Iron Making
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Lecture – 28
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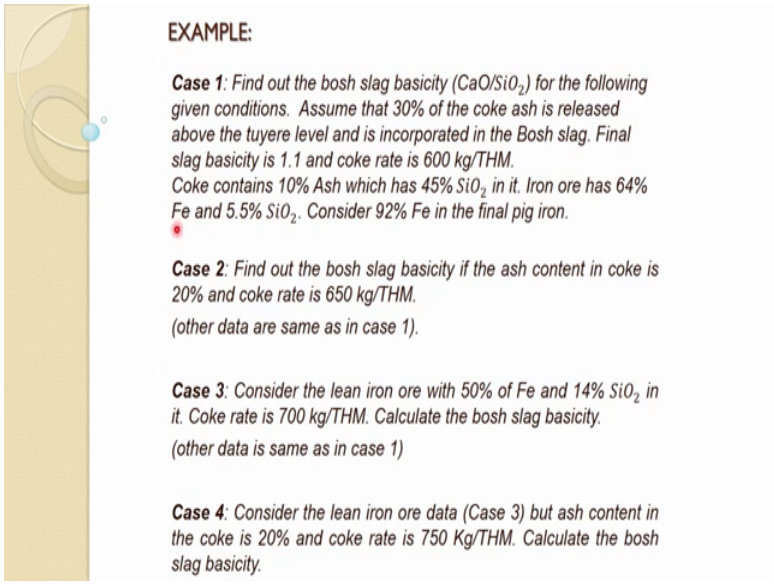

So now, we will come to the example which we were talking about. So, let us have a general thing first find out the bosh slag basicity that is CaO to SiO2 ratio for the following given condition. So, assume that 30 percent of the coke ash is released above the tuyere level and is incorporated in the Bosh slag. Final slag basicity is 1.1, so that is given.

Final slag basicity is given which is means ratio of CaO to SiO2 and coke rate is 600 kg per tonne of hot metal. Coke contains 10 percent ash which has 45 percent SiO2 in it. Iron ore has 64 percent iron in it and 5.5 percent SiO2. But we are talking about the basicity so we are interested mostly in the CaO and SiO2 ratio.

So, we are concentrating more where the CaO and SiO2 is present. So, mostly SiO2 comes from the coke and from the iron. Consider 92 percent iron in the final pig iron. So, 92 percent iron in the final pig iron. Remember what it says. Assume that 30 percent of the coke ash is released above the tuyere level. This is a important one because coke

contains 10 percent ash. So, 30 percent of heat is being released at a tuyere level, remaining is going down in the bosh in the earth.

So, and so this is the case 1; In case 2 find out the bosh slag basicity if the ash content in coke is 20 percent and coke rate is 650 kg per tonne of hot metal. So, all other things are same except that the percentage of ash in coke is not 20 percent and therefore, the coke rate has also increased to 650 kg per tonne of hot metal.

In case 3 we consider a lean iron ore which has 50 percent of iron instead of 64 percent and has 14 percent SiO2 instead of 5.5 percent. So, naturally the Coke rate also it is increased to 700 kg per tonne of hot metal. So, all other things are same. Again you calculate the bosh slag basicity.

In case 4 consider the lean ore data like this, but ash contained in coke is 20 percent just like coke case 2 and the coke rate is 750 per tonne of hot metal. Because both the places now ash contained as in increase SiO2 content so, calculate the bosh slag basicity. So, let us see how does it this composition effect the slag basicity in bosh region with the composition.

