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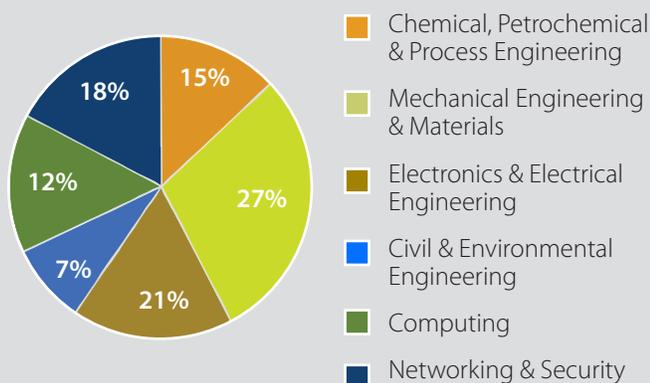
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Handbook of Chemical Technology and Pollution Control  
Hocking, Martin B.  
ISBN-13: 9780120887965, 833 pp  
Academic Press, 2005

Table of Contents Start Chapter

13.3. SMELTING AND REFINING OF CONCENTRATES 401

$\text{Cu}_2\text{O} + \text{FeS} \rightarrow \text{Cu}_2\text{S} + \text{FeO}$	13.9
$2 \text{Cu} + \text{FeS} \rightarrow \text{Cu}_2\text{S} + \text{Fe}$	13.10
$2 \text{Fe} + \text{O}_2 \rightarrow 2 \text{FeO}$	13.11
$\text{Cu}_2\text{S} + 2 \text{CuO} \rightarrow 4 \text{Cu} + \text{SO}_2$	13.12
$\text{FeO} + \text{SiO}_2 \rightarrow \text{FeSiO}_3 \text{ (slag)}$	13.13

The transfer of a part of the iron-bound sulfur to copper, which is an objective of this stage, is the result of the change in the relative heats of formation of cuprous and ferrous sulfides at these high temperatures (e.g., at 1,300°C,  $\Delta H = -174$  and 34.4 kJ, respectively) relative to those at 25°C ( $\Delta H = -79.5$  and 95.1 kJ, respectively).

The product of the reverberatory smelting stage is matte copper, containing primarily copper metal and cuprous sulfide. The analysis will range from 15% (particularly with nonconcentrated ores) to 50% copper [18]. Ideally, the copper concentration in matte copper is kept at 40–45% Cu to maintain the matte as an effective collector of precious metals, and to keep the copper loss in the slag to a minimum. Insufficient sulfur (as  $\text{Cu}_2\text{S}$ , melting point 1,100°C) in the matte also makes it difficult to keep the charge molten (melting point of Cu, 1,083°C; which is depressed by the eutectic mixture of the matte copper).

In converting, the third stage of copper smelting, air is blown through the mass of molten matte copper to complete the oxidation of sulfides, since by this stage the bulk of the iron has been removed (Fig. 13.7) (Eqs. 13.14 and 13.15).

**FIGURE 13.7** Diagram of a side-blown converter used to separate an iron-rich ferro-silicate slag from a sulfur-rich matte copper. (Courtesy of Inco Ltd., Toronto.)

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