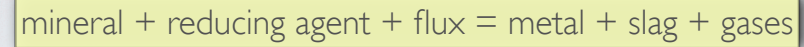


Smelting

Smelting is a process of melting and separation of the charge into two or more immiscible liquid layers, which may be slag, matte, speiss or metal.

The different types of smelting are: (i) reduction smelting; (ii) matte smelting; and (iii) flash smelting

The reduction smelting process involves the reduction of oxidic sources of metals with carbon in the presence of a flux



Example : blast furnace smelting of iron

The matte smelting process involves the fusion of sulfidic sources of metals with a flux without the use of any reducing agent



sulfidic source concentrate + flux = matte + slag + gases

molten
mixture of
sulfides

the gangue
associated with the
starting sources

speiss : a mixture of molten arsenides and antimonides of heavy metals

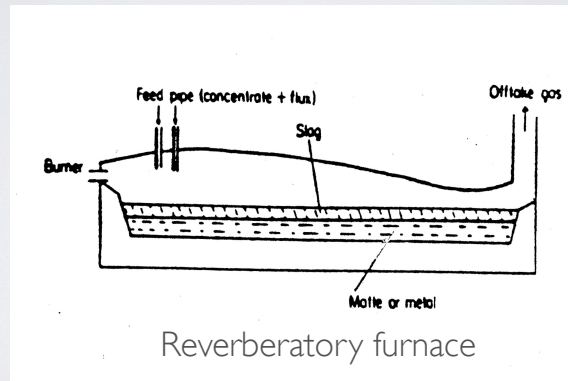
Example : smelting of Cu or Ni ores

The flash smelting process **combines** into one the **flash roasting** and the **smelting operations**

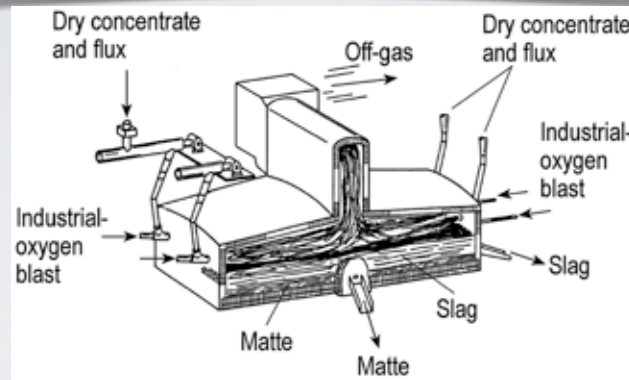


The sulfide concentrate fines react with oxygen at high temperatures. The oxidation process itself generates sufficient heat for the smelting process to occur simultaneously.

Furnaces used in smelting process: reverberatory, direct electric arc, circular blast, flash smelter, rectangular, etc.

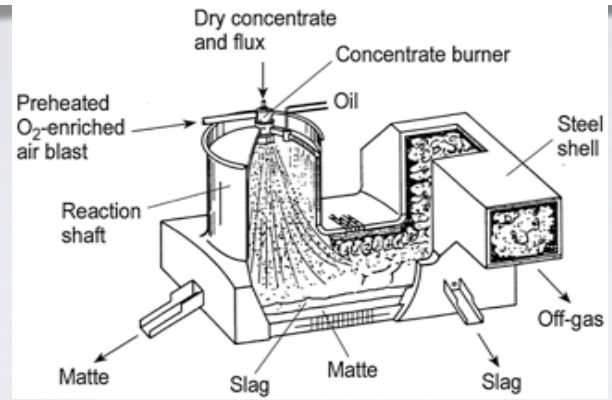


Furnaces used in smelting process: reverberatory, direct electric arc, circular blast, flash smelter, rectangular, etc.



Flash smelter furnace (Inco technology)

Furnaces used in smelting process: reverberatory, direct electric arc, circular blast, flash smelter, rectangular, etc.



