2.1. Nature of Magnesite

Metals occur in nature, some times free (i.e. in uncombined state), but mostly in the combined state, (i.e. as compounds with other elements). When a metal is found free, it is said to occur as 'native'. Metals found in native state are copper, silver, gold, mercury and platinum. Others are found in the combined state. Magnesite is found in a combined state.

The Chemical name of magnesite is magnesium carbonate (MgCO₃). (i.e) Magnesite is a carbonate of magnesium. When pure, it contains 52.4% carbon di-oxide (CO₂), and 47.6% magnesium oxide (MgO). But pure magnesite is rarely found in nature. It is usually associated with small percentage of calcium, silicon, iron and aluminium, totals going upto 10%. These elements are called impurities.

Magresite mineral can be compared with paddy.

<table>
<thead>
<tr>
<th>Paddy</th>
<th>Raw magnesite</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>Processed magnesite or calcined magnesite</td>
</tr>
<tr>
<td>Food</td>
<td>Refractory bricks/ramming mass/ fettling mass/ gunning mix, etc.,</td>
</tr>
</tbody>
</table>
Paddy has limited use. It can be used as a seed only. Similarly, the uses of raw magnesite are very much limited. From paddy, we get rice. Rice cannot be used as such. It is used to produce various food items. Similarly when raw magnesite is processed, it gives calcined magnesite. The calcined magnesite, as such, finds no much use. It is used to produce other usable products.

The rice is converted into food products which can be consumed as such. Similarly, the calcined magnesite is used to produce refractory bricks, gunning mass, ramming mass, fettling mass and many other products which find many uses. Thus, there is a one to one relationship between paddy and magnesite.

2.2: DEFINITIONS

For a clear understanding of the subject of magnesite, a few terms (used in this report) are explained below.

2.2.1: MINERALS

A mineral is a material dugout from earth as such. It is a compound (i.e) it is a combination of more than one metal.
A mineral must have the following characteristics. The material must be inorganic, not formed form any process of animal or plant life, fall within specific limits of chemical composition and have a regular internal arrangement of atoms. Magnesite is a mineral as it satisfies the above characteristics.

2.2.2: ORE

Ore is an aggregation of the minerals and gangue from which one or more metals may be extracted at a profit. Magnesite is an ore as magnesium metal can be profitably extracted from it.

2.2.3: GANGUE

Gangue minerals are the associated non-metallic materials of deposit. They may be introduced minerals or the enclosing rock and are usually discarded in the treatment of the ore. The gangue in customary usage includes only non-metallic minerals such as pyrite, which is usually discarded as worthless. Certain gangue materials, however, may at times, be collected as by-products and utilised. For example rock gangue may be utilised for road metal, quartz for abrasive etc., In the case of magnesite deposit, silicate, calcium, etc., are the gangue materials.
2.2.4: MINING

The process of taking out the ore from the earth is called mining. The magnesite ore is taken out from mother earth by mining. The first step in mining is to locate or find the minerals. This is called prospecting or exploiting. Next the best way of mining is planned and used. Finally, the safety and health of the miners must be cared for.

2.2.5: METALLURGY

The process of extracting the metals from their ores and refining them is called metallurgy.

Note: 1. The process used for the metallurgy of a metal depends on the nature of the ore from which the metal is being extracted and also on the properties of the metal. Thus it is not possible to chalk out a universal method for extraction of all the metals.

Note: 2. Consideration of the extraction of magnesium metal from magnesite is beyond the scope of this study.

2.2.6: REFRACTORIES

These are substances which can withstand high temperature in the furnace without melting and does
not react with the material poured in it. Alumina (Al₂O₃), Chromite (FeO Cr₂O₃), Magnesite (Mg CO₃), Titania (TiO₂), Carborundum (Si C), Zirconia (ZrO₂) are the important refractory materials.⁹

The refractory industry consumes 90-95% of magnesite production in India (Indian mineral year books, Nagpur).

