The General Method of Refractory Bricks Manufacturing

Manufacturing of refractories consists of the following steps.

1- Grinding

Raw materials crushed and ground to fine powder using crushers, hammer mills and ball mills.

2- Mixing

To mix various raw materials for proper distribution in order to alter the chemical properties of the refractories, two or more powdered raw materials are thoroughly mixed with a suitable binding material, which makes moulding easier.

3. Moulding

Moulding is done to provide the required shape and structure. Molding can be done either manually or mechanically by applying of high pressure.

Hand-moulding produces refractories of low strength and low density.

Mechanical-moulding produces refractories of high strength and high density.

4. Drying

Drying is done to remove moisture and volatile matter from refractories. It is carried out at slow rate to avoid voids and high shrinkage.

Drying of moulded refractories increases its green strength by removing moisture and thus making them safe for subsequent handling.

- **5. Firing**

It is done at a temperature as high as or higher than their use temperature. Firing is generally carried out in kilns.

The refractories are fired,

1. to stabilize and strengthen their structures.
2. to remove water of hydration.
3. to facilitate development of stable mineral to form the finished products.

Types of Refractories

The following is the discussion of the outstanding characteristics of the various types of refractories:

1) Fireclay Refractories:

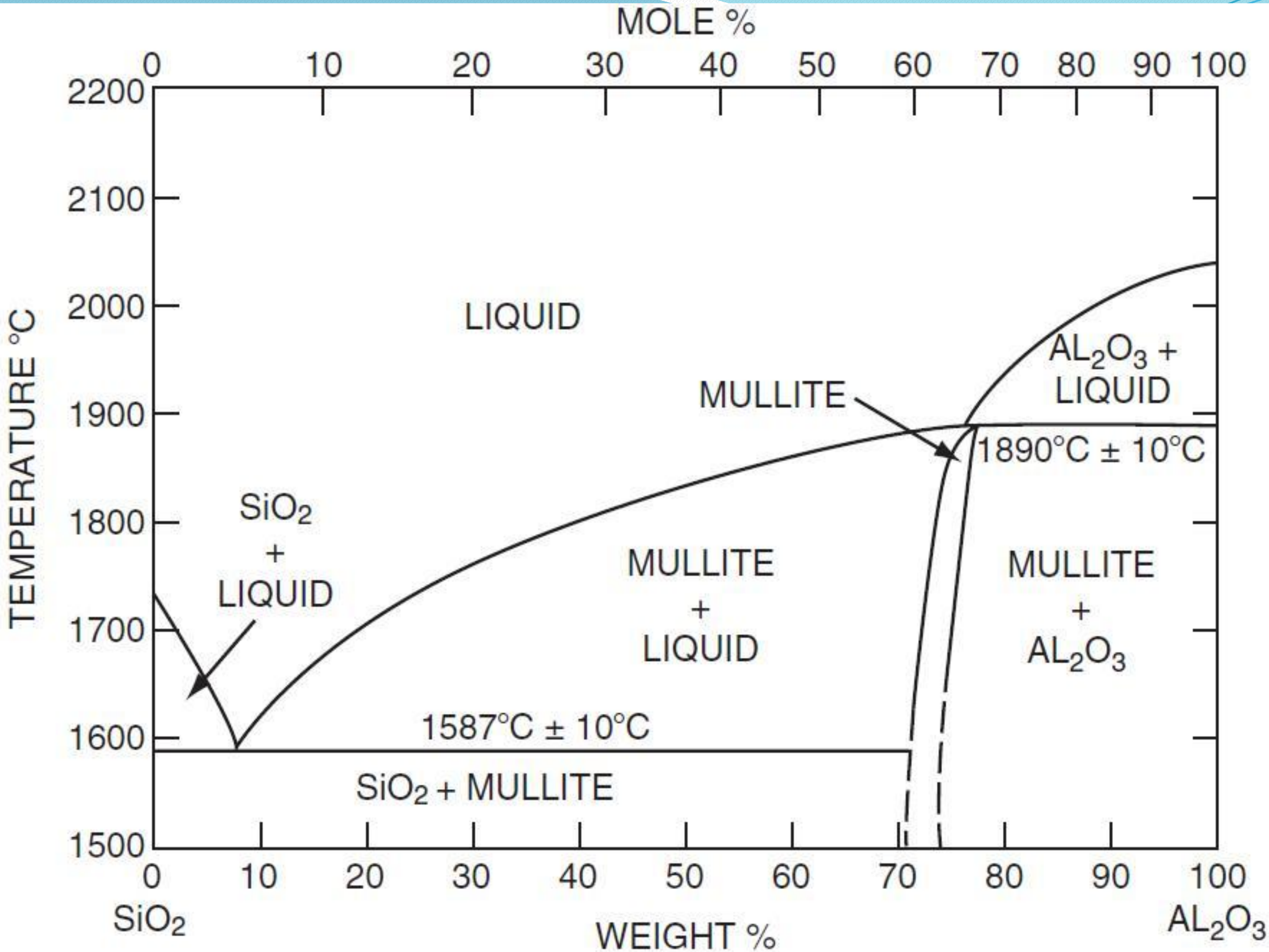
Refractory fireclay consists essentially of hydrated aluminum silicates with minor proportions of other minerals.

