- **Abrasion Of Refractories**: Wearing away of the surfaces of refractory bodies in service by the scouring action of moving solids
- **Absorption**: As applied to ceramic products, the weight of water which can be absorbed by the ware, expressed as a percentage of the weight of the dry ware.
- **Abutment**: The structural portion of a furnace which withstands the thrust of an arch.
- **Acid-Proof Brick**: Brick Having low porosity and permeability, and high resistance to chemical attack or penetration by most commercial acids and some other corrosive chemicals.
- **Acid Refractories**: Refractories such as silica brick which contain a substantial proportion of free silica and which when heated, can react chemically with basic refractories, slags, and fluxes.
- **Aggregate**: As applied to refractories, a ground mineral material, consisting of particles of various sizes, used with much finer sizes for making formed or monolithic bodies.
- **Air-Ramming**: A method of forming refractory shapes, furnace hearths, or other furnace arts by means of pneumatic hammers.
- **Air-Setting Refractories**: Compositions of ground refractory materials which develop a strong bond upon drying. These refractories include mortars, plastic refractories, ramming mixes and gunning mixes and gunning mixes. They are marketed in both wet and dry condition. The dry compositions require tempering with water to develop the necessary consistency.
- **Alumina**:Al_2O_3, the oxide of aluminum; melting point 3720°F (2050°C);in combination with H_2O(water). alumina forms the minerals diaspore, bauxite and gibbsite; in combination with SiO_2 and H_2O, alumina forms kaolinite and other clay minerals.
- **Alumina-Silica Refractories**: Refractories consisting essentially of alumina and silica, and including high-alumina, fireclay and kaolin refractories.
- **Amorphous**: Lacking crystalline structure or definite molecular arrangement; without definite external form.
- **Andalusite**: A brown, yellow, green, red or gray orthorhombic mineral: Al_2SiO_5. Specific gravity 3.1-3.2. Decomposes on heating, beginning at about 2460°F (1350°C) to form mullite ($Al_6Si_2O_{13}$) and free silica.
- **Anneal**: To remove internal stress by first heating and then cooling slowly.
- **Apparent Porosity**: The relationship between the volume of a mass and the volume of water absorbed when the mass is immersed in the water. *See Also Porosity of Refractories*
- **Arc**: As applied to circles, any portion of a circumference; as applied to electricity, the luminous bridge formed by the passage of a current across a gap between two conductors or terminals.
- **Arc Furnace**: A steel melting furnace in which heat is generated by an arc between graphite electrodes and the metal.
- **Arch, Flat**: In furnace construction, a flat structure spanning an opening and supported by abutments at its extremities; the arch is formed by a number of special tapered brick, and the brick assembly is held in place by their keying action. Also called a jack arch.
- **Arch, Sprung**: In furnace construction, a bowed or curved structure which is supported by abutments at the sides or ends only, and which usually spans an opening or space between two walls.
- **Arch, Suspended**: A furnace roof consisting of brick shapes suspended from overhead supporting members.
- **Arch Brick**: A brick shape having six plane faces (two sides, two edges and two ends), in which two faces (the sides) are inclined toward each other and one edge face is narrower than the other.
- **Asbestos**: Commercially, any mineral which remains after burning a fuel or other combustible material.
- **Ash**: The noncombustible residue which remains after burning a fuel or other combustible material.
- **Attrition**: Wearing away by friction; abrasion.

- **Auger Machine**: A machine for extruding ground clays in moist and stiffly plastic form, through a die by means of a revolving screw or auger.

B

- **Backfill**: The process of sealing and filling, and/or the material used to seal or fill, a borehole when completed.
- **Baddeleyite**: A mineral composed of zirconia (ZrO_2). Specific gravity 5.8 Melting point 4890°F (2700°C).
- **Bagasse**: The fibrous material remaining after the extraction of the juice from sugar cane.
- **Ball Clay**: A highly plastic refractory bond clay of very fine grain, which has a wide range of vitrification and which burns to a light color. Often high in carbonaceous matter.
- **Basic Refractories**: Refractories which consist essentially of magnesia, lime, chrome ore or mixtures of two or more of these and, when heated, can react chemically with acid refractories, slags and fluxes.
- **Bauxite**: An off-white, grayish, brown, yellow, or reddish-brown rock composed of a mixture of various amorphous or crystalline hydrous aluminum oxides and aluminum hydroxides (principally gibbsite, some boehmite), and containing impurities in the from of free silica, silt, iron hydroxides, and especially clay minerals: a highly aluminous laterite.
- **Bauxitic Clay**: A natural Mixture of bauxite and clay containing not less than 47 percent nor more than 65 percent alumina on a calcined basis.
- **Bentonite**: A kind of clay derived from volcanic ash and characterized by extreme fineness of grain. Its main constituent is the clay mineral montomorillonite. It is somewhat variable in composition and usually contains 5 to 10 percent of alkalis or alkaline earth oxides. One type has the capacity for absorption of large amounts of water, with enormous increase in volume.
- **Bessemer Process**: An older process for making steel by blowing air through molten pig iron, whereby most of the carbon and impurities are removed by oxidation; the process is carried out in a vessel known as a converter.
- **Blast Furnace**: A tall cylindrical, refractory lined furnace for the production of pig iron or hot metal for direct conversion into steel.
- **Bloating**: Swelling of a refractory when in the thermo-plastic state, caused by temperatures in excess of that for which the material is intended, an exception being the use of this property in one type of ladle brick.
- **British Thermal Unit (BTU)**: The amount of heat required to raise the temperature of one pound of water one degree Fahrenheit at standard barometric pressure.
- **Brucite**: A mineral having the composition $Mg(OH)_2$. Specific gravity 2.38-2.40 A soft, waxy, translucent mineral which dissociates at moderate tempters with the formation of MgO.
- **Bulk Density**: The weight of an object or material divided by its volume, including the volume of its pore spaces.
- **Bunker Oil**: A heavy fuel oil formed by stabilization of the residual oil remaining after the cracking of petroleum.
- **Burn**: The degree of heat treatment to which refractory brick are subjected in the firing process; also, the degree to which desired physical and chemical changes have been developed in the firing of a refractory material.