2.2.7: CALCINATION

Calcination is the process of heating the ore lightly. It does the following things.

i) It removes the volatile impurities like carbon di-oxide (CO₂), matter, moisture etc., from the ore.

ii) It removes water from the hydrated oxide ore.

iii) It removes CO₂ from a carbonate ore.¹⁰

Magnesite is heated lightly to get calcined magnesite.

\[
\text{Mg CO₃ Calcination MgO + CO₂.} \quad \text{---------->}
\]

Sintering refers to heating of the ore at a very high temperature range of 1600 – 2000⁰ C. Magnesite is sintered at a temperature range of 1600 ° – 1800 ° C to get dead burned magnesite. (Sintering is also called calcining in usage)
2.2.9: INDUSTRIAL MINERAL

It is a term of the trade only. A mineral to be an industrial mineral must satisfy the following: (i) the nature of the substance must be inorganic, (ii) it must be available in a combined state, (iii) one or more metals must be extracted from it. profitably, and (iv) some other products must also be produced from it. As magnesite satisfies all these conditions, it is an industrial mineral. Other industrial minerals are alumina\(\text{Al}_2\text{O}_3.2\text{H}_2\text{O}\) carnallite \(\text{KCl. Mg Cl}_2.6\text{H}_2\text{O}\), magnetite \(\text{Fe}_3\text{O}_4\), hematite \(\text{Fe}_2\text{O}_3\), siderite \(\text{Fe CO}_3\), etc.

2.3: MAGNESITE FAMILY

Though the raw magnesite has no much use as such. The various products produced from magnesite have various uses. Hence it is essential to know the various products produced from magnesite. These products may collectively be called "magnesite family". Chart 2.1 given on next page will give a clear picture about the magnesite family.

2.3.1: SEPARATION OF MAGNESITE FROM SOIL

Magnesite bearing earth is first loosened by drilling and blasting. The run-of-mines is separated into raw magnesite (also called crude magnesite) and spoils by
the method of hand picking. Spoils are nothing but the soil and rocks which are obtained along with the magnesite. Spoils are waste and hence have no use.

2.3.2: GRADING OF MAGNESITE

The magnesite ore is chipped and dressed by hand to get rid of the surface impurities associated with it. The raw magnesite is then graded into refractory and non-refractory grades by visual appearance and they are stacked separately.

2.3.3: MAGNESIUM METAL

Magnesium can be obtained from the calcined magnesite either by electrolysis or by thermal reduction methods. 11

2.3.4: REFRACTORY GRADE OF MAGNESITE

The refractory grade magnesite is used to produce DBM and CCM. Magnesite is calcined at a sufficiently high temperature (1600 °C - 1800 °C) to drive off the CO₂ and to form a dense, hard crystalline variety of magnesia, called periclase, which reacts neither with CO₂ nor water at ordinary temperatures. This MgO is called 'Dead-burned magnesite' (DBM). 12 The raw magnesite fired at 700 °C to 1000 °C produces a more porous and reactive
material known as Caustic Calcined Magnesite (CCM). The refractory grade magnesite is used only for these purposes.

The DBM is used to produce ramming mass, gunning mass, fettling mass and refractory bricks. Different chemicals in different proportions are added to DBM to produce these products. These products are called monolithics. They are produced depending upon the chemicals added to DBM by simple production process of crushing.

Refractory bricks are manufactured by mixing different chemicals and additives to DBM and passing the mixture through different stages of production process. Caustic calcined magnesite, also called lightly calcined magnesite (LCM) and simply called calcined magnesite is used as such in many industries for various purposes.

2.3.5: NON-REFRACTORY GRADE OF MAGNESITE

The non-refractory grade magnesite is pulvarised and used by some industries as such. When the non-refractory grade magnesite is calcined at a temperature range of 700° - 1000°C, it also gets converted into caustic calcined magnesite. But this product will be of lower quality than the one obtained from calcining refractory grade magnesite; hence the use of this calcined magnesite will also differ.
2.3.6: IMPROVING THE QUALITY OF LOW-GRADE MAGNESITE

The quality of low-grade magnesite can be improved by physical or chemical beneficiation methods. The magnesite thus converted into high quality, is called High Quality Sinter Magnesia (HQSM). This HQSM can be used to manufacture high quality refractory bricks.

Thus the magnesite family consists of raw magnesite, magnesium metal, calcined magnesite, DBM, ramming mass, gunning mass, fettling mass, refractory bricks, HQSM, etc.,

Note: (i) The use of the various magnesite products are explained latter in this chapter.

(ii) The process of separation of magnesite into refractory and non-refractory grade and the production process of the various products of the magnesite family have been explained in detail in the chapter on 'Mining and Production'.

2.4: PROPERTIES OF MAGNESITE

The raw magnesite has both physical and chemical properties. An account of these properties are given below:-
2.4.1: PHYSICAL PROPERTIES

The following are the physical properties of magnesite.

