

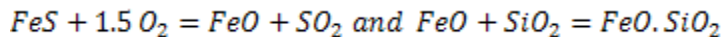
## Converting

**Key words:** Copper production, converting, material balance

It is important that the reader should consult any text book on non-ferrous metal extraction to familiarize with the process of converting. Detailed description about the converting process is not given here. The following description is given with a view to solve the problems on converting.

In production of copper, converting is an important unit process. Matte, which is a mixture of copper and iron sulphide, is treated in Pierce-smith-Converter. The converter has the form of a horizontal cylindrical drum, and is usually lined with magnesite brick.

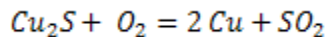
In converting matte is converted to molten copper. It is done in two stages. In the stage-1 air is blown to oxidize all Fe of matte. During blowing of air silica is added to flux the FeO. The reaction is



The oxidation of iron sulphide produces enough heat to maintain the temperature of the bath 1300 °C.

After practically all iron is slagged-off more matte is added to the converter and the process is repeated until a sufficiently large amount of copper sulphide is obtained. This is called white metal.

After removal of last slag, blowing is continued to produce molten blister copper. The reaction is



The reaction of oxidation of copper sulphide is exothermic. In the converting process no heat supply from outside is needed. The basics of converting operation are illustrated by the following problem;

### Illustration with solution and discussion

A copper converter is charged with 20 tons of matte and blown down to blister copper. Copper grade of the matte is 46%. The flux used carries  $Cu_2S$  4%, FeS 16% and  $SiO_2$  80%. The slag carries 29%  $SiO_2$ . Assume no loss of copper in slag. Also air is supplied at the rate of 90  $m^3/min$ .

**Calculate:**

- (a) Total weight of flux and slag produced
- (b) The cubic meter of blsat for the entire blow
- (c) The blowing time for each of the following stages
- (d) Percent  $SO_2$  in the gases
- (e) Assuming all fluxes added at the start, after how many minutes blowing will the matte contain 60% copper
- (f) Heat generated in both the stages.

No loss of copper in slag, Also it must be known that slag consists of FeO and  $SiO_2$  only. Hence slag composition is 29%  $SiO_2$  and 71% FeO.

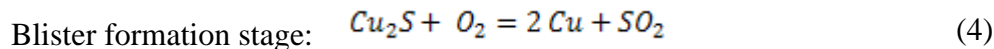
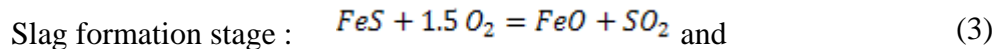
Let X kg is the weight of flux and Y kg is the weight of slag.

**From  $SiO_2$  balance:  $0.8X = 0.29Y$  (1)**

**FeO balance:  $0.102X + 5409 = 0.132Y$  (2)**

**By solving equations 1 and 2 we get weight of flux = 3807 Kg and that of slag is 10503 Kg.**

Converting reaction for the entire blow:



From the amounts of  $Cu_2S$  and FeS oxidised, one can calculate the amount of oxygen and hence amount of air for both the stages.

**The amount of air  $24325.3 m^3$ .**

Time required for slagging stage =  $\frac{\text{Amount of air for reaction 3}}{\text{Air rate}}$

Time required for blister copper formation stage =  $\frac{\text{amount of air for reaction 4}}{\text{air rate}}$

**On substituting the values we get time required for slagging stage = 184 minutes and time required for blister copper formation stage = 86 minutes**

From reactions 3 and 4 we get

**%  $SO_2$  in slag formation = 15% and in blister copper stage = 21%**

Let X kg FeS remains in matte after oxidation. From the definition of the matte grade

$$0.6 = \frac{\text{Amount of copper}}{\text{Amount of } Cu_2S + \text{Amount of FeS}}$$

Moles of FeS remaining = 44.1. Moles of FeS to be oxidised = 59.4

**Air required = 9504  $m^3$**

Heat generated/minute can be calculated from reaction 3 and 4 in that we use the moles of reactants participating in the reactions. The following values may be used:

Heat of formation of FeO at 298K = -64300 kcal/kg.mole

Heat of formation of FeS at 298K = -23100 kcal/kg.mole

Heat of formation of  $SO_2$  at 298K = -70940 kcal/kg.mole

**Heat generated in slag formation stage =  $63 \times 10^4$  kcal/minute**

**Heat generated in blister copper stage =  $4.4 \times 10^4$  kcal/minute**

### **Do Yourself -I**

The slag from a copper converter contains the following:

$SiO_2 = 32\%$ ,  $Al_2O_3 = 1\%$ ,  $CaO = 8\%$ ,  $FeO = 59\%$

The flux carries 75%  $SiO_2$ , 5% Fe $S_2$ , and 2%  $Cu_2S$ . The matte charged is 40 tons of 34% copper grade. The flux is added in batches of 3000 kg; the converter is blown to slag of the above composition after each addition and the slag pored off before the next batch is added. The air rate is 100  $m^3/min$ .

Calculate (a) the time of each partial blow, (b) The number of partial blows and the weight of flux to be added for the last partial blow to produce a slag of the same composition as in other partial blows and (c) the total time for blowing the charge to blister copper.

**Answer:**

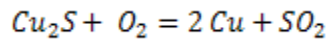
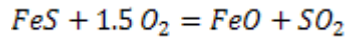
**(a) 87.7 minutes**

**(b)  $\approx$  5 blows, 1903 kg**

(c) 548.5 minutes

### Do Yourself –II

In converting matte the following reactions occur



The air is blown in at 50 °C and 1210 mm Hg total pressure. The gases exit at 1200 °C and 775 mm Hg pressure. The converting operation is done without the use of fuel. Air is stoichiometric in amount. The air is moist and the relative humidity of the air is 50 mm Hg at 50 °C the vapour pressure of water at saturation is 92.5mm Hg). The matte contains 50% Cu.

Calculate (a) The volume of dry air at 273 K and 1 atm. Pressure (b) The volume of moist air at 323K and 1210K

**Answer: (a) 1098.7 m<sup>3</sup> (b)849 m<sup>3</sup>**

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