- **Calcination**: A heat treatment to which many ceramic raw materials are subjected, preparatory to further processing or use, for the purpose of driving off volatile chemically combined components and effecting physical changes.
- **Calcite**: A material having the composition $CaCO_3$. Specific gravity 2.71 for pure calcite crystals. Calcite is the essential constituent of limestone, chalk and marble and a minor constituent of many other rocks.
- **Cap or Crown**: The arched roof of a furnace, especially a glass tank furnace.
- **Carbon Deposition**: The deposition of amorphous carbon, resulting from the decomposition of carbon monoxide gas into carbon dioxide and carbon within a critical temperature range. When deposited within the pores of a refractory brick, the carbon can build up such a pressure that it destroys the bond and causes the brick to disintegrate.
- **Carbon Refractory**: A manufactured refractory comprised substantially or entirely of carbon (including graphite) . ASTM Standard definitions C71-57; or ASTM " Tentative Definitions" are used where applicable.
- **Carbon - Ceramic Refractory**: A manufactured refractory comprised of carbon (including graphite) and one or more ceramic materials such as fire clay and silicon carbide.
- **Castables Refractory**: a mixture of a heat-resistant aggregate and a heat-resistant hydraulic cement ; for use, it is mixed with water and rammed, cast or gunned into place.
- **Catalyst**: A substance which causes or accelerates a chemical change without being permanently affected by the reaction.
- **Cement**: A finely divided substance which is workable when first prepared but which becomes hard and stonelike as a result of chemical reaction or crystallization; also, the compact groundmass which surrounds and binds together the larger fragments or particles in sedimentary rocks.
- **Ceramic Bond**: In a ceramic body, the mechanical strength developed by a heat treatment which causes the cohesion of adjacent particles.
- **Ceramics**: Originally , the term ceramics referred only to ware formed from clay and hardened by the action of heat, and to the art of making such ware. However, its significance has gradually been extended by usage, and it is now understood to include all refractory materials, cement, lime, plaster, pottery, glass, enamels glazes, abrasives, electrical insulation products and thermal insulation products made from clay or from other inorganic nonmetallic mineral substances.
- **Checkers**: Brick used in furnace regenerators to recover heat from outgoing hot gases and later to transmit the heat to cold air or gas entering the furnace; so-called because the brick are arranged checkerboard patterns, with alternating brick units and open spaces.
- **Chemically-Bonded Brick**: Brick manufactured by processes in which mechanical strength is imparted by chemical bonding agents instead of by firing.
- **Chord**: As applied to circles, a straight line joining any two points on a circumference.
- **Chrome Brick**: A refractory brick manufactured substantially or entirely of chrome ore.
- **Chrome-Magnesite Brick**: A refractory brick which can be either fired or chemically bonded, manufactured substantially of a mixture of chrome ore and dead-burned Magnesite, in which the chrome ore predominates by weight.
- **Chrome Ore**: A rock having as its essential constituent the mineral chromite or chrome spinel, which is a combination of FeO and MgO with Cr_2O_3, Al_2O_3, and usually a small proportion of Fe_2O_3. The composition, which is represented by the formula $(Fe,Mg)(Cr, Al)_2O_4$, is extremely variable. Refractory grade chrome ore has only minor amounts of accessory minerals and has physical properties that are suitable for the manufacture of refractory products.

- **Clay**: A natural mineral aggregate, consisting essentially of hydrous aluminum silicates (See also Fire Clay).
- **Collector Nozzle**: *Please See Nozzle Brick.*
- **Colloid**: (1) A particle-size range of less than 0.00024 mm, i.e. smaller than clay size; (2) originally, any finely divided substance that does not occur in crystalline form; in a more modern sense, any fine-grained material in suspension, or any such material that can be easily suspended.
- **Conductivity**: The property of conducting heat, electricity or sound.
- **Congruent Melting**: The change of a substance, when heated, from the solid form to a liquid of the same composition. The melting of ice is an example of
- **Continuous Casting**: Continuous forming of semi-finished steel, e.g.. slabs, blooms and billets, direct from molten steel.
- **Continuous Type Furnace**: A furnace used for heat-treating materials that progress continuously throughout the furnace, entering one door and being discharged from another.
- **Convection**: The transfer of heat by the circulation or movement of the heated parts of a liquid or gas.
- **Corbel**: A supporting projection of the face of a wall; and arrangement of brick in a wall in which each course projects beyond the one immediately below it to form a support, baffle or shelf.
- **Corrosion of Refractories**: Deterioration or wearing away of refractory bodies largely at their surface through chemical action of external agencies.
- **Corundum**: A natural or synthetic mineral theoretically consisting solely of alumina (Al_2O_3). Specific gravity 4.00-4.02. Melting point 3720°F (2050°C). Hardness 9.
- **Course**: A horizontal layer or row of brick in a structure.
- **Cryptocrystalline**: A crystalline structure in which the individual crystals are so small that they cannot be made visible by means of the petrographic microscope but can be seen with an election microscope. Various so-called amorphous minerals are actually cryptocrystaline.
- **Crystal**: (1) A homogeneous, solid body of a chemical element, compound or isomorphous mixture having a regularly repeating atomic arrangement that can be outwardly expressed by plane faces: (2) rock crystal.
- **Crystalline**: Composed of crystals.
- **Cupola**: A cylindrical, vertical furnace usually lined with refractories, for melting metal in direct contact with coke by forcing air under pressure through openings near its base.

