

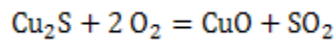
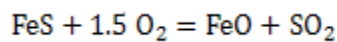
Material and heat balance in converting

By solving we get.

Total flux = 10941 kg and total slag = 23505 kg

Copper balance gives weight of blister copper = 20748kg

Slag forming stage is in two stages. One has to calculate moles of oxygen for first stage and second stage. The reactions are



Moles of oxygen for 1st stage = 226.32

Moles of oxygen for 2nd stage = 84.95

Moles of oxygen for copper formation = 162

total O₂ moles = 473.29kg moles

Air for entire blow = 50484 m³

Time for 1st slagging = 219 minutes

Time for 2nd slagging = 82 minutes

Time for blister copper = 157 minutes

Do yourself-1

A copper converter treats per charge 10 tons of 40% matte. Blast is furnished at the rate of 100Cu.m per minute. Before adding flux a preliminary blow of 9 min is given to produce a magnetite coating, which analyzes as Fe₃O₄ 75%, FeO 5%, CuO 5%, and unoxidized constituents 15%. Assume that this is entirely corroded by the SiO₂. The flux carries Cu₂S 3%; FeS 27%; SiO₂ 52%.

The blister copper is 100% Cu. The converter gases carry no free oxygen.

Required:

- The weight of magnetite coating produced, flux required and slag made.
- The weight of blister copper, and the % of copper recovery
- The blowing time of each stage.
- The volume and % composition of the converter gases.

Answer

- Weight of coating: 1184 kg. weight of flux and slag 1998.8kg and 6496kg
- 3788kg, 94% recovery
- Slag formation stage; 87.35 minutes and blister ^{Cu} 32 minute.
- Coating stage; SO_2 28.5% N_2 71.5%

Slag formation stage; SO_2 14.5%, N_2 85.5%

Blister ^{Cu} SO_2 21% N_2 79%

Illustration –Heat balance

A copper converter is charged with 40 tons of matte whose copper grade is 50%. The flux is 9% Cu, 18% Fe, 10% S and 56% SiO_2 . The slag analyses 26% SiO_2 , 65% FeO and 4% CuO. Fe in flux not as CuFeS_2 , the blister copper contains 98% Cu.

The matte is charged at 1323K, the flux at 298K, and the blast is at 400K. The bath temperature is 1400K. The slag and gases discharge at 1400K.

Specific heat of matte 0.14 Kcal/Kg °C independent of composition; melting point of matte 1273K; Heat content of liquid matte at melting point 205 kcal per kg

Melting point of slag 1393K and specific heat 0.25 kcal/kg °C; Heat content of liquid slag at melting point 300 kcal per kg. Heat of formation of the slag is 376 kcal per kg of SiO_2 .

In the blister copper formation, bath temperature is 1500K, Heat content of Cu_2S is at 1500K. gases discharge 28790KCal/kg mole at 1500K. Gases discharge at 1400K.

Required: A heat balance of the converter at the end of the slagging period and at the end of the blow

Solution

First we have to perform materials balance:

Some problems on materials balance have already been illustrated. Results of material balance are:

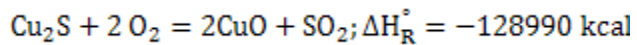
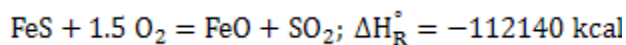
Input (slag making stage)	Output
Matte: 40,000kg	Slag 22600kg
Flux: 10500 kg	Gases SO ₂ =209.65 kg moles N ₂ =1193kg moles
Air : N ₂ 1193 kg moles O ₂ 317 kg moles	

Thermo- chemical data:

Heat of formation of slag = 376 kcal/kg SiO₂

Heat content of slag at melting point = 300 kcal/kg .

Heat of reaction



Sensible heat at the respective temperatures in kcal/kg mole is

$$H_{400} - H_{298} \text{ for N}_2 = 710$$

$$H_{400} - H_{298} \text{ for O}_2 = 723$$

$$H_{1400} - H_{298} \text{ for N}_2 = 8288$$

$$H_{1400} - H_{298} \text{ for SO}_2 = 13432$$

Heat input

Sensible heat in air = 1.08×10^6 kcal.

Heat input

Sensible heat in flux = 0

Heat of reaction of reaction = 23.65×10^6 kcal.

Heat output:

Sensible heat in matte = 8.9×10^6 kcal

Sensible heat in slag = 9×10^6 kcal.

Sensible heat in gases = 12.7×10^6 kcal.

Heat balance in blister copper stage.

Materials balance

Input: $\text{Cu}_2\text{S} = 158$ kg moles

$\text{O}_2 + \text{N}_2 = 158 + 594$ kg moles

Output: $\text{Cu} = 316$ kg moles

Gases $\text{SO}_2 = 158$ kg moles and $\text{N}_2 = 594$ kg moles

Data

Heat of reaction of $\text{Cu}_2\text{S} + \text{O}_2 = 2\text{Cu} + \text{SO}_2$

$$\Delta H_R^\circ = -51990 \frac{\text{Kcal}}{\text{Kg}} \text{ mol}$$

Heat input

Sensible heat in $\text{Cu}_2\text{S} = 4.5 \times 10^6$ kcal

Heat reaction = 8.2×10^6 kcal

Heat out put

Sensible heat = 7×10^6 kcal

Sensible heat in blister Cu = 3.55×10^6 kcal

References:

1) Rosenquist : Principles of extractive metallurgy

2) Butts, Allison: Metallurgical Problems, McGraw Hill Book Company, 1943