Blast furnace: Thermal and Chemical Features

MSE-S206
(Iron and Steel Making)

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Blast Furnace: Thermal & Chemical Features

• Mass Balances

- The mass balance excersise consists of solving a set of simultaneous linear equations equating the input and the output of the individual elements or compounds, if they do not decompose in the process itself, such as CaO and Al_2O_3.

- An additional equation can be formulated based on the balance of the total mass input with the mass output.

- All balances are done on the basis of per thm.

- The balances may be generalised as:

Inputs per thm = Outputs per thm

- Calculation of weight of ore used for making hot metal through blast furnace :-

Q:- A blast furnace makes hot metal containing 3.6 wt% C, 1.4% Si, the remainder being Fe (i.e 95%). Other data are as follows:

→ The ore contains 85% Fe_2O_3, the remainder being 15% gangue of SiO_2 + Al_2O_3.

→ The coke contains 85% fixed carbon and 15% ash.

→ Coke consumption is 800 Kg per tonne of hot metal.

→ Flux contains 95% $CaCO_3$ and the remainder is SiO_2, & its consumption is 400 Kg/tonne hot metal.

→ The blast furnace top gas contains a ratio of $CO/CO_2 = 28/12$.

- Calculate the following (per tonne of hot metal)

(i) The weight of ore used (W_{ore})

(ii) The weight of slag made (W_{slag})

(V_g)

A :- All quantities in the following material balances are in Kg per tonne of hot metal produced.

(i) Fe - Balance: (W_{Fe} in Ore = W_{Fe} in hot metal)

weight of Fe in ore/hot metal = 1000×0.95
= **950 Kg**

then, weight of ore used (W_{ore}):

$$W_{(ore)} = 950 \times \frac{M_{(Fe_2O_3)}}{2M_{(Fe)}} \times \frac{100}{85}$$

$M_{(Fe_2O_3)} = 160$ + $M_{(Fe)} = 56$

then, **$W_{ore} = 1597$ Kg**

(ii) $W_{(slag)}$ = Weight of gangue in ore + Weight of ash in Coke
+ weight of CaO in flux
+ weight of gangue in flux
− weight of SiO_2 equivalent of (Si) in hot metal

- Weight of gangue in ore:

In this question, it is 15% of weight of ore.

then $W_{(gangue)} = 1597 \times \frac{15}{100} \Rightarrow \boxed{W_{(gangue)} = 239.6 \text{ kg}}$

- Weight of ash in coke:

In this question, it is 15% of total used coke (800 Kg/tonne of hot metal)

$W_{(coke)} = 800 \times \frac{15}{100} \Rightarrow \boxed{W_{coke} = 120 \text{ Kg}}$

- Weight of CaO in flux:

$400 \times \left(\frac{95}{100}\right) \times \frac{M_{CaO} = 56}{M_{CaCO_3} = 100} \Rightarrow \boxed{212.8 \text{ Kg} = W_{(CaO \text{ in flux})}}$

- Weight of gangue in flux:

$400 \times \frac{5}{100} \Rightarrow \boxed{W_{(gangue \text{ in flux})} = 20 \text{ Kg}}$

- Weight of SiO_2 equivalent of Si in hot metal:

$1000 \times \left(\frac{1.4}{100}\right) \times \left(\frac{M_{(SiO_2)} = 60}{M_{(Si)} = 28}\right) = 30 \text{ Kg}$

$\boxed{W_{(SiO_2)} = 30 \text{ Kg}}$

(ii) $W_{(slag)} = 239.6 + 120 + 212.8 + 20 - 30$

$\Rightarrow \boxed{W_{(slag)} = 562.4 \text{ Kg}}$