%Cr}{wt\%C}\right] = -\frac{13800}{T + 4.21\, wt\%Ni} + 8.76 - 0.925 \log p_{CO} \quad (B)$$

Nickel increases the activity coefficient of C in the melt.

So, therefore, use of high carbon ferrochrome required the decarburization of iron, chromium, carbon containing melt. I have also said, that decarburization in presence of chromium, can only occur at very high temperature. If we blow oxygen, until that high temperature reaches, chromium oxidizes in preference to carbon. I have also said at that time, that we have to find out a temperature at which carbon oxidation begins in preference to chromium oxidation. In that connection, I had given you two equations and those equations I have again written for you, that is the equation a, it tells the distribution of chromium and carbon as a function of temperature and partial pressure of carbon monoxide for iron, chromium and carbon melt. If the melt has nickel also, nickel increases the activity coefficient of carbon. So, therefore, an another equation was proposed for decarburization of iron, chromium, carbon and nickel melt and this equation is shown in b.

Now, let us today illustrate the effect of temperature and partial pressure of carbon monoxide for two different melts. What I am doing, I will be taking the different temperature; I will be also taking different partial pressure of carbon monoxide to illustrate to the effect of temperature and partial pressure of carbon monoxide; then I will take an example for iron, chromium and carbon melt and I will also take an example of iron, chromium, carbon and a constant nickel, for example, 10 percent nickel.

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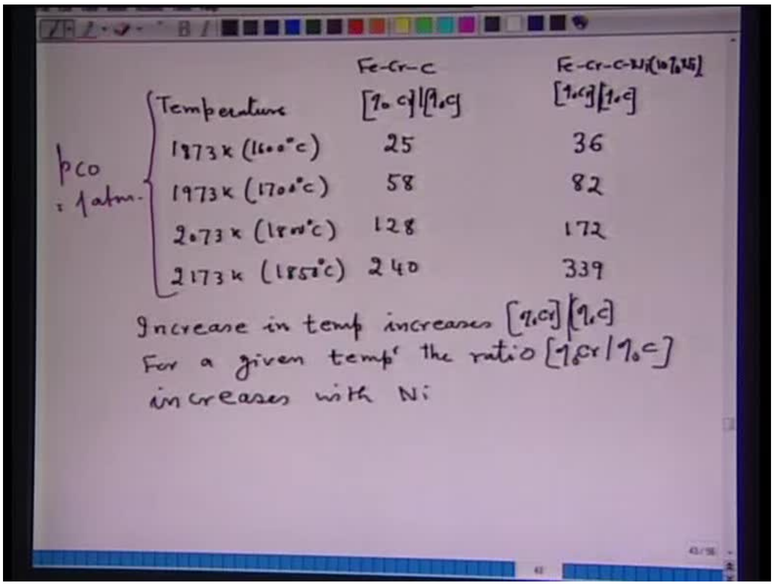

$p_{CO} = 1$ atm.

Temperature	Fe-Cr-C [%Cr]/[%C]	Fe-Cr-C-Ni(10%Ni) [%Cr]/[%C]
1873 K (1600°C)	25	36
1973 K (1700°C)	58	82
2073 K (1800°C)	128	172
2173 K (1850°C)	240	339

Increase in temp increases [%Cr]/[%C]
For a given temp' the ratio [%Cr/%C]
increases with Ni

Now, as regards the calculation procedure, I have presented over here. I take temperature. Then, I have taken iron, chromium, carbon melt and I will calculate the ratio of percentage chromium upon percentage carbon in melt. Next, I will calculate for the same temperature, the ratio of weight percent chromium upon weight percent carbon in melt, for iron, chromium, carbon and nickel. I am illustrating for a constant percent nickel, for example, 10. You can calculate, for example, for 12 or 14 or whatever, if the need arises.

So, what I am doing, I am using the equations a and b for that calculation purposes. So, suppose, I take temperature 1873 Kelvin which is 1600 degree Celsius, I substitute that value and I put p C O is equal to 1 atmosphere, then I will be calculating this ratio as 25 and here this ratio is 36. If I take now, a temperature 1973 Kelvin, which is equal to 1700 degree Celsius, then the ratio is 58 for iron, chromium, carbon melt and the ratio is 82 for iron, chromium, carbon and nickel melt. If I take a temperature now of 2073 Kelvin, which is 1800 degree Celsius, then the ratio becomes 128 and here 172. If I take the temperature 2173 Kelvin, which is equal to 1850 degree Celsius, the ratio becomes 240 and here it becomes 339. Now, mind you, these calculations are performed by taking partial pressure of C O that is equal to 1 atmosphere.

What this calculation says? Increase in temperature increases the ratio of chromium to carbon in the melt, that I am going to write, increase in temperature, increase in temperature, increases percent chromium in metal upon percent carbon in metal. So, for example, if I take 1600 degree Celsius as my temperature, then the ratio is only 25. If I take now 1850 degree Celsius, the ratio is 240, which increases, when nickel is there to 339. So, another is that, for a given temperature, the ratio percent chromium upon percent carbon in melt, it increases with nickel content. Reason is obvious, because nickel increases the activity coefficient of carbon. So, now, let me illustrate, what is the effect of when we decrease the partial pressure of carbon monoxide.

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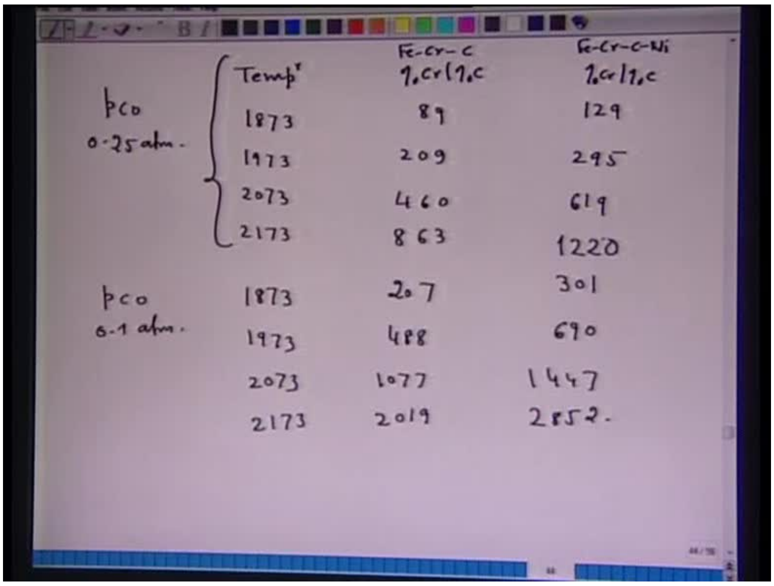

		Fe-Cr-C	Fe-Cr-C-Ni
	Temp	%Cr/%C	%Cr/%C
p_{CO} 0.25 atm.	1873	89	129
	1973	209	295
	2073	460	619
	2173	863	1220
p_{CO} 0.1 atm.	1873	207	301
	1973	488	690
	2073	1077	1447
	2173	2019	2852.