D

- **Dead-Burned Dolomite**: A coarsely granular refractory material prepared by firing raw dolomite with or without additives, to a temperature above 2800°F (1538°C), so as to form primarily lime and magnesia in a matrix that provides resistance to hydration and carbonation.
- **Dead-Burned Magnesite**: A coarsely granular dense refractory material composed essentially of periclase (crystalline magnesium oxide): prepared by fire raw magnesite (or other substances convertible to magnesia) at temperatures sufficiently high to drive off practically all of the volatile materials, and to effect complete shrinkage of the resultant magnesia, thereby producing hard dense grains which are entirely inert to atmospheric hydration and carbonation and free from excessive shrinkage when again subjected to a high temperature.
- **De-airing**: Removal of air from firebrick mixes in an auger machine before extrusion by means of a partial vacuum.

- **Density**: The mass of a unit volume of a substance. It is usually expressed either in grams per cubic centimeter or in pounds per cubic foot.
- **Devitrification**: The change from a glassy to a crystalline condition.
- **Diaspore**: A mineral having the theoretical composition Al_2O_3-H_2O (85 percent alumina: 15 percent water). Specific gravity 3.45.
- **Diaspore Clay**: A rock consisting essentially of diaspore bonded by flint clay. Commercial diaspore clay of the purest grade usually contains between 70 and 80 percent alumina after calcination.
- **Diatomaceous Earth**: A hydrous form of silica which is soft, light in weight and consists mainly of microscopic shells of diatoms or other marine organisms. It is widely used for furnace insulation.
- **Division Wall**: Wall dividing any two major sections of a furnace.
- **Dobie**: A molded block of ground clay or other refractory material, usually crudely formed and either raw of fired.
- **Dolomite**: The mineral calcium-magnesium carbonate: $CaMg(CO_3)_2$. Specific gravity 2.85-2.95. The rock called dolomite consists mainly of the mineral of that name and can also contain a large amount of the mineral calcite ($CaCO_3$).
- **Dry Pan**: A pan-type rotating grinding machine, equipped with heavy steel rollers or mullers which do the grinding and having slotted plates in the bottom through which the ground material passes out.
- **Dusting**: Conversion of a refractory material either wholly or in part into fine powder or dust. Dusting usually results from (1) chemical reactions such as hydration: or (2) from mineral inversion accompanied by large and abrupt change in volume, such as the inversion of beta to gamma dicalcium silicate upon cooling.
- **Dutch Oven**: A combustion chamber built outside and connected with a furnace.

E

- **Eccentric Bottom Tapping (EBT)**: A steel-making process used to ensure slag free liquid metal into the Ladle Refining Furnace (LRF). Specifically, this method allows efficient tapping without tilting the vessel, and is desirable for maintaining the cleanliness of the molten steel, because the carry over of oxidizing slag into the ladle during tapping can be prevented.
- **Electron Beam Furnace**: A furnace in which metals are melted in a vacuum at very high temperatures by bombardment with electrons.
- **Electric Arc Furnace (EAF)**: Steel-making Arc furnace where the scrap is generally 100% of the charge. Heat is supplied from the electricity that arcs from the graphite electrodes to the metal bath. Furnaces maybe either alternating current (AC) or direct current (DC). DC units consume less energy and fewer electrodes, but they are more expensive. *See also Arc Furnace*
- **Emissivity, Thermal**: The capacity of a material for radiating heat: commonly expressed as a fraction or percentage of the ideal "black body" radiation of heat which is the maximum theoretically possible.
- **Erosion of Refractories**: Mechanical wearing away of the surfaces of refractory bodies in service by the washing action of moving liquids, such as molten slags or metals.
- **Eutectic Temperature**: The lowest melting temperature in a series of mixtures of two or more components.
- **Exfoliate**: To expand and separate into rudely parallel layers or sheets, under the action of physical, thermal or chemical forces producing differential stresses.
- **Expansion Joint**: Joint or separation made between different materials that have different expansion rates to allow for expansion when heated. A filler strip is placed in the joint.

- **Extrusion**: A process in which plastic material is forced through a die by the application stresses.

F

- **Fayalite**: A mineral having the composition Fe_2SiO_4. Specific gravity 4.0-4.1. Melting point 2201°F (1205°C).
- **Feldspar**: A group of aluminum silicate minerals with a general formula MAl $(Al,Si)_3O_8$ where M=K, Na, Ca, Br, Rb, Sr and Fe. The most important feldspars are: (1) the potash group, of which orthoclase and microcline (k) are the most common, and (2) the soda-lime group, of which albite (Na) and anorthite (Ca) form the end members of a continuous series of solid solutions. Specific gravity 2.55-2.76. Melting points 2050° to 2820°F (1120° to 1550°C).
- **Fillet**: The concave curve junction of two surfaces which would otherwise meet at an angle. Fillets are used at reentrant angles in the design of brick shapes to lessen the danger of cracking.
- **Firebrick**: Refractory brick of any type.
- **Fireclay Brick**: A refractory brick manufactured substantially or entirely from fire clay.
- **Flat arch**: An arch in which both outer and inner surfaces are horizontal planes.
- **Flint**: A hard fine-grained crytocrystalline rock, composed essentially of silica.
- **Flint Clay**: A hard or flint-like fire clay which has very low natural plasticity and which usually breaks with a smooth or shell-like fracture. Its principal clay mineral is halloysite.
- **Flux**: A substance or mixture which promotes fusion of a solid material by chemical action.
- **Fluxing**: Fusion or melting of a substance as a result of chemical action.
- **Forsterite**: A mineral having the composition Mg_2SiO_4. Specific gravity 3.21. Melting point approximately 3450°F (1900°C).
- **Friable**: Easily reduced to a granular or powdery condition.
- **Furnace Chrome**: A mortar material prepared from finely ground chrome ore, suitable for laying brick or for patching or daubing in furnaces.
- **Furnace Magnesite**: A mortar material prepared from finely ground dead-burned magnesite, suitable for use as a joint material in laying magnesite brick, and for patching or daubing furnace masonry.
- **Fused -Cast Refractories**: Refractories formed by electrical fusion followed by casting and annealing.
- **Fused Quartz**: Silica in the glassy state produced by melting clear quartz crystalline feed . It is clear without entrapped gas bubbles or other impurities or diluents. Synonyms include quartz glass and vitreous quartz.
- **Fused Silica**: Silica in the glassy or vitreous state produced by arc-melting sand. It always contains gas bubbles. Synonyms include vitreous silica and silica glass.
- **Fusion**: A state of fluidity or flowing in consequence of heat: the softening of a solid body, either through heat alone or through heat and the action of a flux, to such a degree that it will no longer support its own weight, but will slump or flow. Also the union or blending of materials, such as metals, upon melting, with the formation of alloys.
- **Fusion Point**: The temperature at which melting takes place. Most refractory materials have no definite melting points, but softer gradually over a range of temperatures.