(i) COLOUR: The colour ranges from chalk white to grayish white and pinkish white and sometimes takes greenish or brown colour.

(ii) HARDNESS: Varies from 3.5 to 5 in the Moh’s scale.14

(iii) SPECIFIC GRAVITY: The specific gravity ranges from 3.0 to 3.1215. It is comparatively a light mineral.16

(iv) LUSTRE: The lustre of magnesite ranges from earthy dull in the case of amorphous variety to vitreous in crystalline variety.17

(v) STREAK: White.18

(vi) CLEAVAGE: Perfect.19

(vii) FRACTURE: Conchoidal.20

(viii) STATE: Solid state

(ix) CRYSTAL SYSTEM AND HABITS: Trigonal, rhombohedra; massive, fibrous, granular, compact.21

(x) QUALITY: It is heterogeneous in quality.22

2.4.2: CHEMICAL PROPERTIES

The chemical properties of raw magnesite are very much limited but the calcined magnesite has many chemical
properties. Hence here we give the important chemical properties of raw magnesite and that of the calcined magnesite in the appropriate place.

(i) CHEMICAL COMPOSITION: The chemical composition of magnesite varies from place to place and hence it is not possible to give a general chemical composition of magnesite. However, the usual grade of magnesite treated for calcination will contain the following composition.  

\[
\begin{align*}
\text{MgO} & \quad 45\% \\
\text{Al}_2\text{O}_3 & \quad 2\% \\
\text{CaO} & \quad 1\% \\
\text{SiO}_2 & \quad 2.5\% \\
\text{LOI} & \quad 49.5\% \\
\end{align*}
\]

(ii) MELTING POINT: Around 2800° C.  

(iii) HEAT CONDUCTIVITY: Very low.

2.5: FORMATION, OCCURRENCE AND STRUCTURE

Magnesite is formed in different ways. It occurs in different varieties and the structure of magnesite also varies from variety to variety.
2.5.1: FORMATION OF MAGNESITE

Magnesite is found in nature usually as secondary deposit formed due to i) alteration of ultramafic rocks (mostly serpentine) as is found in Chalk hills, Salem, and Dodkanya in Karnataka; ii) replacement deposit in carbonate rock as found in Almora (U.P) in dolomite rock; iii) bedded deposits as found in Manchuria and South Nevada; and iv) as a vein filling. Thus there are four varieties of magnesite based on the process of formation. Commercial deposits are found mainly in (i) to (iii) types of deposits. In India, bedded or vein filling deposits have not been located.

2.5.2: OCCURRENCE OF MAGNESITE

Magnesite has three modes of occurrences as described below: (i) replacement of dolomite or limestone (Ex. Washington, Austria, Manchuria, Czechoslovakia, and Quebec); (ii) veins (Ex. California, Greece, India, Russia, Yugoslavia and Nevada); (iii) sedimentary beds (Ex. Nevada).

The replacement deposits yield the crystalline variety and have resulted from progressive replacement (rarely complete) of limestone or dolomite by Mg CO₃ through hydrothermal solutions. This forms bedded deposits, lenslike or irregular in shape and of large size. They generally contain some ferrous iron.
The veins contain the hard amorphous variety and occupy fractures of crushed zones in serpentine or ultrabasic rocks. They result from the breakdown of serpentine by hydrothermal solutions, accompanied by the release of silica, which forms opal or chalcedony. 29

The sedimentary deposits are probably formed by evaporation but they are so interbedded with dolomite and other rocks to make their extracting unprofitable. 30

2.5.3: STRUCTURE OF MAGNESITE

There are three kinds of magnesite, namely, (i) cryptocrystalline (ii) crystalline, and (iii) amorphous. 31 This classification is on the basis of the structure of magnesite.

Magnesite is formed by the alteration of dolomitic limestone by magnesium-bearing solution associated with the intrusive rocks. The crystalline varieties of magnesite are the products of such alterations. The crypto crystalline varieties are the products of alteration of serpentine and of similar magnesium bearing rocks. Magnesite of this type is found extensively in an area where there are serpentine rocks and it occurs in fissures or in the sheer-zones thoroughly mixed up with serpentine, along with some opal and chalcedony. 32 Magnesite resulting from the alteration of serpentinous rock is amorphous in nature. 33
2.6: EFFECTS OF IMPURITIES

The magnesite is associated with various objectionable constituents, called impurities, like silica in the form of talc, lime in the form of calcite, lime-stone dolomite and iron as sederite. The effects of impurities are given below.