Now, the same thing, I take now partial pressure of carbon monoxide say 0.25 atmosphere . Again I take here, temperature and the ratio of percentage chromium upon percentage carbon for iron, chromium and carbon melt and percentage chromium upon percentage carbon in the melt for iron, chromium, carbon and nickel. Temperatures, again I take 1873, 1973, 2073 and 2173. The ratio here is 89, 209, 460 and 863. Here 129, 295, 619 and 1220. So, you see, decrease in partial pressure of carbon monoxide from 1 atmosphere to 0.25 atmosphere, it increases the ratio of percentage chromium upon percentage carbon in the melt for all temperatures.

Now, if I take for example, further I reduce the pressure. So, I do p C O is equal to 0.1 atmosphere. So, these are for p C O is equal to 0.1 atmosphere and I again calculate for all the four temperatures, then the ratio becomes 207, 488, 1077 and 2019. Here it becomes 301, 690, 1447 and 2852. So, what this calculation indicates? This calculation indicates, if we reduce the partial pressure of carbon monoxide, then the ratio of percent chromium upon percentage carbon, it increases drastically.

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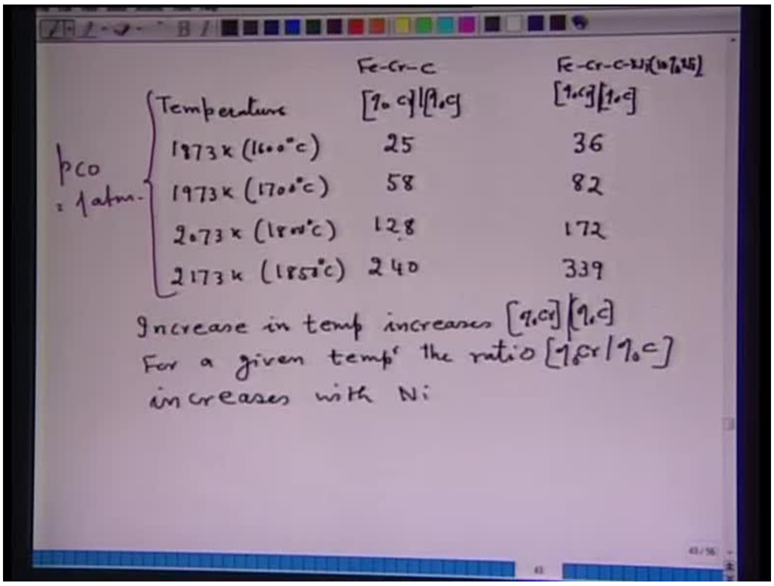

	Temperature	Fe-Cr-C [%Cr]/[%C]	Fe-Cr-C-Ni (10%Ni) [%Cr]/[%C]
p_{CO} = 1 atm.	1873 K (1600°C)	25	36
	1973 K (1700°C)	58	82
	2073 K (1800°C)	128	172
	2173 K (1850°C)	240	339

Increase in temp increases [%Cr]/[%C]
For a given temp' the ratio [%Cr/%C]
increases with Ni

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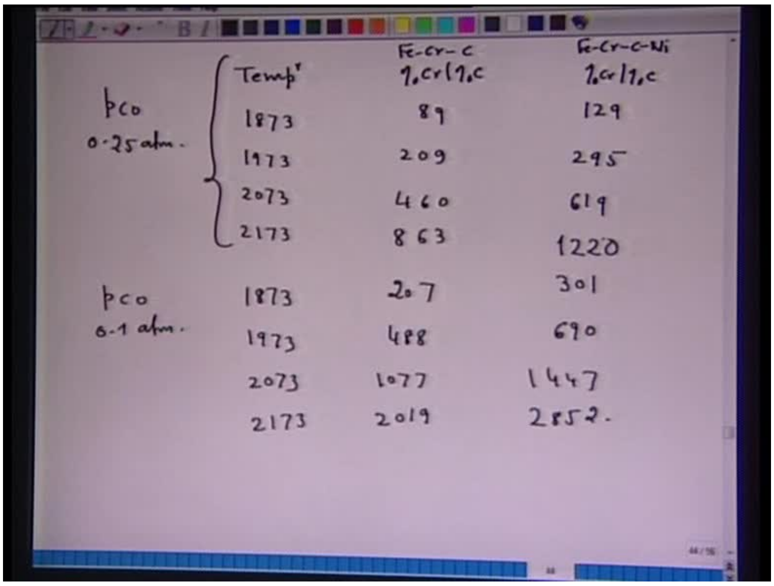

	Temp'	Fe-Cr-C %Cr/%C	Fe-Cr-C-Ni %Cr/%C
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	2073	1077	1447
	2173	2019	2852.

If I take p C O is equal to 1 atmosphere for example, if I take p C O is equal to 1 atmosphere at 2073 Kelvin, the ratio is 128. The same ratio becomes 460, when p C O is 0.25 atmosphere and the same ratio becomes 1077, when p C O is equal to 1 atmosphere. That means now, by decreasing the partial pressure of carbon monoxide, I can increase this ratio; that means, I can allow now carbon reaction to proceed at much lower temperature. So, that is what the importance of temperature and partial pressure of carbon monoxide.

So, what we gather or what the scientific calculation suggest us, that, if you want to carry out decarburization of iron, chromium, carbon, nickel melt at partial pressure of carbon monoxide is equal to 1 atmosphere, then the decarburization is only possible at a very high temperature. Now, this temperature can be reduced, when you decrease the partial pressure of carbon monoxide. The extent of reduction of this temperature will depend upon, the extent of reduction of the partial pressure of carbon monoxide. If you can lower down further the partial pressure of carbon monoxide, for example, you make stainless steel under vacuum and pressure is very low, then, the decarburization can be carried out still at lower temperature. So, this is an important conclusion of this particular calculation, as far as the effect of temperature and partial pressure of carbon monoxide is concerned.