G

- **Ganister**: A dense, high-silica rock (quartzite), suitable for the manufacture of silica brick. Confusion sometimes results from the use of this term, because it is also applied in some parts of the United States to crushed firebrick or to mixtures of either crushed firebrick or silica rock with clay, for use in tamped linings.
- **Gas Purging**: Where the risk assessment has identified the presence or possible presence of flammable or toxic gases or vapors, there may be a need to purge (purify) the air, gas or vapor from the confined space. This will be done with air or an inert gas where toxic contaminants are present, but with inert gas only where there are flammable contaminants.
- **Gibbsite**: A white or tinted monoclinic mineral: $Al(OH)_3$. Specific gravity 2.3-2.4.
- **Glass**: An inorganic product of fusion which ha cooled to a rigid condition without crystallizing. A.S.T.M. Standard Definitions C 71-57: or A.S.T.M. "Tentative Definitions" are used where applicable.
- **Grain Magnesite**: Dead-burned magnesite in the form of granules, generally ranging in size from about 5/8 inch in diameter to very fine particles.
- **Grain Size**: As applied to ground refractory materials, the relative proportions of particles of different sizes; usually determined by separation into a series of fractions by screening.
- **Grog**: A granular product produced by crushing and grinding calcined or burned refractory material, usually of alumina-silica composition.
- **Ground Fire Clay**: Fire clay or a mixture of fire clays that have been subjected to no mechanical treatment other than crushing and grinding
- **Grout**: A suspension of mortar material in water, of such consistency that when it i poured on horizontal courses of brick masonry, it will flow into vertical open joints.
- **Gunning**: The application of monolithic refractories by means of air-placement guns.

H

- **Halloysite**: One of the clay minerals; a hydrated silicate of alumina similar in composition to kaolinite, but amorphous and containing more water; $Al_2SiO_5(OH)_4 2H_20$.
- **Header**: A brick laid on flat with its longest dimension perpendicular to the face of a wall.
- **Heat-Setting Refractories**: Compositions of ground refractory materials which require relatively high temperatures for the development of an adequate bond, commonly called the ceramic bond.
- **Hematite**: The mineral Fe_20_3 (red iron ore). Specific gravity 4.9 - 5.3.
- **High-Alumina Refractories**: Alumina-silica refractories containing 45 percent or more alumina. The materials used in their production include diaspore, bauxite, gibbsite, kyanite, sillimanite, andalusite and fused alumina (artificial corundum).
- **High-Duty Fireclay Brick**: Fireclay brick which have a P.C.E. not lower than Cone 31 1/2 or above 32 1/2 - 33.
- **HMOR**: Hot Modulus of Rupture. *See Modulus of Rupture*
- **Hot Modulus of Rupture (HMOR)**: *See Modulus of Rupture*
- **Hydrate (verb)**: To combine chemically with water.
- **Hydraulic-Setting Refractories**: Compositions of ground refractory materials in which some of the components react chemically with water to form a strong hydraulic bond. These refractories are commonly known as castables.

I

- **Illite**: A group of three-layer, mica-like minerals of small particle size, intermediate in composition and structure between muscovite and montmorillonite.
- **Impact Pad**: A refractories board in ladle / tundish which is helpful for enhanced the furnace life
- **Impact Pressing**: A process for forming refractory shapes, in which the ground particles of refractory material are packed closely together by rapid vibration.
- **Incongruent Melting**: Dissociation of a compound on heating, with the formation of another compound and a liquid of different composition from the original compound.
- **Ingot Mold**: A mold in which ingots are cast.
- **Insulating Refractories**: LIghtweight, porous refractories with much lower thermal conductivity and heat-storage capacity than other refractories. Used mostly as backing for brick of higher refractoriness and higher thermal conductivity. These materials provide fuel economy through lower heat losses, increased production due to shorter heat-up time, economy of space (size and weight) because of thinner walls and improved working conditions. Insulating refractories are available as brick or monoliths.
- **Inversion**: A change in crystal form without change in chemical composition; as for example, the change from low-quartz to high-quartz, or the change from quartz to cristobalite.
- **Isomorphous Mixture**: A type of solid solution in which mineral compounds of analogous chemical composition and closely related crystal habit crystallize together in various proportions.

J

- **Jack Arch**: See Arch, Flat.
- **Jamb**: (1) Avertical structural member forming the side of an opening in a furnace wall,(2) a type of brick shape intended for use in the sides of wall openings.

K

- **Kaldo Process (Stora)**: An oxygen process for making steel.
- **Kaliophilite**: A Hexagonal mineral of volcanic origin; $KAISi0_4$.
- **Kaolin**: A white-burning clay having kaolinite as its chief constituent. Specific gravity 2.4 - 2.6. The P.C.E. of most commercial kaolins ranges from Cone 33 to 35.
- **Kaolinite**: A common white to grayish or yellowish clay mineral; $AI_2Si_20_5(OH)_4$. Kaolinite is the principal constituent of most kaolins and fireclays. Specific gravity is 2.59. The P.C.E. of pure kaolinite is Cone 35.
- **Key**: In furnace construction, the uppermost or the closing brick of a curved arch.
- **Key Brick**: A brick shape having six plane faces (two sides, two edges and two ends), in which two faces (the edges)are inclined toward each other and one of the end faces is narrower than the other.
- **K-factor**: The thermal conductivity of a material, expressed in standard units.
- **Kyanite (Cyanite)**: A blue or light-green triclinic mineral;AL_2Si0_5. Specific gravity 3.56 - 3.67. Decomposition begins at about 2415°F (132555°C) with the formation of mullite and free silica.