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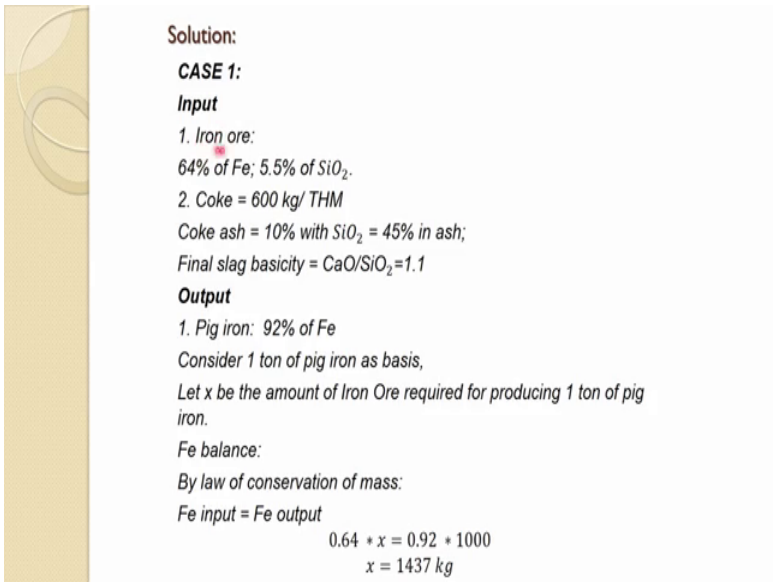

So, in case 1 the input is iron ore which is having a 64 percent of iron, 5.5 percent of SiO2. Coke consumption is 600 kg per tonne of hot metal. Coke is contain 10 percent coke. Coke in coke ash is 10 percent and which contains about 45 percent SiO2. And

final slag basicity is given 1.1. So, we have to do it with mass balance so that how much ore actually we need it. So, pig iron is saying 90 contains 92 percent of iron.

So, if we consider 1 tonne of pig iron as a basis, so let x be the amount of iron ore required for producing 1 tonne of pig iron. So, iron balance would be like iron input equal to iron output. So, 64 percent iron is given in the ore into x that will give the iron input and iron output per tonne basis we have 92 percent iron in the hot metal. So, that gives you the ore requirement is about 1437 kg. So that many kg of iron ore is required. Now, once we know this iron ore we can calculate the SiO2.

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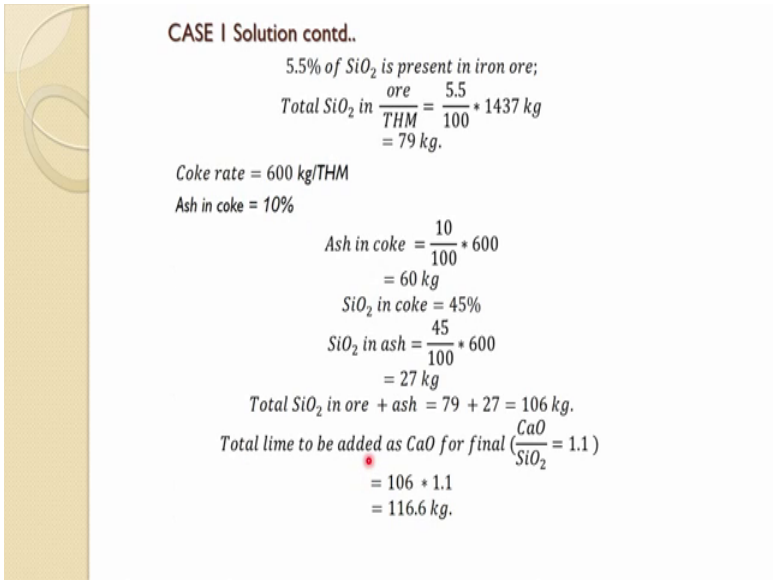

So, 5.5 percent of SiO2 is present in the iron ore. So, total SiO2 would be is multiplied this convert it into small friction or friction. That multiplied with iron ore per tonne basis which is needed. So, you get 79 kg of SiO2 which is present in 1437 kg of iron ore. Now, coke rate is given 600 kg per tonne of hot metal and ash contained in it is 10 percent.

So, and in this 10 percent so what how much ash is there? Again the same way we can calculate at about 60 kg. But this 60 kg contain only 45 percent SiO2. So SiO2 present in this would be the fraction of this and multiplied with this 600. So, that will gives you 27 kg of SiO2.