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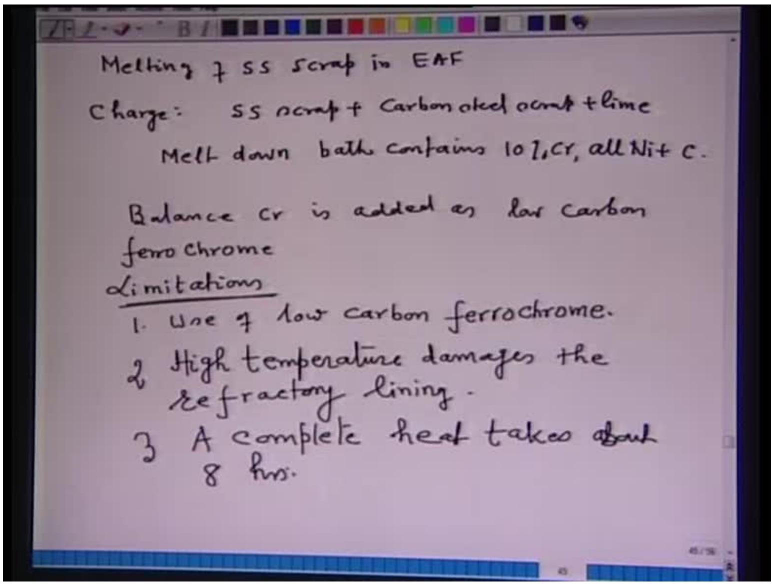

Melting of SS scrap in EAF

Charge: SS scrap + Carbon steel scrap + lime

Melt down bath contains 10 % Cr, all Ni + C.

Balance Cr is added as low carbon ferro chrome

Limitations

1. Use of low carbon ferrochrome.
2. High temperature damages the refractory lining.
3. A complete heat takes about 8 hrs.

Now, another important thing, in this particular case, also, how to make now use of these calculations in the stainless steel making. So, let us see, first of all, melting of scrap in, melting of stainless steel scrap in E A F, in the light of knowledge that we have gathered previously. So, charge, it consists of S S scrap plus carbon steel scrap plus lime. Mind you, the melting of S S scrap in E A F is carried out at atmospheric pressure. So, p C O is that 1 atmospheric pressure. After charging, same, melt down, the charge is molten in the melt down period and at the melt down period the bath contains, for example, 10 percent chromium, all nickel which you have charged, plus carbon.

Now, oxygen is blown into iron, chromium, nickel, carbon melt. Unless the temperature rises, the carbon oxidization does not begin. So, lot of chromium gets oxidized. Oxidation of chromium is exothermic reactions. Temperature of the bath rises and then, carbon also begin to decrease. So, initially chromium oxidizes until bath temperature rises to 1800 degree Celsius. Above 1800 degree Celsius, carbon begins to oxidize. So, what is important here is that, higher chromium content at the end of melt down stage will require higher temperature, as already we have seen in the calculation.

So, what is important, at the melt down stage that the chromium content, I should not say too low, but it should not be very high, because then you will be requiring very high temperature for carbon to oxidize. So, when this practice, when this has been attained, a decarburization has occurred, then, in the finishing stage, balance chromium is added, as low carbon ferrochrome and then, the heat is finished. It is tapped and well, cast and so on and so forth.

Now, this particular technology was working for a long time, but there are certain limitations of this technology. The first limitation of this technology is use of low carbon ferrochrome. Second effect, as a result of high temperature working in electric arc furnace is at high temperature, damages the refractory lining. Third important point is this. A complete heat, a complete heat, it takes about 8 hours from charging to finishing. We require a stainless steel at a reasonable cost. These limitations or that technology using electric arc furnace, made this stainless steel cost high. What is to be done? It is a challenge to the technologist and these limitations that were imposed in electric arc furnace steelmaking paved the way to find out an alternative technology.

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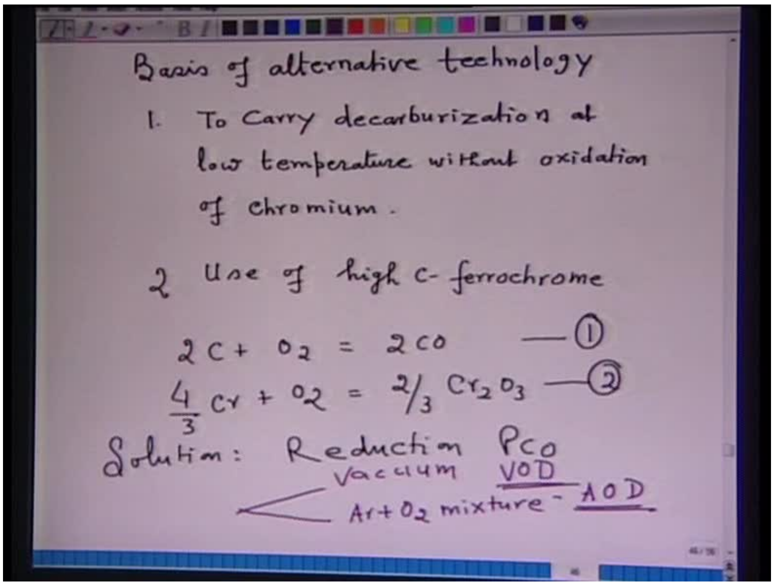

Basis of alternative technology

1. To Carry decarburization at low temperature without oxidation of chromium.

2 Use of high C- ferrochrome

$$2C + O_2 = 2CO \quad \text{—} ①$$

$$\frac{4}{3} Cr + O_2 = 2/3\, Cr_2O_3 \quad \text{—} ②$$

Solution: Reduction P_{CO}

Vacuum VOD

Ar+O_2 mixture - AOD

The basis of alternative technology is, basis of alternative technology is, one to carry decarburization at low temperature. This is one particular challenge or one particular basis of development of a new technology, to carry decarburization at low temperature without oxidation of chromium. Second, as repeatedly I have said, low carbon ferrochrome is very expensive and hence, high carbon ferrochrome, if it can be used for production of a stainless steel containing high chromium, then it will be economical.