L

- **Ladle**: A refractory-line vessel used for the temporary storage or transfer of molten metals.
- **Ladle Metallurgy Furnace**: An intermediate steel processing unit that further refines the chemistry and temperature of molten steel while it is still in the ladle. The ladle metallurgy step comes after the steel is melted and refined in the electric arc or basic oxygen furnace, but before the steel is sent to the continuous caster.
- **Ladle Nozzle**: *See Nozzle Brick and Ladle.*
- **Lance** / **Lance Pipe**: A length of pipe used to convey gas
- **L-D Process**: A process for making steel by blowing oxygen on or through molten pig iron, whereby most of the carbon and impurities are removed by oxidation.
- **Limestone**: A sedimentary rock composed essentially of the mineral calcite ($CaCO_3$) or of calcite mixed with dolomite, $CaMg(CO_3)_2$. Specific gravity 2.6 - 2.8.
- **Limonite**: A mineral consisting of hydrous ferric oxides; the essential component of "brown ore." Specific gravity 3.6 - 4.0.
- **Lintel**: A horizontal member spanning a wall opening.
- **Loss on Ignition**: As applied to chemical analyses, the loss in weight which results from heating a ample of material to a high temperature, after preliminary drying at a temperature just above the boiling point of water. The loss in weight upon drying is called "free moisture;" that which occurs above the boiling point, "loss on ignition."
- **Low-Duty Fireclay Brick**: Fireclay brick which have a P.C.E. not lower than Cone 15 nor higher than 28 - 29.

M

- **Magnesioferrite**: One of the spinel group of minerals: (Mg, Fe) Fe_2O_4. Rarely found in nature; usually constitutes the brown coloring material in magnesite brick. Specific gravity 4.57 - 4.65.
- **Magnesite**: A Mineral consisting of magnesium carbonate; MgCO3. A rock containing the mineral magnesite as it essential constituent (See also Magnesite, Caustic and Dead-Burned Magnesite).
- **Magnesite Brick**: A refractory brick manufactured substantially or entirely of dead-burned magnesite which consists essentially of magnesia in crystalline form (periclase).
- **Magnesite, Caustic**: The product obtained by calcining magnesite, or other substances convertible to magnesia upon heating at a temperature generally not exceeding 2200°F (1205°C). The product is readily reactive to water and to atmospheric moisture an carbon dioxide.
- **Magnesite-Chrome Brick**: A refractory brick which can be either fired or chemically bonded, manufactured substantially of a mixture of dead-burned magnesite (magnesia) and refractory chrome ore, in which the magnesite predominates by weight.
- **Magnesium Hydroxide**: The compound of magnesium oxide an chemically combined water; $Mg(OH)_2$. Naturally occurring magnesium hydroxide is known as brucite.
- **Magnetite**: A black, isometric, strongly magnetic, opaque mineral of the spinel group;$(Fe,Mg)Fe_2O_4$. Specific gravity 5.17 - 5.18. Melting point about 2901°F (1594°C).
- **Medium-Duty Fireclay Brick**: A fireclay brick with a P.C.E. value not lower than Cone 29 nor higher than 31 - 31 1/2.
- **Melting Point**: The temperature at which crystalline and liquid phase having the same composition coexist in equilibrium. Metals and most pure crystalline materials have sharp

melting point, i.e. they change abruptly from solid to liquid at definite temperatures. However, most refractory materials have no true melting points, but melt progressively over a relatively wide range of temperatures.

- **Metalkase Brick**: Basic brick provided with thin steel casings.
- **Metal Zone**: An area or region (such as in a furnace) that contains, stores or is in contact with metal.
- **Mica**: A group of rock minerals having nearly perfect cleavage in one direction and consisting of this elastic plates. The most common varieties are muscovite and biotite.
- **Micron**: The one-thousandth part of a millimeter (0.001 mm); a unit of measurement used in microscopy.
- **Mineral**: A mineral species is a natural inorganic substance which is either definite in chemical composition and physical characteristics or which varies in these respects within definite natural limit. Most minerals have a definite crystalline structure; a few are amorphous.
- **Modulus of Elasticity (Physics)**: A measure of the elasticity of a solid body; the ratio of stress (force) to strain (deformation) within the elastic limit.
- **Modulus of Rupture (MOR)**: A measure of the transverse or "crossbreaking" strength of a solid body.
- **Monolithic Lining**: A furnace lining without joints, formed of material which is rammed, cast, gunned or sintered into place.
- **Monticellite**: A colorless or gray mineral related to olivine; CaMg SiO_4. Specific gravity 3.1 - 3.25. Melts incongruently at 2730°F (1499°C) to form MgO and a liquid.
- **Montmorillonite**: A group of expanding-lattice clay minerals containing variable percentages of one or more of the cations of magnesium, potassium, sodium and calcium. A common constituent of bentonites.
- **MOR**: *See Modulus of Rupture*
- **Mortar (Refractory)**: A finely ground refractory material which becomes plastic when mixed with water and is suitable for use in laying refractory brick.
- **Mullite**: A rare orthorhombic mineral $Al_6Si_2O_{13}$. Specific gravity 3.15. An important constituent of fireclay and high-alumina brick. Melting point under equilibriumC) conditions approximately 3362°F (1850°C).
- **Mullite Refractories**: Refractory products consisting predominantly of mullite ($Al_6Si_2O_{13}$) crystals formed either by conversion of one or more of the sillimanite group of minerals or by synthesis from appropriate materials employing either melting or sintering processes.
- **Muscovite**: A mineral of the mica group; KAl_2 (AlSi) O_{10} $(OH)_2$. It is usually colorless, whitish or pale brown and i a common mineral in metamorphic and igneous rocks and in some sedimentary rocks.