So we it should be actually 60 because we are calculating in this, 60 kg of ash. So it should be 60, then only you will get about 27 kg. So, we can out of this. This should be

60 not 600. So, total SiO2 in the ore 79 kg is coming from the iron ore. A total and 27 is kg is coming from the coke. So, total SiO2 would be 106 kts kg; 79 plus 27 equal to 106 kg.

Now, total lime to be added as CaO for the liquid for the final; we know basicity is given which is nothing CaO to SiO2 ratio. So, CaO to SiO2 ratio equal to 1.1. So, with this basicity SiO2 we already know, it is 106. So, we can calculate the lime requirement. So, total lime is required about 116.6 kg in order to get 1.1 basicity. Remember this is saying the final slag basicity is 1.1; so, based on that this has been calculated.

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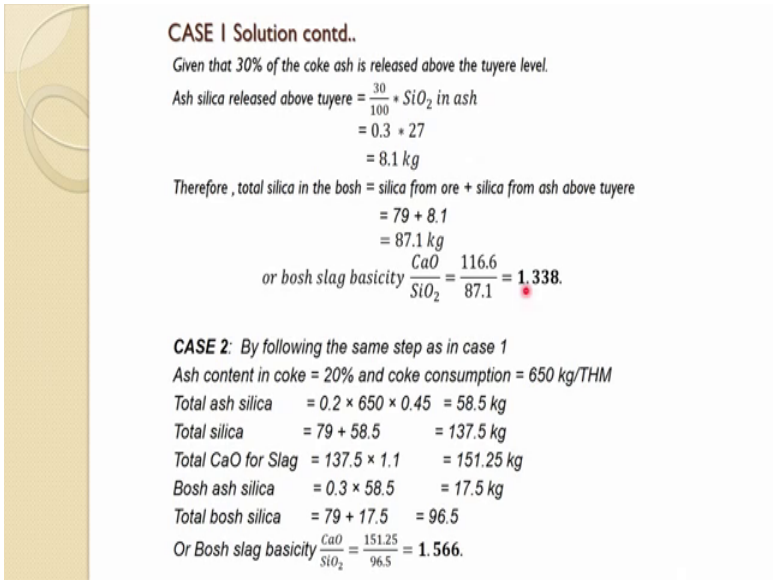

Now, we know this and now we have to see the case 1 which says 30 percent of the ash which is released from the coke above the tuyere level. So, 30 percent is going and which is actually will be contributed toward the formation of the bosh slag. So, silica released above tuyere level.

So, that we not 27 kg was present, 30 percent is being released; so, which is come to 8.1 kg. So, this is the amount which is being released above the tuyere level which will form the part of the bosh slag. So, total silica in the bosh region coming from the ore is about 79 and coming from the ash is about 8.1. So that gives 87.1 kg.

Now, lime will not change so which we already got it 116.6. So, this CaO to SiO2 ratio would be 1.338. So, look at that 1.338. So, as we said even before when we were

discussing three types of slag primary, slag bosh slag and the final slag we mentioned that and the bosh region usually the basicity of the slag is higher. So, you can see the final slag basicity is given 1.1 that is actually in the ash region. And in the bosh region the slag basicity is 1.34; so higher than the final basicity.

Now, if we come to the second case, where what it is saying the ash contained in the coke has increased from 10 to 20 percent. And coke consumption from 600 to 650 kg per tonne of hot metal. All other data are same. So, naturally that ash total silica in the ash will increase because 45 this will get the total ash in the coke. So, 20 20 percent ash in the coke; so, 650 is the rate. So this will give total ash in total ash 45 percent is silica content. So, that going to give you total silica present in the coke 58.5.

Now, iron ore is not changing. So, whatever it was a before 1437 kg it is the same. Percentage of SiO_2 is also same in that which we calculated 79 kg. So, total silica would be silica present in the ore plus silica present in the coke 137.5; Total CaO for the slag having the same final basicity of the final slag 1.1. It has increased to 151 kg. So, look at that from 116 to 151. It has increased substantially to maintain this basicity of the slag as a final one.