So, the second challenge was, use of high carbon ferrochrome. What is the scientific solution? The scientific solution is that, if carbon is to be oxidized in preference to chromium at a given temperature, what we should do it? I have just told you the role of partial pressure of carbon monoxide. I have also illustrated what happens, if I reduce the partial pressure of carbon monoxide. In the earlier calculation I have shown you, that deduction of partial pressure of carbon monoxide increases the ratio of chromium to carbon in the melt and as a result I can produce a low carbon without causing oxidation of chromium. That is what the calculation we have seen.

So, what is the solution? To oxidize the carbon in preference to chromium, we must aim at the reduction of partial pressure of carbon monoxide below 1 atmosphere. For example, whatever you can reduce, you will gain in deduction in the temperature, 1, 2.5, 2.25 or 0.1, as you see in the calculation, then this is possible. Simple. We can also see, for example, if I write down the reaction 2 C plus O 2 that is equal to 2 C O. 1 mole of oxygen it produce 2 moles of C O. So, obviously, decrease in pressure will favor carbon oxidization in presence, for example, if I have 4 by 3 chromium plus O 2 that is equal to two third chromium oxide.

I need not want to carry out the calculation. Just, I have to see both these equations, and if I see both these equation, in the equation one there is a effect of pressure, in the equation two there is no effect of pressure. So, by simple seeing the reaction, it is clear that if I decrease the partial pressure of carbon monoxide, then the carbon oxidation will be favored. So, what is the solution, now, to those two challenges. The solution is reduction in partial pressure of carbon monoxide.

Now, how this reduction of partial pressure of carbon monoxide can be done? Say, it is easy, but then, it is to be done, it is to be practiced, it is to be used and then you have to produce stainless steel at the economic cost. That is the important because, that technology which is economical, which will work. Otherwise, that will lose its significance. How to reduce partial pressure of carbon monoxide? One way, we use vacuum. That is vacuum oxygen decarburization process. Very expensive to employ vacuum and then to carry out the stainless steel making; however, for various special quality this process is being adopted.

Another is that, we use argon plus oxygen mixture. Imagine, if I take now, a mixture of argon and oxygen, instead of pure oxygen, then argon will react as a diluents and it will decrease the partial pressure of carbon monoxide. So, this particular process, using argon and oxygen mixture has become very popular and this process is known as A O D, A stands for argon O stands for oxidation and D stand for decarburization. So, the whole process is known argon oxygen decarburization process. Now, let us see what this process is.

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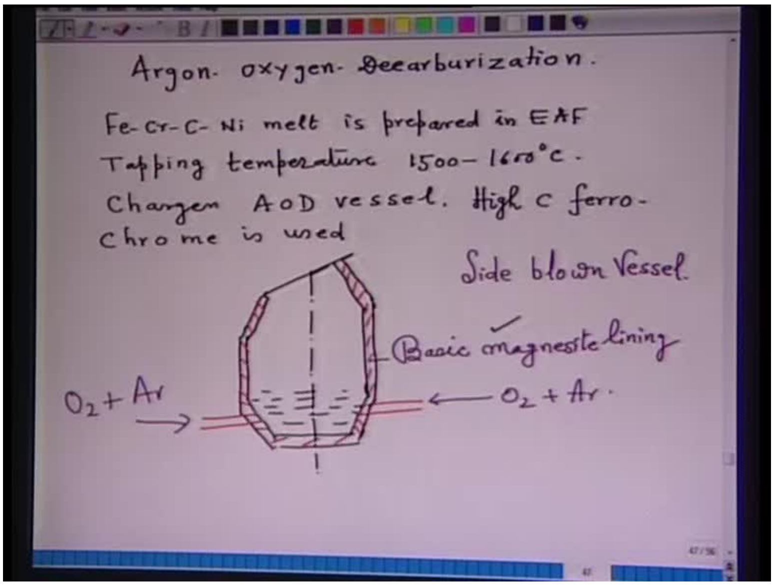

Argon- oxygen- Decarburization.

Fe-Cr-C-Ni melt is prepared in EAF
Tapping temperature 1500–1600°C.
Charged in AOD vessel. High C ferro-chrome is used

So, argon oxygen decarburization process. Now, in this process, the iron, chromium, carbon, nickel melt is prepared as usual in electric arc furnace; that means, this argon oxygen decarburization process works in combination with electric arc furnace. So, the input of this argon oxygen decarburization process is the output of electric arc furnace and the output of electric arc furnace is a melt which contains iron, chromium, carbon, nickel melt is prepared in the electric arc furnace. Tapping temperature is 1500 to 1600 degree Celsius, charged in A O D vessel. Here high carbon ferrochrome is used to prepare stainless steel.

So, typically I have shown A O D converter. So, it is again a pear shaped vessel, lined with basic magnesite lining. Now, the important point in this A O D vessel is that, these vessels are side blown. On the side of the converter, there are 4 to 6 or 8 tiers are arranged and a mixture of oxygen plus argon is blown into the vessel. Those heats which can tolerate nitrogen, then a mixture of oxygen and nitrogen can also be blown. But to start with, if those heats which cannot tolerate the nitrogen content in steel, then you have to blow argon, in order to reduce the partial pressure of carbon monoxide.

So, how this is done? Iron, chromium, carbon, nickel melt from electric furnace is transferred to the A O D vessel. High carbon ferrochrome is added and the blow begins with the blowing of argon and oxygen mixture.

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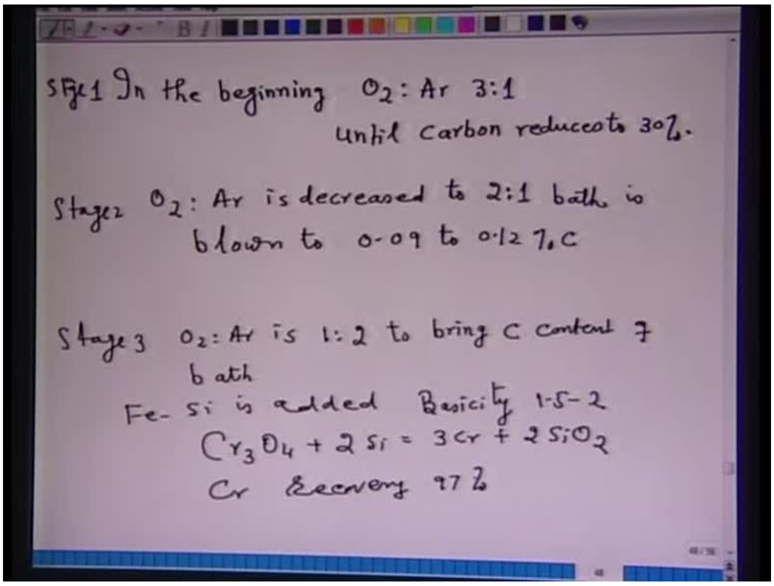

Stage 1 In the beginning O_2 : Ar 3:1
until carbon reduces to 30%.