The chemical composition typical for fire clays are **23-34% Al_2O_3**, **50-60% SiO_2** and **6-27%** loss on ignition with various amounts of Fe_2O_3, CaO, MgO, K_2O, Na_2O and TiO_2.

As defined by the American Society for Testing Materials (ASTM C-27), there are five standard classes of fireclay brick:

- **superduty,**
- **high-duty,**
- **medium-duty,**
- **low-duty and**
- **semi-silica**.

These classes cover the range from approximately **18% to 44% alumina**, and from about **50% to 80% silica**


MOLE %
0
10
20
30
40
50
60
70
80
90
100
2200
2100
2000
1900
1800
1700
1600
1500
TEMPERATURE °C
LIQUID
MULLITE
AL_2O_3 +
LIQUID
1890°C ± 10°C
SiO_2
+
LIQUID
MULLITE
+
LIQUID
MULLITE
+
AL_2O_3
1587°C ± 10°C
SiO_2 + MULLITE
0
10
20
30
40
50
60
70
80
90
100
SiO_2
WEIGHT %
AL_2O_3

Superduty fireclay brick have good strength and volume stability at high temperatures and an alumina content of **40% to 44%.** Some superduty brick have superior resistance to cracking or spalling when subjected to rapid changes of temperature.

High-duty fireclay brick are used in large quantities and for a wide range of applications. Because of their greater resistance to thermal shock, high-duty fireclay brick can often be used with better economy than Superduty brick for the linings of furnaces.

Medium-duty brick are appropriate in applications where they are exposed to conditions of moderate severity. Medium-duty brick can withstand abrasion **better** than many brick of the high-duty class.

Low-duty fireclay brick find application as supported for brick with higher refractoriness, and for other service where relatively moderate temperatures prevail.

Semi-silica fireclay brick contain

18% to 25% alumina and

72% to 80% silica, with a low content of alkalies and other impurities. With notable resistance to shrinkage, they also have excellent load-bearing strength and volume stability at relatively high temperatures.

- In general, Fire clay consists mainly of **kaolinite clay** that can withstand very high temperatures. These clays have fusion point higher than **1600 °C**, therefore it is suitable for **lining furnaces**, as fire brick, and for manufacture the **crucibles**. Because of its stability during firing in the kiln, it can be used to make complex items of pottery such as pipes and sanitary ware.

Fireclay Brick Manufacturing:

The manufacture of fireclay brick and structural clay products involves **mining**, **grinding**, **screening** and **blending** or **mixing** of the raw materials followed by **forming**, **cutting** or **shaping**, **drying**, **firing**, **cooling**, **storage**, and **shipping** of the final product.

Most fireclay bricks are made from **mixing** of two or more clays. Some brick, especially those of the low-duty class, are made of single clay.

The mixes for **superduty** and **high-duty** brick commonly contain raw **flint** and **bond clays**, with or without **calcined clay**.

Calcined clay or **grog** is added to the brick mix to reduce the firing shrinkage and to give greater stability in applications.

Grog is fire clay which has already been heated to **1300°C**, so that no further contraction in volume takes place. Broken and used fireclay bricks are also used as grog.

A small amount of plastic clay is added to facilitate moulding. A mixture is made by grinding raw **fire clay**, **grog** and **plastic clay** with **water**. There are several ways of giving a final shape to the mixture.

Grog addition to fireclay is mainly as an anti-shrinkage element in the fireclay manufacturing process.

The main advantages of grog addition to fireclay are:

- **Reduced shrinkage on heating**.
- **Enhanced strength of fire refractories**.
- **Greater spalling resistance**.
- **Increased specific gravity and decreased apparent porosity**.
- **Increased production rate** due to necessity of less addition of water to get a workable plasticity and **lesser time** required for drying the raw refractories.

The dried fireclay bricks are fired in batch or continuous type kilns. Depending upon the kiln/furnace temperature and **changes** that take place in the dried refractories, firing of fire-clay bricks are divided into following five stages namely:

- Steaming.
- Decomposition of clay.
- Oxidation or full fire stage.
- Primary fusion.
- Annealing and cooling.

- In full fire or oxidation stage, various mineral transformations occur. At 950°C the **mullite** ($3Al_2O_3.2SiO_2$) formation takes place when alumina begins to combine with silica. Between (1350 to 1380)°C crysalation of mullite is completed.