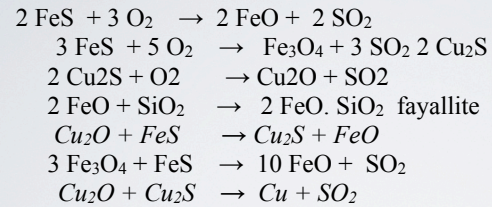
Fluid furnace (Outokumpu technology)

Notes:

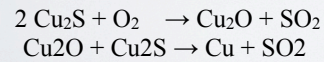
1. In smelting choice of slag composition to give the optimum balance of basicity and fluidity is important : maximum removal of impurities.
2. Matte smelting can be conducted at lower melting point than metal oxide smelting.
3. Matte smelting is normally carried out in a reverbatory furnace; electric arc furnace for higher temp. (1500°C); flash smelting: modern, improved, incorporating flash roasting with smelting

Example: Matte smelting of $\text{Cu}_2\text{S} - \text{FeS}$

1. stage (removal of FeS) \rightarrow 1350 °C



2. stage (removal of S) \rightarrow raw Cu (blister): *Ag, Au, Pt-kovy, Se, Te, Pb, Zn, Ni, As, Sb, Ni, Co, O₂* 1150 °C

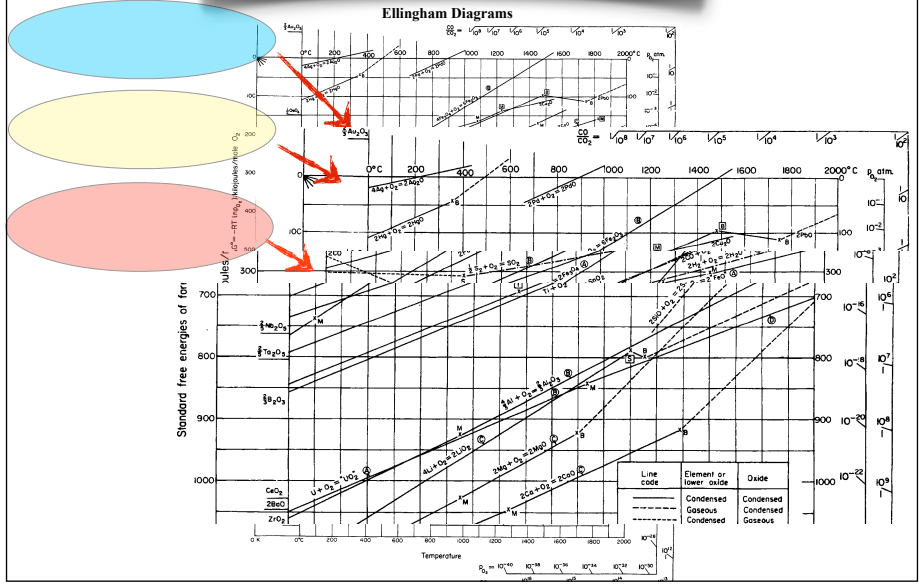


Reduction

Metal oxides may be **reduced** to the metal by carbon, carbon monoxide, hydrogen or other metals which form more stable oxides.

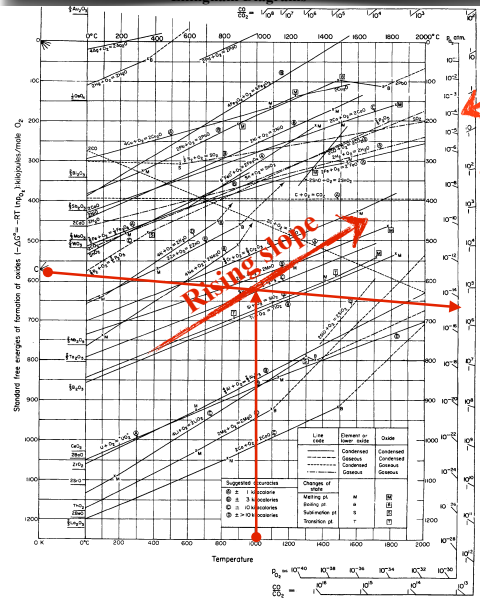
1. $\text{MeO(s)} + \text{C(s)} \leftrightarrow \text{Me(s)} + \text{CO(g)}$
2. $\text{MeO(s)} + \text{CO(g)} \leftrightarrow \text{Me(s)} + \text{CO}_2\text{(g)}$