Stage 2 O_2 : Ar is decreased to 2:1 bath is
blown to 0.09 to 0.12 % C

Stage 3 O_2 : Ar is 1:2 to bring C content of
bath
Fe- Si is added Basicity 1.5-2
$Cr_3O_4 + 2Si = 3Cr + 2SiO_2$
Cr Recovery 97%

Now, typically, in the beginning, oxygen is to argon ratio is kept 3 is to 1; that is, in the beginning until carbon reduces to around 30 percent. Now, since they are blowing along with the argon, so, it is possible to carry out decarburization at a lower temperature also. Now, when carbon is reduced to 30 percent, then oxygen to argon ratio is decreased to 2 is to 1. Now, decrease the oxygen, because you require less oxygen for the oxidation of carbon and the bath is blown to 0.09 to 0.12 percent carbon. So, if you call this as a stage 1, this is stage 2. Then in stage 3, the oxygen to argon ratio is 1 is to 2, to bring carbon content of bath to the desired value, could be 0.02 0.025 or whatever. So, this is the blowing schedule of a typical argon oxygen decarburization converter in order to produce a stainless steel.

The main point to understand over here is, a mixture of argon and oxygen is blown and that mixture does the job of removal of carbon at lower temperature. Now, major change in this practices is occurred in the last few years. That is instead of argon, those heats which can tolerate little amount of nitrogen, nitrogen can also be blown. However, some degassing is also possible in the stage 3, some amount of nitrogen can also be removed.

Some manifestation, say, first stage blow it generates heat and a coolants of the order of 5 to 10 percent of the coolant, they are added. Stainless steel as a coolant is better. The cooling or the coolant addition is done during first stage, when temperature rises to 1690 or 1700 degree Celsius. When carbon has been removed, then ferrosilicon is added to recover lost chromium into slag, back to the metal. Because, when a mixture of oxygen argon is blown, some amount of chromium will also be oxidized in the beginning and that chromium as C r 2 O 3 it collects in the slag.

Now, the most important is decarburization. Let little amount of chromium, if it oxidizes, let it oxidize, because then it can be recovered by addition of ferrosilicon and that is being done in the practice. When carbon is come down to the specification, then ferrosilicon is added to recover chromium oxide. Basicity of slag is maintained at around 1.5 to 2 and the reaction is C r 3 O 4 plus 2 silicon that gives 3 C r plus 2 S i O 2.

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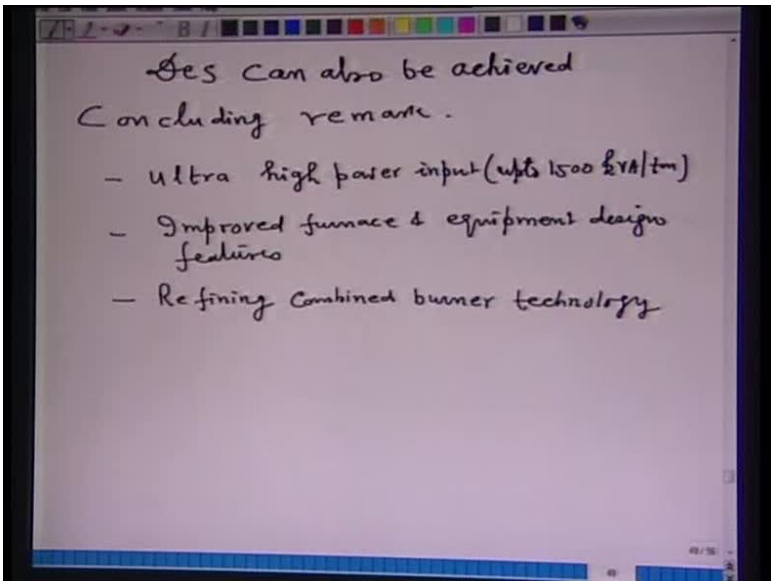

Des can also be achieved

Concluding remark.

- ultra high power input (upto 1500 kVA/ton)
- Improved furnace & equipment design features
- Refining Combined burner technology

The chromium recovery it may vary, but some figure like 97 percent chromium can be recovered from the slag, back to the metal. Some sort of desulphurization can also be achieved, if the need arises. If very low nitrogen content in stainless steel required, then nitrogen blowing is not done. If little amount of nitrogen can be tolerated by stainless steel, then nitrogen blowing is being done. So, this is about the production of stainless steel by A O D and electric arc furnace.

Now, this particular lecture concludes on modern steel making processes. Now, as a concluding remark, I have to say the following. In the coming years the production of steel by electric arc furnace will grow. For very simple reason, if you compare with the root, coke oven, blast furnace and B O F, which is valid for integrated steel plant, the production of steel by electric arc furnace can be, can be done at a very competitive price. So, in the years to come the production of steel by electric arc furnace is going to grow; that means, the developments in electric arc furnace will continue to grow in the following direction. The first development that you will see, use of ultra-high power input. For example, up to 1500 kilo volt ampere per ton of power input is envisaged.

Second development is, improved furnace and equipment design features. Third, refining combined burner technology, burner technology for enhanced E A F performance, through oxygen injection, carbon injection or through natural gas burner injection; these are bound to come. So, for example, a 120 ton ultimate electric arc furnace is capable of increase in 50 percent capacity, roughly equivalent to 180 tons, by incorporating these above mentioned modern gadgets. Also, the developments will go on in using the furnace for different charge mixes, starting from 100 percent scrap to a combination of a scrap D R I, H B I and hot metal.