N

- **Nepheline (Nephelite)**: A hexagonal mineral of the feldspathoid group; (Na,K)$AlSiO_4$. A common reaction product in furnaces wherein slags or vapors of high soda content come into contact with fireclay or high-alumina brick. Stable at 2278°F (1248°C) at which temperature it inverts to the artificial mineral carnegieite, which has the same composition, but a different crystalline form. Natural nepheline contains a small amount of potash. Specific gravity 2.67.
- **Neutral Refractories**: A refractory material which is neither acid nor base such as carbon, chrome or mullite.
- **Nine Inch Equivalent**: A brick volume equal to that of a 9 x 4 1/2 x 2 1/2 inch straight brick (101.25 cubic inches); the unit of measurement of brick quantities in the refractories industry.

- **Nodule Clay**: A rock containing aluminous or ferruginous nodules, or both bonded by flint clay; called "burley" clay or "burley flint" clay in some districts.
- **Nosean (Noselite)**: A feldspathoid mineral of the sodalite group; $Na_8AI_6Si_6O_{24}$ (SO_4). It is grayish, bluish or brownish and is related to hauyne.
- **Nozzle Brick**: A tubular refractory shape used in a ladle (or collector) with a hole through which steel is teemed at the bottom of the ladle, the upper end of the shape serving as a seat for the stopper.

O

- **Olivine**: (1) An olive-green, grayish-green or brown orthorhombic mineral; $(Mg,Fe)_2SiO_4$. It comprises the isomorphous solid-solution series forsterite-fayalite. (2) A name applied to a group of minerals forming the isomorphous system $(Mg,Fe,Mn,Ca)_2SiO_4$, including forsterite, fayalite, tephroite and a hypothetical calium orthosilicate. Specific gravity 3.27 - 3.37, increasing with the amount of iron present.
- **Overfiring**: A heat treatment which causes deformation or bloating of clay or clay ware.
- **Oxiduction**: Alternate oxidation and reduction.
- **Oxygen-arc Cutting:** Thermal cutting in which the ignition temperature is produced by an electric arc, and cutting oxygen is conveyed through the centre of an electrode, which is consumed in the process.
- **Oxygen Lance**: A length of pipe used to convey oxygen onto a bath of molten metal.
- **Oxygen Lancing**: A thermal cutting process in which oxygen-lance is used.
- **Oxygen Process**: A process for making steel in which oxygen is blown on or through molten pig iron, whereby most of the carbon and impurities are removed by oxidation.

P

- **Periclase**: An isometric mineral; MgO. Specific gravity 3.58. Melting point approximately 5070°F (2800°C).
- **Perlite**: A siliceous glassy rock composed of small spheroids varying in size from small shot to peas; combined water content 3 to 4 percent. When heated to a suitable temperature, perlite expands to form a lightweight glassy material with a cellular structure.
- **Permeability**: The property of porous materials which permits the passage of gases and liquids under pressure. The permeability of a body is largely dependent upon the number, size and shape of the open connecting pores and is measured by the rate of flow of a standard fluid under definite pressure.
- **Plasma Jet**: Ionized gas produced by passing an inert gas through a high-intensity arc causing temperatures up to tens of thousands of degrees centigrade.
- **Plastic Chrome Ore**: An air-setting ramming material having a base of refractory chrome ore and shipped in plastic form ready for use.
- **Plastic Fire Clay**: A fire clay which has sufficient natural plasticity to bond together other materials which have little or no plasticity.
- **Plastic Refractory**: A blend of ground refractory materials in plastic form, suitable for ramming into place to form monolithic linings.
- **Plasticity**: That property of a material that enables it to be molded into desired forms which are retained after the pressure of molding has been released.
- **Pores**: As applied to refractories, the small voids between solid particles. Pores are described as "open" if permeable to fluids; "sealed: if impermeable.

- **Porosity of Refractories**: The ratio of the volume of the pores or voids in a body to the total volume, usually expressed as a percentage. The "true porosity" is based on the total pore-volume; "apparent porosity" on the open pore-volume only.
- **Porous Plugs**: This structurally integrated product consists of porous refractories, the pore diameter and porosity of which are adjusted to the specified gas flow, and a covering of a high strength castable refractory material, which gives it excellent corrosion resistance.
- **Power Pressing**: The forming of refractory brick shapes from ground refractory material containing an optimum amount of added water by means of high pressure applied vertically in a power-driven press.
- **Pug Mill**: A machine used for blending and tempering clays in a moist or stiffly plastic condition.
- **Purging Plug**: A kind of porous plug which used to feed gas into the EAF/converter or Ladle's molten steel to force the impurities to float to the top surface of the molten steel. This plug is characterized by stable structure, high permeability, high erosion and corrosion resistance, spalling resistance and long life.
- **Pyrite**: The most common sulfide mineral; FeS_2. Specific gravity 4.9 - 5.2. Color, brass-yellow. Used mainly for making sulfuric acid and sulfates.
- **Pyrometric Cone**: One of a series of pyramidal-shaped piece consisting of mineral mixtures and used for measuring time-temperature effect. A standard pyrometric cone is a three-sided truncated pyramid; and is approximately either 2 5/8 inches high by 5/8 inch wide at the base or 1 1/8 inches high by 3/8 inch wide at the base. Each cone is of a definite mineral composition and has a number stamped on one face and when heated under standard conditions it bends at a definite temperature.
- **Pyrometric Cone Equivalent (P.C.E.)**: The number of that Standard Pyrometric Cone whose tip would touch the supporting plaque simultaneously with a cone of the refractory material being investigated when tested in accordance with the Method of Test for Pyrometric Cone Equivalent (P.C.E.) of Refractory Materials.
- **Pyrophyllite**: A mineral consisting of hydrated silicate of aluminum; $AlSi_2O_5(OH)$.
- **Pyroplasticity**: The physical state induced by soaking heat which permits a refractory body to be readily deformed under pressure or by it own weight.