Ellingham diagrams



Ellingham diagrams

Ellingham Diagrams

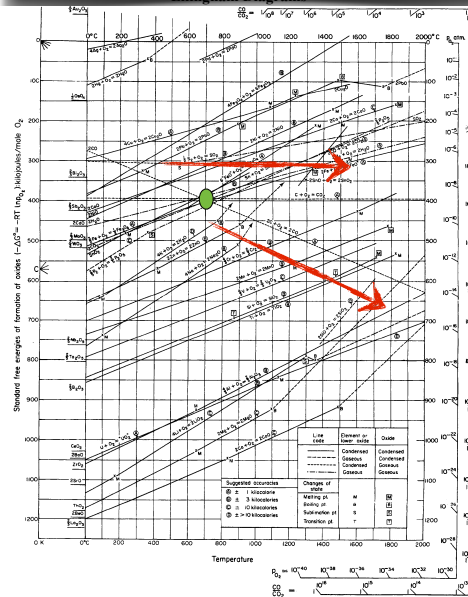


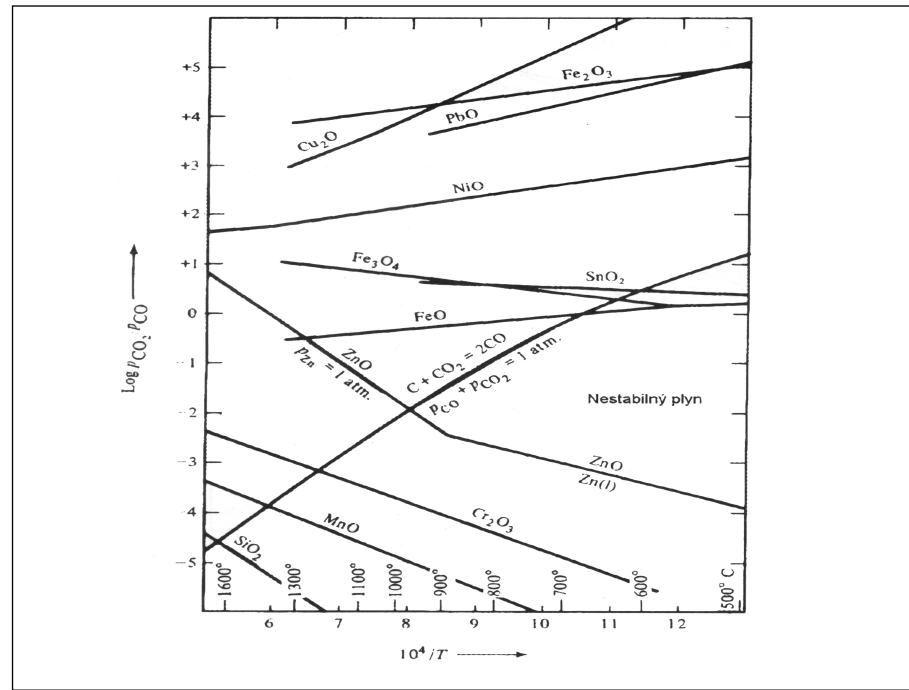
O_2 grid

CO_2/CO grid

Ellingham diagrams

Ellingham Diagrams





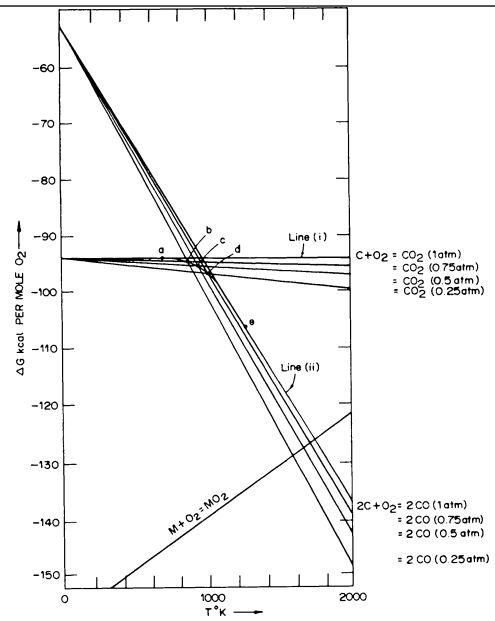


Figure 4.10 The effect of varying the pressures of the product gases of the reactions.