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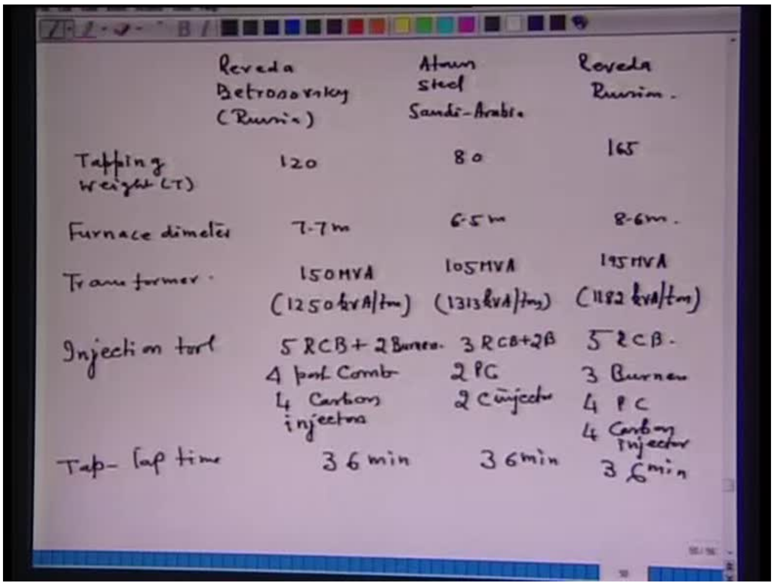

	Reveda Betrosovsky (Russia)	Atoun steel Saudi-Arabia	Reveda Russia.
Tapping weight (T)	120	80	165
Furnace dimeter	7.7 m	6.5 m	8.6 m.
Transformer.	150 MVA (1250 kvA/ton)	105 MVA (1313 kvA/ton)	195 MVA (1182 kvA/ton)
Injection tool	5 RCB + 2 Burner. 4 post Comb 4 Carbon injector	3 RCB+2B 2 PC 2 C injector	5 RCB. 3 Burner 4 PC 4 Carbon Injector
Tap-tap time	36 min	36 min	36 min

Now, I will give you some key data of ultimate E A F installations. For example, I put here, the some company, Reveda, Betrosorsky in Russia, that is one company, then Atoun Steel in Saudi-Arabia and Reveda company in Russia, they have installed three most modern electric arc furnaces. Their specifications are as follows: one, tapping weight in tons, it is 120, here it is 80, here it is 165. Furnace diameter 7.7 meter, 6.5 meter and 8.6 meter. Transformer, please note the transformer capacity. Transformer, here it is 150 mega volt ampere; then this correspond to 1250 kilo volt ampere per ton.

This furnace is operating. Here it is 105 mega volt ampere, which correspond to 1313 kilo volt ampere per ton and here it is 195 mega volt ampere, which correspond to 1182 kilovolt ampere per ton.

So, you can see now, some plants are already working with the modern gadgets, having ultra-high power furnaces. Now, these ultra-furnaces, they have injection tools. This company have 5 R C B, that is refining combined burner plus 2 burners, 4 post combustion system, plus 4 carbon injectors. Appears to be the most modern furnace. This one is having 3 R C B plus 2 burners, 2 post combustion system, 2 carbon injectors, may be because its capacity is low. Third one has 5 R C B, 3 burners, you know the burners are used for meltdown period, natural gas and oxygen mixture, 4 post combustion systems and 4 carbon injectors.

Now, what is the ultimate objective of employing these modern gadgets? The ultimate objective is to have a tap to tap time parallel to B O F steelmaking. You remember, a B O F steelmaking or a B O F converter taps 300 to 400 tons of steel in just a matter of 60 minutes. Compared to electric arc furnace, which used one and half to 2 hours. So, the whole idea of employing these gadgets, is to make the electric arc furnace competitive with reference to tap to tap time and these modern gadgets made possible, if I write now tap to tap time, in all the cases is 36 minutes.

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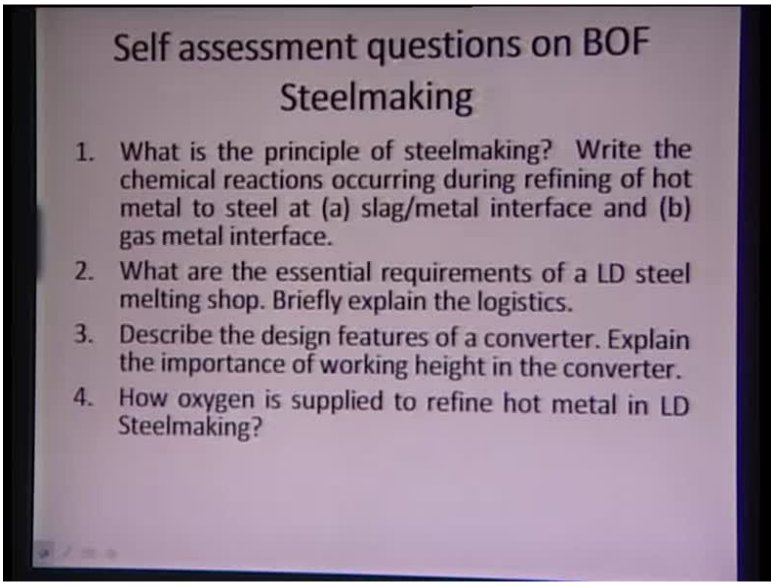

Self assessment questions on BOF Steelmaking

1. What is the principle of steelmaking? Write the chemical reactions occurring during refining of hot metal to steel at (a) slag/metal interface and (b) gas metal interface.
2. What are the essential requirements of a LD steel melting shop. Briefly explain the logistics.
3. Describe the design features of a converter. Explain the importance of working height in the converter.
4. How oxygen is supplied to refine hot metal in LD Steelmaking?

So, you can imagine, where the electric arc furnace development will lead to. Ultimately, it will be parallel to B O F steelmaking. So, here are some questions, that is self-assessment questions in B O F steelmaking. Question one, what is the principle of steelmaking? Write the chemical reactions as already I have said, you have to write down. Second, what are the essential requirements of a L D steel melting shop? Briefly explain the logistics.