Q

- **Quartz**: A common mineral consisting of silica (SiO_2). Sandstones and quartzites are composed largely of quartz. Specific gravity 2.65.
- **Quartzite**: A Hard compact rock consisting predominantly of quartz. There are two types: (1) metaquartzite, a metamorphic rock usually derived from sandstone; and (2) orthoquartzite, a sedimentary rock consisting of grains of silica sand cemented together by a least 10 percent of precipitated silica.

R

- **Ramming Mix**: A ground refractory material which is mixed with water and rammed into place for patching shapes or for forming monolithic furnace linings. Usually of a less plastic nature than plastic refractories.
- **Ramming Mass**: *See Ramming Mix*
- **Recuperator**: A system of thin-walled refractory ducts used for the purpose of transferring heat from a heated gas to colder air or gas.

- **Refractories**: Nonmetallic materials suitable for use at high temperatures in furnace construction. While their primary function is resistance to high temperature they are usually called on to resist other destructive influences also, such as abrasion pressure, chemical attack and rapid changes in temperature.
- **Refractories, Acid**: See *Acid Refractories*
- **Refractories, Basic**: See *Basic Refractories*
- **Refractories, Neutral**: See *Neutral Refractories*
- **Refractoriness**: In refractories, the capability of maintaining a desired degree of chemical and physical identity at high temperatures and in the environment and conditions of use.
- **Refractory (adj.)**: Chemically and physically stable at high temperatures; The quality of resisting heat.
- **Refractory Chrome Ore**: A refractory ore consisting essentially of chrome-bearing spinel with only minor amounts of accessory minerals, and with physical properties that are suitable for making refractory products.
- **Refractory Clay**: An earthy or stony mineral aggregate which ha as the essential constituent hydrous silicate of aluminum with or without free silica; plastic when sufficiently pulverized and wetted, rigid when subsequently dried and of sufficient purity and refractoriness for us in commercial refractory products.
- **Refractory Composite Coating**: A combination of heat-resistant ceramic materials applied to a metallic substrate which may or may not require hear treatment prior to service. This term may also be used for coatings applied to nonmetallic substrates, for example graphite.
- **Refractory Magnesia**: A dead-burned refractory material consisting predominantly of crystalline magnesium oxide.
- **Refractory Metal**: A metal having an extremely high melting point. In broad sense, it refers to metals having melting points above the range of iron, cobalt and nickel.
- **Regenerator**: A refractory structure in which thermal energy from hot furnace gases is alternately absorbed by checker brick work and released to cold air or gas.
- **Regenerator Checkers**: Brick used in furnace regenerators to recover heat from hot outgoing gases and later to release this heat to cold air or gas entering the furnace; so-called because of the checkerboard pattern in which the brick are arranged.
- **Relining**: Once it wears out, the brick lining of a furnace must be cooled, stripped and replaced. This process is called Relining.
- **Rise of Arches**: The vertical distance between the level of the spring lines and the highest point of the under surface of an arch.
- **Rock**: A naturally occurring mineral aggregate consisting of one or more minerals. For example, quartzite rock is an aggregate consisting essentially of crystals of the mineral quartz; granite is an aggregate consisting essentially of spar and quartz.
- **Rotary Kiln**: A cylindrical, refractory lined, gas-fired kiln that rotates at an angle and in which the charge is introduced into the higher end and travels down the slope of the kiln to the discharge end.
- **Rowlock Course**: A course of brick laid on edge with their longest dimensions perpendicular to the face of wall.
- **Rutile**: A mineral consisting of titanium dioxide (Ti_2O). Specific gravity 4.18 - 4.25.

- **Screen Analysis**: The size distribution of noncohering particles as determined by screening through a series of standard screens.
- **Secondary Expansion**: The property exhibited by some fireclay and high-alumina refractories of developing permanent expansion at temperatures within their useful rang; not the same as overfiring. A behavior not to be confused with the bloating caused by excessive temperatures which impair the useful properties of a refractory.
- **Semi-Silica Fireclay Brick**: A firclay brick containing not less than 72 percent silica.
- **Serpentine**: A group of rock forming minerals; $(mg.Fe)_3Si_2O_5(OH)_4$. Specific gravity 2.5 - 2.7. Also, a common rock consisting essentially of serpentine minerals.
- **Silica**: SiO_2, the oxide of silicon. Quartz and chalcedony are common silica materials; quartzite, sandstone and san are composed largely of free silica in the form of quartz.
- **Silica Brick**: A fired refractory consisting essentially of silica and usually made from quartzite bonded with about 1.8 to 3.5 percent of added lime.
- **Silica Fire Clay**: A refractory mortar consisting of a finely ground mixture of quartzite, silica brick and fire clay of various proportions; often called silica cement.
- **Silicon Carbide**: A compound of silicon and carbon; SiC.
- **Silicon Carbide Refractories**: Refractory products consisting predominantly of silicon carbide.
- **Sillimanite**: A brown, grayish, pale-green or white orthorhombic mineral; Al_2SiO5. Specific gravity 3.24. At about 2785°F (1530°C) it begins to dissociate into mullite and free silica.
- **Sintering**: A heat treatment which caused adjacent particles of material to cohere at a temperature below that of complete melting.
- **Skewback**: The course of brick, having an inclined face, from which an arch is sprung.
- **Slag**: A substance formed in any one of several ways by chemical action and fusion at furnace operating temperatures: (1) in smelting operations, through the combination of a flux, such as limestone, with the gangue or waster portion of the ore: (2) in the refining metals, by substances, such as lime, added for the purpose of effecting or aiding the refining; (3) by chemical reaction between refractories and fluxing agents, such as coal, ash or between two different types of refractories.
- **Slagging of Refractories**: Destructive chemical action between refractories and external agencies at high temperatures resulting in the formation of a liquid.
- **Slag Zone**: An area or region (such as in a furnace) that contains, stores or is in contact with slag.
- **Sleeves**: Tubular refractory shapes used to protect the metal rod which holds the stopper head in the valve assembly of a bottom-pouring ladle.
- **Slurry**: A suspension of finely pulverized solid material in water of creamy consistency.
- **Soapstone**: A metamorphic rock consisting mainly of talc and derived from the alteration of ferromagnesian silicate minerals.
- **Soldier Course**: A course of brick set on end; little used in the case of refractories except in the bottoms of some types of furnaces.
- **Solid Solution**: A homogeneouse crystalline phase with a variable composition. The most common solid solutions involve two or more substances having the same crystalline structure. However, the term can also refer to the solution of small proportions of a material in a seemingly unrelated substance.
- **Spalling of Refractories**: The loss of fragment (spalls) from the face of a refractory structure, through cracking and rupture, with exposure of inner portions of the original refractory mass.
- **Specific Gravity**: The ratio between the weight of a unit volume of a substance and that of some other standard substance under standard conditions of temperature and