2.6.1 SILICA AND LIME

Silica and lime form fluid silicate with relatively low melting point and greatly reduce the strength of magnesite bricks in which they are present. When much silica is present, dicalcium silicate \((2\text{CaO} \cdot \text{SiO}_2)\) forms and as this disintegrates on cooling, it tends to break down the whole mass. Magnesium calcium silicate containing 20% of magnesium, 30% of lime and 50% of silica has a melting point of 1350°C only. High silica in magnesite causes ring or well formation inside the kiln (rotary) resulting in chocking. Keeping silica under control is the major problem for the magnesite industry. At present, the silica in magnesite is controlled by selective mining, efficient manual dressing, crushing and screening.

The silica present usually forms a much less refractory product with any lime or iron oxide present. However, a small proportion of lime is considered favorable
as without it, magnesium ferrite is not readily formed. When dicalcium ferrite is formed. It produces an entectics with magnesia which melts at 1380°C so that the whole mass can sinter at or slightly below 1400°C. When a mixture of magnesia and iron oxide is heated to 1500°C-1550°C, an entectic melting at that temperature is formed. This and the silicates which are molten at this temperature form a viscous fluid which instead of assisting, hinders the formation of crystals of periclase.37

2.6.2: IRON OXIDE

The presence of iron oxide is not regarded commercially as an impurity because magnesite which is almost free from iron oxide is very difficult to sinter. If this is present in the range of 2 to 4%, it acts as a convenient flux and can thus produce a well sintered product. If present in large percentage, it is undesirable because it reduces the refractoriness of the product.38

2.7: SPECIAL FEATURES OF MAGNESITE

In this section, some of the special features of magnesite are given.

2.7.1: PURITY

The purity of magnesite is decided on the basis of its silica content. If the silica content is more, the
magnesite is not pure. On the otherhand, if it is less, then the material is said to be pure (ie, of high grade). The Chalk Hills magnesite (Salem dt.,TN) is said to be of high grade compared to Almora (U.P) magnesite.39

2.7.2: PURIFICATION

When the raw magnesite is heated, the carbondioxide in it goes out; but the silica does not decompose. Silica can be reduced only by physical or chemical benefication of the raw magnesite. When silica content is reduced, the purity of the magnesite is improved/increased.

2.7.3: VARYING TEMPERATURES

The temperature range to produce CCM and DBM varies according to the quality of the input raw magnesite. The temperature required is determined by testing the raw magnesite in the chemical laboratory to give the output at a desired level of purity.

2.7.4: EFFECTS OF HEATING ON CHEMICAL PROPERTIES OF MAGNESITE

When raw magnesite is heated around 800°C it becomes free from carbondioxide. When the magnesite is further heated to 1600°C, the material becomes more stronger. In calcination, there is a slight possibility of the presence of some chemical properties whereas in sintering the material (DBM) becomes inert.
2.7.5: NO EFFECT ON FURTHER HEATING

Once the magnesite is heated and cooled down, it becomes inactive and hence it will not get any effect on further heating. So calcined magnesite, obtained at a temperature range of 700 - 1000°C cannot be used as the input in the manufacture of DBM, which is obtained at a temperature range 1400 - 1600°C.

2.7.7: THE PROPERTY OF DOUBLING OF SILICA (SiO₂) IN CALCINATION

Magnesite is a compound of Mg, CaO, SiO₂, FeO, Al₂O₃, CO₂ etc. Of these elements, CO₂ is a gassious element whereas the others are solids. When magnesite is heated, the silica content (the impurity which determines the quality of the magnesite) gets doubled in proportion to MgO. This can be understood from the following:

Let the SiO₂ content in the raw magnesite be 6% (i.e) 100 grams of magnesite contains 6 grams of SiO₂. Let loss on ignition(LOI) be 50% (usually it is 49-52%). When 100 grams of raw magnesite is heated, 50 grams of CO₂ and other impure gases will escape due to loss on ignition and hence after heating the weight of the calcined magnesite will be around 50 grams only. As silica is a solid, it will not decompose upon heating. Hence the same 6 grams of silica will remain with the calcined magnesite, even after heating (i.e) in the quantum of 50 grams of calcined magnesite, 6 grams of silica will be present. In otherwords, the silica
content in the calcined magnesite expressed as a percentage will be 12. This means that the portion of silica in calcined magnesite has doubled compared to that of raw magnesite.