So, this much limes you need; Now, because the ash which is released in the bosh region is 30 percent from that. So, we have 58.5 in the coke. So, 30 percent of is 17.5. So, the total SiO_2 in the bosh reason would be 79 plus 17.5. It is a 96.5. So, slag basicity naturally a ratio of CaO to SiO_2. So, CaO is 151 and SiO_2 is 96 that keeps about 1.6 is your basicity of the bosh slag.

So, it is a substantial increment of the basicity in the bosh slag in comparison to the final slag in the ash region. So, by increasing 20 percent of this because you have to add extra lime, lime requirement increases which contribute also towards the higher basicity of the slag in the bosh region.

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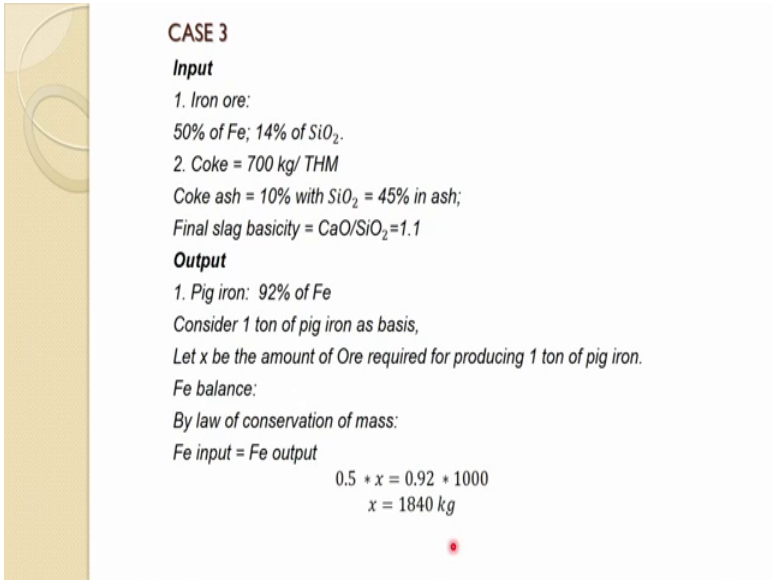

Now, we look at that lean ore. So, it says the 50 percent of iron in the ore and 14 percent of silica. And coke rate has also increased to 700 kg per tonne of hot metal. But coke ash is same 10 percent in ash in that 145 percent silica. And final basicity of the slag is still 1.1. So, output again we can use our calculation based on per tonne of pig iron. So, iron input is same calculation we have done in case 1. So, I am not repeating it here.

So, iron input equal to iron output simple mass balance. So, 50 percent of iron into x amount of ore that is a input and 0.92 is iron in pig iron and 1 tonne. So, that gives you the requirement of ore in 1840 kg. While when it was a 64 percent iron or in one way iron rich ore that ore requirement was almost 400 kg lower as you can see in this one 1437 here and here in the in this one we have 1840 kg. So, that is substantial significant increase in this.

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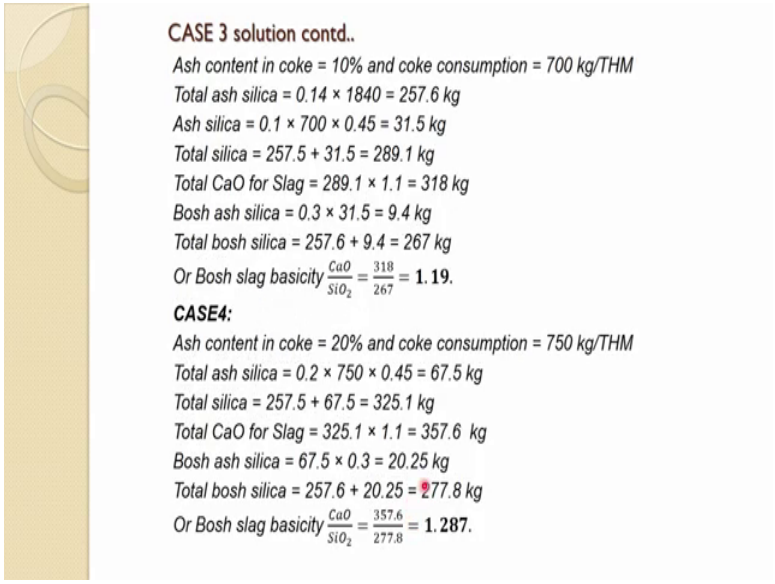

