REFRACTORIES

It is any material which can withstand high temp. without softening or suffering a deformation in shape. The main objective of refractory is to confine heat or resist loss of heat and to resist the abrasive and corrosive action of molten metals, slags, gases at high operating temp. in industrial unit without undergoing any change.

Classification :-

According to chemical properties, the refractories are classified into -

1. Acid Refractories :- resistant to acidic materials eg. alumina (Al_2O_3), silica (SiO_2)
2. Basic Refractories :- resistant to basic materials eg. CaO, MgO etc.
3. Neutral Refractories :- most common type of refractory consisting of weakly acidic or basic materials eg. graphite, chromite ($FeO.Cr_2O_3$) Zirconia (ZrO_2), carborundum (SiC) etc.

Characteristics of Refractory :-

A good refractory should have the following characteristics :-
(a) infusibility (b) chemical inertness (c) resist the abrasive action of fuel gases, flames etc. (d) sufficiently strong to bear the weight or load of structure at operating temp. (e) do not crack and suffer changes in size and shape.

Manufacture of Refractories :-

The manufacture of refractory essentially consist of the following steps :-

(a) crushing and grinding of the raw materials
(b) screening to purify the raw materials by settling, magnetic separation or by chemical methods.
(c) Storage and Mixing :- to make the latter steps easier, the materials are well mixed and stored
(d) Moulding :- The raw materials are then moulded into desired shape either manually or mechanically applying vacuum.
(e) Drying :- It is done slowly in Tunnel dryers to remove moisture etc.
(f) Firing :- Finally the dried material with proper shape is fired at a temp. higher than their use limp.

Selection of Refractory Bricks depending upon use:-

1) Silica Bricks :- The quarzite sand bricks are heated to about 1500°C whereby it converts into a mixture of its tuff allotropic forms Tridymite and Cristobalite. They do not contract in size and expands on heating.
2) Fireclay Bricks :- Made of Bauxite ($Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O$) Their crushing strength is very high and melts at around 1300°C.

3. Magnesite Bricks :- Made of calcined magnesite (MgO), withstand upto a temp. of 2000°c without load and upto 1500°c with load.

(4) Dolomite Bricks :- made of calcined mixture of $CaO + MgO$, withstand upto a temp. of 1500°c.

(5) Chromite Bricks :- made of chromite ($FeO.Cr_2O_3$) mixed with a little clay as binding material. Very good type of refractory, withstand upto 1800°c temp. with load.

Properties of Refractory :-

1) Thermal conductivity :- The densest and least porous bricks have the highest thermal conductivity (as needed in muffle furnace walls) and porous bricks (achieved by mixing some carbonaceous material with raw materials) have the least thermal conductivity for the presence of air voids.

2) Strength under load :- R.U.L test (Refractories under load) is performed by applying a constant load to the specimen under test and then heating at a constant rate. The record of the specimen with load having the cone shape vs. temp. is observed and plotted into a curve and expressed as 10% deformation which takes place at a temp.

3. Porosity :- All refractories contain pores which may be open or closed arising due to manufacturing methods and is measured by the ratio of pores volume to the bulk volume as below —

$$P = \frac{W - D}{W - A} \times 100$$

where W = wt. of saturated specimen
D = " " dry "
A = " " saturated specimen in water.

The porosity determines the thermal conductivity of the refractory.

4. Chemical inertness :- The refractory should be chosen such that it do not react with the product.
5. Thermal expansion :- It should have least thermal expansion though some allowance for expansion is to be kept in the furnace.
6. Thermal spalling :- Spalling is breaking, cracking, peeling off or fracture of a refractory brick or block under high temp. So the refractory should be good resistant to thermal spalling, which is generally achieved by using high porosity, low coefficient of expansion and good thermally conductive refractory bricks.

Some other desirable properties are :-

7. Electrical conductivity :- it should be low for electric furnaces.
8. Heat capacity :- it should be high.
9. Texture :- it should be rough or coarse with high porosity.

Condition leading to failure of a refractory material:-

① using a refractory with less thermal conductivity than operating temp.
② using bricks of higher thermal expansion.
3) using heavy weight refractory bricks.
4) using refractory bricks which are not properly fired and which undergo considerable volume changes.
5) using chemical non-friendly refractory in a process.