In DBM also, the presence of silica shall be the same (doubled) as in the case of calcined magnesite, because, when heating is increased to 1600°C, nothing goes out except that the material becomes stronger.

This is further confirmed from the following: "While manufacturing the high grade basic refractories, SiO₂ content should be reasonably low in DBM. The ISI has prescribed that the SiO₂ content in DBM and magnesite bricks should not exceed 5.5%. In order to achieve this requirement, the raw magnesite should not contain more than 2.5% SiO₂." ⁴⁰

2.8: USES OF MAGNESITE PRODUCTS

The uses of various magnesite products are given below:

2.8.1: RAW MAGNESITE

The raw magnesite has the following applications.

(i) On addition of sulphuric acid, it forms magnesium sulphate, commonly known as epsom salt. ⁴¹ Epsom salt is used in the manufacture of artificial silk, tanning and in pharmaceuticals. Each kilogram of rayon produced consumes about 5 kgs of epsom salt. ⁴²
(ii) Pure magnesite free from iron is used in the glass industry to control the viscosity and improve the workability of the glass.\textsuperscript{43}

(iii) Raw magnesite is used in the electrode industry to protect the molten metal from aerial oxidation by way of forming slag and layer of \textit{CO}_2. \textsuperscript{44}

(iv) Raw magnesite is used as a constituent of vitreous enamal frit and ceramic glaze frit in ceramic industry.\textsuperscript{45}

(v) The paper and pulp industry uses magnesite to produce magnesium bi-sulphate which acts as cooking liquor.\textsuperscript{46}

(vi) High grade raw magnesite is used in the pharmaceutical industry.

(vii) Raw magnesite is used as a very good filler agent in many products.

(viii) Small chips of low grade magnesite are used in the manufacture of mosaic tiles to give attraction to the floor.\textsuperscript{47}

2.8.3: CAUSTIC CALCINED MAGNESITE (CCM)

CCM is useful for the following purposes:

(i) MANUFACTURE OF SORE CEMENT: Sorel cement, discovered by Sorel in 1867, requires magnesia as a raw material.\textsuperscript{49} When pulverised CCM is treated with a strong solution of magnesium chloride, sorel cement, called magnesium oxychloride, is obtained. This cement expands
very slightly after setting. It appears to be warm in touch in cold weather; it is also noiseless and therefore used as flooring material in hospitals, hotels, ships and docks. It is flexible, durable, non-shrinking and dustless. This cement is used as wood preserver, particularly for railway sleepers. It is also used in the manufacture of grinding stone and abrasive wheels. Emery powder is mixed carefully with sorel cement for manufacturing durable abrasives.

(ii) FERTILIZER: CCM with 90% MgO is used in fertilizer. It increases crop production. Usually magnesia alone is not added to the soil, but it is introduced in the soil along with superphosphate, as a chemically balanced constituent of complex fertilizer.

(iii) PAPER: CCM is very useful in manufacturing paper pulp from wood and bamboo. It is capable of producing high quality paper. For the manufacture of cigarette papers, magnesia is considered as an excellent ingredient for harmless smoking.

(iv) GLASS: By virtue of its chemical purity, it is suitable for the manufacture of colourless and scientific glassware. It improves the chemical resistance of the finished product. It is also used as opacifier.
(v) RUBBER : It is used extensively as a powerful accelerator in the manufacture of rubber. It increases resilience and tensil strength. It acts as a curing agent in the process of rubber manufacture. It is also used for the manufacture of synthetic rubber. It is very much preferred for hard rubber moulding.

(vi) CHEMICALS : It is used in the manufacture of magnesium based chemicals.

(vii) AEROPLANE : Because of lightness and strength of the magnesium alloy, it is being increasingly used in the manufacture of aeroplane parts.52

(viii) RICE MILLS : Magnesia cement is used in rice mills in conjunction with emery powder for hulling and polishing the rice. 53

(ix) PHARMACEUTICALS : Magnesia is used in a number of medical preparations such as magnesia pondezosa (heavy) magnesia levis(light) and milk of magnesia. 54

(x) COSMETICS : It is also used in the preparation of cosmetics.