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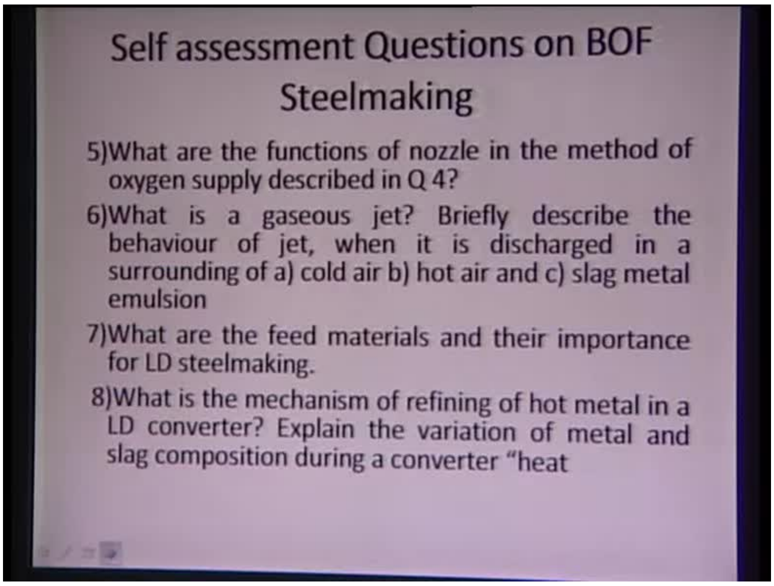

Self assessment Questions on BOF Steelmaking

5)What are the functions of nozzle in the method of oxygen supply described in Q 4?

6)What is a gaseous jet? Briefly describe the behaviour of jet, when it is discharged in a surrounding of a) cold air b) hot air and c) slag metal emulsion

7)What are the feed materials and their importance for LD steelmaking.

8)What is the mechanism of refining of hot metal in a LD converter? Explain the variation of metal and slag composition during a converter "heat

I explained to you already. Third, describe the design features of a converter. Explain the importance of working height in the converter. You know already. Fourth, how oxygen is supplied to refine hot metal in L D converter? This has also been explained in the form of the jet, free-jet and momentum flow rate and so on. Question number fifth, what are the functions of nozzle in the method of oxygen supply described in question 4? Nozzle, it converts a given flow rate of the jet into energetic supply and I have already described 4 or 5 functions, that you have to bring it over to here.

6, what is a gaseous jet? Briefly describe the behavior of jet, when it is discharged in a surrounding of a cold air, hot air and slag metal emulsion. Here, you have to bring the ratio of density of jet to density of surrounding. 7, what are the feed materials? That already I have said. Eighth, what is the mechanism of refining of hot metal in L D converter? You recall, I have superimposed lance profile with the physico-chemical interaction between the jet and bath, you can bring it over here.

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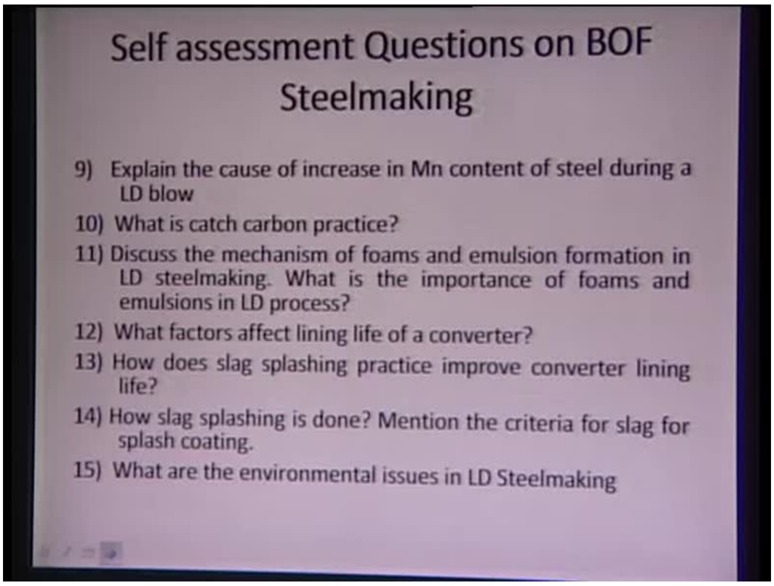

Self assessment Questions on BOF Steelmaking

9) Explain the cause of increase in Mn content of steel during a LD blow
10) What is catch carbon practice?
11) Discuss the mechanism of foams and emulsion formation in LD steelmaking. What is the importance of foams and emulsions in LD process?
12) What factors affect lining life of a converter?
13) How does slag splashing practice improve converter lining life?
14) How slag splashing is done? Mention the criteria for slag for splash coating.
15) What are the environmental issues in LD Steelmaking

Question 9, explain the cause of increase in manganese. 10, what is catch carbon practice? 11, discuss the mechanism of foams and emulsion formation in L D steelmaking. This is, also, I have already described. Twelfth, what factors affect lining life and 13, 14 and 15, they rather addresses or these questions have been formulated to know what are the different technologies available for repairing of the lining.

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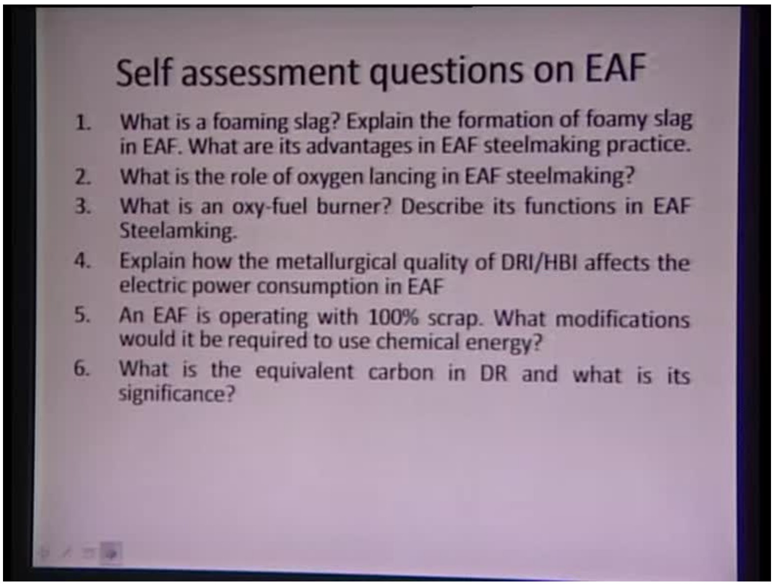

Self assessment questions on EAF

1. What is a foaming slag? Explain the formation of foamy slag in EAF. What are its advantages in EAF steelmaking practice.
2. What is the role of oxygen lancing in EAF steelmaking?
3. What is an oxy-fuel burner? Describe its functions in EAF Steelamking.
4. Explain how the metallurgical quality of DRI/HBI affects the electric power consumption in EAF
5. An EAF is operating with 100% scrap. What modifications would it be required to use chemical energy?
6. What is the equivalent carbon in DR and what is its significance?

