Lecture 24: Exercise on lead smelting

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Exercise-1

A lead blast furnace uses a burden comprising of sinter, skimmings, limestone, cinder and coke. The analysis of the burden is:

Sinter (150 Tons)   PbS 18% , PbSO4 6%, PbO 28%, Cu_2S 1%, Fe_2O_3 19%, SiO_2 22 %, CaO 6% ,2.268 Kg silver /ton sinte*r*

Skimming (10 Tons)   Pb 25% and PbO 75%

Limestone (15 Tons) SiO_2 5 %, C_aCO_3 95%,

Cinder(50 Tons)Cu_2S 2%, Fe_2O_3 90% and SiO_2 8 %,

Coke(30 Tons) SiO_2 10 % and C 90%

The slag contains 10 parts FeO to 7 parts SiO_2. Neglect any lead in slag and gases. 2/3rd of the copper charged enters in the matte and 1/3rd enters into lead bullion. All sulphur goes into matte. All silver enters lead bullion.

The gases carry 1.5 parts of CO and 1 part of Co_2

Find:

a) The charge balance of the furnace.
b) % composition of all products
c) Percentage of carbon burnt at the tuyere when 90% carbon of coke is burnt to
   CO and 10% to CO_2.

Solution:

Solution given here is very brief. The reader should make attempt to solve the problem.

Charge balance refers to complete details of input and outputs.The amount of inputs and their composition are given. We have to determine amount of outputs and their composition to complete the balance.

Output consists of

i) Lead bullion which is a mixture of
Ag + Cu + Pb and its amount is 71.16 Tons and consists of 98.58 %, Pb, 0.94 % Cu, rest Ag

ii) Amount of matte:20.42 tons with Pbs = 44.27%, $Cu_2S = 8.18\%$ and rest FeS

iii) Amount of slag:115.94 tons. FeO 50.2% , SiO_2 35.2% rest CaO

In lead blast furnace carbon burns at the tuyere level it is important to calculate the amount of carbon burnt at the tuyere level. It can be calculated as follows:

Let X ton moles of O_2 is supplied through tuyeres and y ton moles of co and co2 exit the furnace.

Oxygen balance
$$0.6 + X = 0.3Y + 0.4\ Y$$
$$\text{Carbon balance} \quad Y = 2.3925 \text{ moles.}$$
$$X = 1.075 \text{ ton moles}$$

TotalC in tons = 24.5 tons
% C burnt at tuyeres level = 90.7%

Exercise-2: Do yourself.
A roasted lead ore is smelted in a blast furnace with enough $CaCO_3$ to make a slag of 18.5% CaO.The coke is 16% of the roasted ore and analyzes 90% C and 10% SiO_2.
The composition of roasted
ore;PbO 25%, PbS 18%, Fe_2O_3, 22% , Cu_2S 2% , SiO^2 29%, and CaO 4%

Of the lead charged 5% is lost in dust andflue, and 8% enters the matte. Of the copper charged 50 % enters the matte and rest copper enters into lead bullion .Ten % of S enters into gases.
Find: Per 1000Kg roasted ore
The amounts of lead bullion, matte and $CaCO_3$

The readers are expected to solve this problem and compare the answers given in lecture 24 of video course on materials and heat balance in metallurgical processes.
Purposely answers are not given.

Reference:

1) Butts: Metallurgical problems
2) S.C.Koria: Video course on material and heat balance in metallurgical processes, NPTEL website