(xi) STEAM PLANTS : Lightly calcined magnesia is incorporated with asbestos in boiler lagging compositions, producing a permanent and efficient covering which greatly improves the thermal efficiency of any steam plant to which it is applied.55
(xii) PLASTICS: High purity (99% MgO) magnesia produced by a chemical direct acidification process is used in elastomer plastics and thermo plastics to impart flame retardant properties.\textsuperscript{56}

(xiii) ANIMAL FEED: Caustic calcined magnesia is used in the preparation of animal feed.

(xiv) AS A POLISHING MATERIAL: Magnesia powder is used as a polishing material in preparing metallurgical and ore-mineral test pieces examined under the reflecting microscope.

2.8.4. DEAD BURNED MAGNESITE (DBM)

The principal use of magnesite is in the manufacture of refractory material which is used for furnace lining. When DBM is mixed with chromite in different proportions, chrome-mag bricks and mag-chrome bricks (depending upon the ratio of magnesite and chrome) are manufactured.

DBM is desired chiefly as a basic refractory for basic slags in metallurgical furnaces, for kiln and for use with corrosive materials. It is most suited for use in industrial processes, where an acidic reaction is undesirable.\textsuperscript{57} It is an ideal mineral for manufacture of super duty basic refractory bricks.
Magnesia bricks are used for bottoms and sides of furnaces employed in iron and steel industries; the construction of bottom and side walls of electric furnaces; the construction of refining furnaces for gold, silver, and platinum; the construction of melting furnaces for lead, antimony and copper; all other construction furnaces where high temperatures and high resistance to metallic oxides and slags are required; and covering fire clay bricks. 58

2.8.5: FUSED MAGNESIA

Fused magnesia is manufactured by fusing pure calcined magnesia in a high temperature electric furnace within a temperature range of 2550° - 3000°C. The fused product looks like the normal mineral periclase, which has a fusion point of 2800°C. The product is highly resistant to chemical changes which take place in a metallurgical furnace at high temperatures. It is used in the shape of moulded vessels and also as compressed material during the melting operation of non-ferrous metals and alloys such as lead, copper, zinc and tin. Fused magnesia bricks can withstand very high temperature and hence used extensively in alloy steel manufacture and non-ferrous metal refining furnaces. It is commonly used for immersion heaters, resistance elements, melting pots, annealing chamber and laboratory-wave. 59
Due to the non-availability of high temperature electric furnaces in India, fused magnesia is not produced and hence imported for our metallurgical industries.\textsuperscript{60}

2.8.6: RAMMING MASS

As already stated, ramming mass is produced from DBM by mixing some chemicals and then crushing the mixture. It will be of coarse variety after crushing. It is used as the intermittent binder between two bricks in the construction of the kiln with the magnesite bricks. After the construction of the kiln, a thin coating is given on the inside surface of the walls of the kilns with ramming mass to make the surface uniform.

2.8.7: FETTLING MASS

Fettling mass is finer in variety than ramming mass. When the furnace is put into operation, due to wear and tear, patches may occur on the inner surface of the walls. To set-right these patches, the kiln operation cannot be stopped because, it will result in loss of production and high cost in fuel consumption. Fettling mass is made into paste form by adding water and then it is thrown on the patches through the outlet of the kiln with shavels. The chemicals mixed with the DBM to produce fettling mass have the sticking property and hence when thrown on the patches, it immediately sticks on the walls and makes the surface almost uniform.
2.8.8: GUNNING MASS

When the patches on the inside walls of the kiln could not be set right with fettling mass, gunning mass is used.

Gunning mass is finer in variety. It can be mixed with water easily. A special equipment called air-gun is used to spray this mixture on the patches. The equipment is made to hung from the top of the kiln and the mixer is allowed to flow through the equipment when operated. The position of the equipment may be adjusted with the help of a crane. Powerful binacualar is used to locate the patches and then the equipment is placed in the proper position so that when sprayed, the mixture will stick on the patch and make it right. Thus gunning mix is used to set right all patches that occur on the surface of the inner side of the kiln.

Note: (i) Ramming mass, fettling mass and gunning mass are generally called 'monolithics'.

(ii) They may also be called ramming mix, fettling mix and gunning mix, respectively.
REFERENCES


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11. ibid, P.918.


19. ibid, Appendix
20. ibid, Appendix
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28. ibid, P. 724.
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44. ibid, P. 4.
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49. ibid, P. 342.
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