The questions of electric arc furnace steelmaking. What is a foaming slag? Explain the formation of foamy slag. Discussed. What is the role of oxygen lancing? Also discussed.

What is an oxy-fuel burner? Oxy-fuel burner is used in the melt down period to increase the rate of melting and to attain quick (( )) bath condition.

Explain how the metallurgical quality of D R I and H B I affects the electric power consumption in E A F. I have discussed, I have calculated some values also. An E A F is operating with 100 percent scrap. What modification would be required to use chemical energy? A modification would be, either you inject carbon or you inject oxygen, because for utilizing chemical energy, you have to have chemical reaction. What is the equivalent carbon in D R and what is its significance? Already I have calculated the carbon content in D R I and stoichiometric, all this thing you have to bring over to here.

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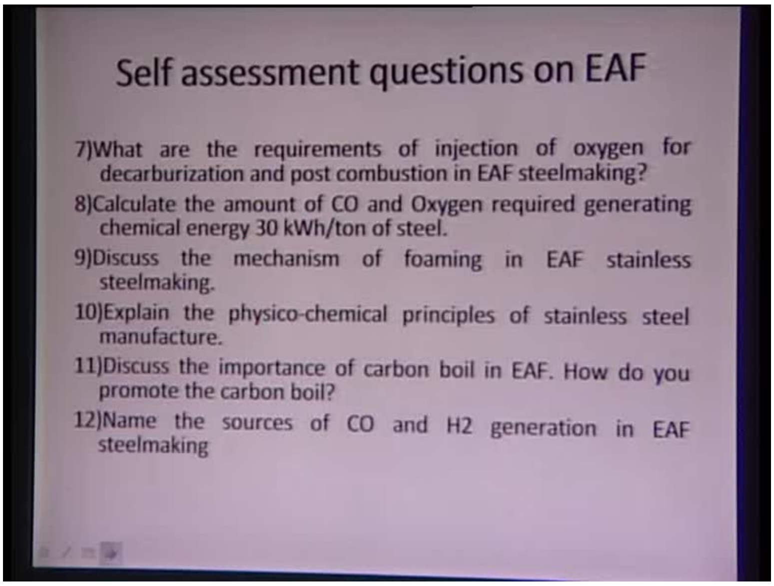

Self assessment questions on EAF

7)What are the requirements of injection of oxygen for decarburization and post combustion in EAF steelmaking?

8)Calculate the amount of CO and Oxygen required generating chemical energy 30 kWh/ton of steel.

9)Discuss the mechanism of foaming in EAF stainless steelmaking.

10)Explain the physico-chemical principles of stainless steel manufacture.

11)Discuss the importance of carbon boil in EAF. How do you promote the carbon boil?

12)Name the sources of CO and H2 generation in EAF steelmaking

Question 7, what are the requirements of injection of oxygen for decarburization and post combustion in E A F steelmaking? Discussed. Calculate the amount of C O and oxygen required generating chemical energy 30 kilo watt hour per ton of steel. You have to write down the reaction C O plus half O 2 is equal to C O 2, find out the heat of formation and make it equivalent to 30 kilo watt hour per ton, so that, you can calculate how much amount of C O will be required. Discus the mechanism of foaming. Explain the physico-chemical principles of stainless steel manufacture. This I have discussed right now. Discuss the importance of carbon boil. How do you promote the carbon boil by injecting carbon also thing I have been discussed. Name the sources of C O and hydrogen generation in E A F steelmaking.

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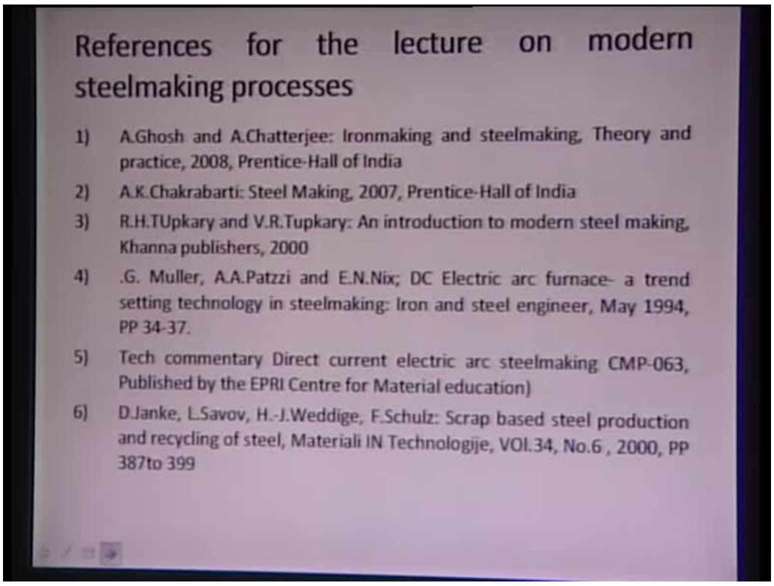

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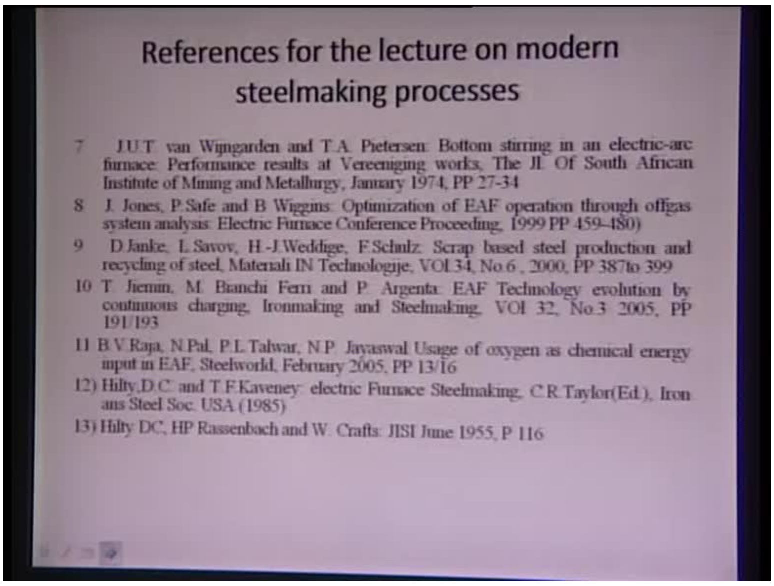

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Now, these are the references which you can consult. The lecture has been prepared from these references, plus these references…