So, now based on this if we calculate the ash contained in coke 10 percent, coke consumption is this. Total ash in silica; So, this is actually in the ore what we are calculating to total silica in the ore because this is says 14 percent. Silica and ore we got it in 40.

So, in friction form 257.6 kg silica in iron ore and silica in coke in the form of ash; So, this first figure gives this one as the total ash in the coke because 700 kg per tonne of hot metal 10 percent. So 0.1 into 700 total ash and in that ash 45 percent SiO2 multiplying with this. This gives you the total silica in the coke, total silica in the ore. So, total silica is 289.1 kg.

Now, total CaO again we are maintaining the final slag basicity 1.1. So, your CaO requirement would be 318 kg. Now this 318 kg of course, we put it in the starting. So, when it is coming it would be the same that much. However, the silica content in the coke in the bosh region would be 30 percent of it. So, bosh ash silica from the coke is 30 percent of it would be only 9.4 kg. So, 9.4 kg plus 257 kg which is coming from the iron ore would be the total silica which is present in the bosh region. .

So, if we look at that so that gives you 267 kg silica and our lime requirement is 318. So this gives you about 1.2, basicity in this slag region. So, this is really not very high if your ore is lean in iron and then at the slag basicity in bosh region is slightly up than the

final slag which is 1.1. So, lean ore that is why ash disadvantage in this form. Now, if we look at the Case 4: so, in fact, in we will come back around this comparison again. .

Now, in case 4 what we said the ash content in coke is increased to 20 percent and coke consumption is also increased to 750 kg per tonne of hot metal. So, total ash in or ash total a silica in the coke ash. So, 0.2 into 70 will give the total ash contained in the coke and multi because it has 45 percent silica.

So, multiplying this will give you 67.5 kg silica in the coke ash. And this is not going to increase because this is still lean ore we are taking and for lean ore we already got the silica content 257.6 and plus 67.5 from the coke ash. 0049t gives you 325.1 kg total silica.

Now, because this is 67.5 so substantial increase in this, 30 percent of it; Now, before the 30 percent of it goes to bosh. So, 67.5 and 30 percent means 20.25 only. So, total bosh silica is 257 plus 20.25 gives you 277 or 78. However, our final slag basicity is to the same 1.1. So, we can calculate the lime requirement in the slag is about which comes to about 357.6 kg because total silica is 325.

So, now we know lime requirement is this. We know the total silica in the bosh reason is this. So, the bosh basicity actually is about 1.3. So, with higher coke consumption or not just little higher coke consumption, if coke is also of inferior quality where you have ash content more, then your basicity of the bosh slag increases to 1.2 or 1.3 in comparison to the previous case where it was 1.2. And this is of course, higher than the final slag composition in the ash. So, So, this is 1.3.

All these examples you can see that bosh slag compose basicity is always higher than the final slag basicity in the ash region. The this calculation shows you how you can calculate the basicity of the slag, which could be suitable to get the final chemistry of the metal. And proper liquid is solidus temperature in the bosh region and a cohesive zone and in the earth.

So, and so, this calculation as you remember when we were doing mass balance for the raw material charging and finding out the composition of liquid iron. We prepared the excel sheet and that was much easier than doing this way the calculation which takes a

longer time. So, I would recommend that you do all these calculation on a excel sheet. In fact, next slide will show you about that.

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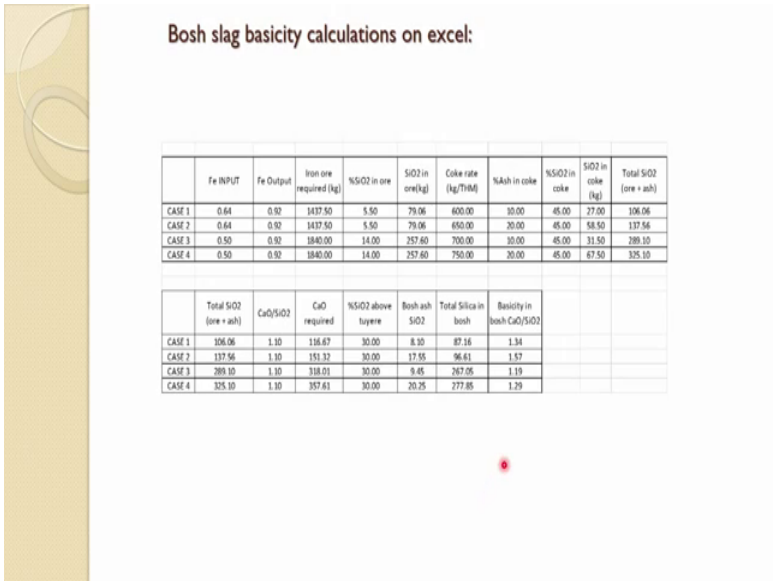

So, if you look at this of course, I cannot in this slide form I cannot show you that. If I go, if I come out from this slide form and I double click on these then actually this is embedded excel sheet in this.

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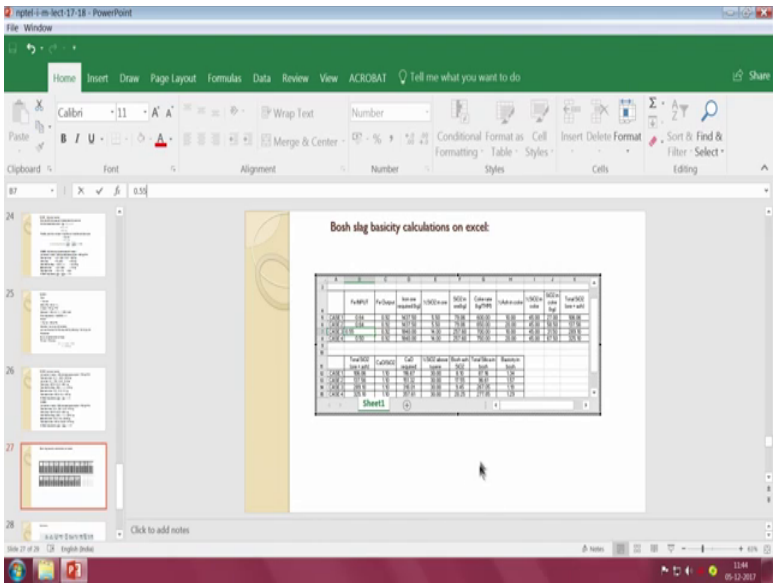

And if I change any I can change the input, I can change any output as you can see in the case 3 of a final basicity in the bosh region was 1.19, when iron was 50 percent in the

ore. If I change this to let us say 55 percent, and then we can see immediately what would be the effect of it. So, if we change to this, this immediately gives me with you the basicity is increased to 1.2; so instead of 1.9 and similar similarly if is your iron content so, you can change any of these variable which here.

Now, SiO2 content seemed a bit high if I instead of 5.5 or 14 percent. Let us say in case of 4 I make it to 10 percent in this. Then I can. Ok so, this is a I think in I make it 10 percent. So, the basicity is 1.23 29. And we, so if I put it this 10 percent then I can see what would be my basicity has increased to 1.35. .

So, this is a good advantage of doing all this calculation on a excel worksheet. So, you can change any of these parameters like here I changed to 10 percent SiO2 in iron ore, my basicity in the bosh region of the slag is about 1.35. I change the iron input to 55 percent my basicity has increased to 1.2 in the case 3. So, like that you can study and you can manipulate the slag or basicity composition in the iron making operation.

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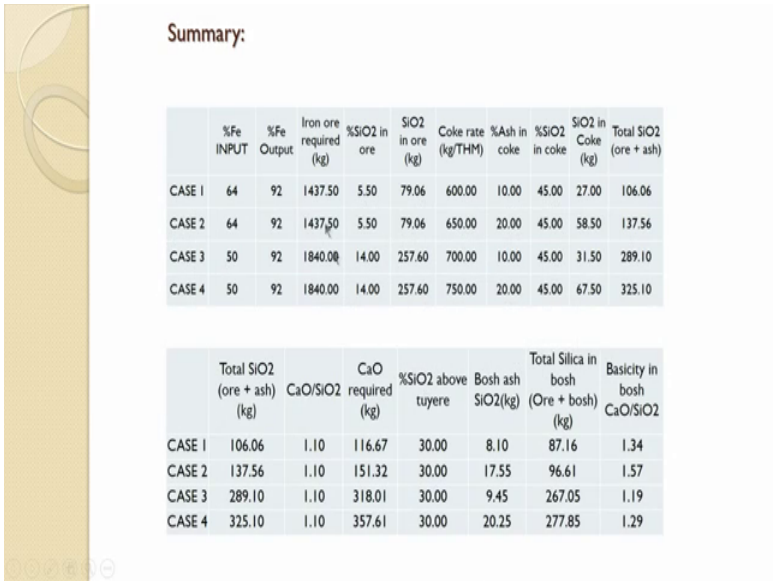

	%Fe INPUT	%Fe Output	Iron ore required (kg)	%SiO2 in ore	SiO2 in ore (kg)	Coke rate (kg/THM)	%Ash in coke	%SiO2 in coke	SiO2 in Coke (kg)	Total SiO2 (ore + ash)
CASE 1	64	92	1437.50	5.50	79.06	600.00	10.00	45.00	27.00	106.06
CASE 2	64	92	1437.50	5.50	79.06	650.00	20.00	45.00	58.50	137.56
CASE 3	50	92	1840.00	14.00	257.60	700.00	10.00	45.00	31.50	289.10
CASE 4	50	92	1840.00	14.00	257.60	750.00	20.00	45.00	67.50	325.10

	Total SiO2 (ore + ash) (kg)	CaO/SiO2	CaO required (kg)	%SiO2 above tuyere	Bosh ash SiO2(kg)	Total Silica in bosh (Ore + bosh) (kg)	Basicity in bosh CaO/SiO2
CASE 1	106.06	1.10	116.67	30.00	8.10	87.16	1.34
CASE 2	137.56	1.10	151.32	30.00	17.55	96.61	1.57
CASE 3	289.10	1.10	318.01	30.00	9.45	267.05	1.19
CASE 4	325.10	1.10	357.61	30.00	20.25	277.85	1.29

This gives you the summary see it what we have done till now. So, like 64 percent and this is the iron percentage iron in iron ore. 64 and 50 percent case we took output was always constants. Based on that your iron requirement was changed and of course, the SiO2 was change and coke rate also changed.

So, based on the coke rate and knowing the ash contained in the coke, our ash and SiO2 be kept constant in the ash our SiO2 in the coke also changed and based on that we calculated total SiO2 in ores in ore and ash. And then we kept our a final basicity constant to 1.1 with calculated the CaO requirement, the lime requirement and because the 30 percent SiO2 was there of total going into the bosh region.

So, based on that we calculate SiO2 present in bosh and with this and this is setting them up we know SiO2. We calculated there will lime requirement and rest of that we calculated the basicity of the bosh slag in this form.