pressure. For solids and liquids the specific gravity is based on water as the standard. The "true specific gravity" of a body is based on the volume of solid material excluding all pores. The bulk or volume specific gravity is based on the volume as a whole, ie. the solid material with all included pores. The apparent specific gravity is based on the volume of the solid material plus the volume of the sealed pores.

- **Specific Heat**: The quantity of heat required to raise the temperature of a unit mass of a substance one degree.
- **Spinel**: (1) The mineral composed of magnesium aluminate; $MgAl_2O_4$. Specific gravity 3.6. Melting point 3875°F (2135°C). (2) A group of minerals of general formula; AB_2O_4 where A represents magnesium, ferrous iron, zinc or manganese or any combination of them and B represents aluminum, ferric iron or chromium.
- **Spring Line**: The line of contact between the inside surface of an arch and the skewback.
- **Sprung Arch**: An arch which is supported by abutments at the side or ends only.
- **Stretcher**: A brick laid on flat with its length parallel to the face of the wall.
- **Superduty Fireclay Brick**: Fireclay brick which have a P.C.E. not lower than Cone 33 and which meet certain other requirements as outlined in A.S.T.M. Designation C 27-58T.
- **Suspended Arch**: An arch in which the brick shapes are suspended from overhead supporting members.

T

- **Taconite**: A compact ferruginous chert or slate in which the iron oxide is do finely disseminated that substantially all of the iron-bearing particles are smaller than 20 mesh. Typical analyses of the ore grade show total iron at 32 percent.
- **Talc**: A hydrous magnesium silicate mineral; $Mg_3Si_4O_{10}(OH)_2$. Specific gravity 2.7 - 2.8. Hardness 1.
- **Thermal Conductivity**: The property of matter by virtue of which heat energy is transmitted through particles in contact.
- **Thermal Expansion**: The increase in linear dimensions and volume which occurs when materials are heated and which is counterbalanced by contraction of equal amount when the materials are cooled.
- **Thermal Shock**: A sudden transient temperature change.
- **Tolerance**: The permissible deviation in a dimension or property of a material from an established standard or from an average value.
- **Tridymite**: A mineral form of silica;SiO_2. Stable from 1598 to 2678°F (870° to 1470°C). Specific gravity 2.26. An important constituent of silica brick.
- **Trough**: An open receptacle through which molten metal is conveyed from a holding device or furnace to a casting mold or another receptacle.
- **True Porosity**: *Please see Porosity of Refractories*
- **Tundish**: The shallow refractory lined basin on top of the continuous caster. It receives the liquid steel from the ladle, prior to the cast, allowing the operator to precisely regulate the flow of metal into the mold.
- **Tuyere Brick**: A refractory shape containing one or morel holes through which air and other gases are introduced into a furnace.

V

- **Vacuum Degassing:** An advanced steel-refining method wherein a ladle of molten metal is placed within a chamber which is then evacuated. This reduces gas content, particularly hydrogen, thus reducing non-metallic inclusions to produce a purer and cleaner form of the metal.
- **Vacuum Furnace:** A furnace using low atmospheric pressures instead of a protective gas atmosphere, like most heat-treating furnaces. Vacuum furnaces are categorized as "hot wall" or "cold wall", depending on the location of the heating and insulating components.
- **Vacuum Pressing**: A method of forming brick shapes by which they are subjected to a partial vacuum during pressing in a power press.
- **Vermiculite**: A group of micaceous minerals, all hydrated silicates, varying widely in composition; $(Mg.Fe,Al)_3(AlSi)_4O_{10}(OH)_2.4H_2O$. When heated above 302°F (150°C) vermiculite exfoliate and increases greatly in volume.
- **Vesicular**: Having a cellular structure; applied to fire clays which have become bloated by over-firing.
- **Vibratory Pressing**: A process for forming refractory shapes in which the ground particles of refractory material are packed closely together by rapid impact--type vibrations of the top and bottom dies; also called impact pressing.
- **Vitrification**: A process of permanent chemical and physical change at high temperature in a ceramic body, such as fire clay, with the development of a substantial proportion of glass.

W

- **Warpage**: The deviation of the surface of a refractory shape from that intended, caused by bending or bowing during manufacture.
- **Wedge Brick**: A brick shape having six plane faces (two sides, two edges an two ends), in which two faces (the sides) are inclined toward each other and one end face is narrower than the other.
- **Wetting**: The adherence of a film of liquid to the surface of a solid.
- **Wollastonite**: A triclinic mineral; $CaSiO_3$. Specific gravity 2.9. Inverts at 2192°F (1200°C) to pseudowollastonite. Melts incongruently at 2811°F - 1544°C.

Y

- **Yield**: The load per unit of original cross section at which, in soft steel, a marked increase in deformation occurs without increase in load.
- **Young's Modulus**: In mechanics, the ratio of tensile stress to elongation within the elastic limit; the modulus of elasticity.

Z

- **Zircon**: A mineral; $ZrSiO_4$. Specific gravity 4.7. Begins to melt incongruently at 3045°F (1685°C) forming ZrO_2 solid solution plus liquids; completely melted at about 4800°F (2650°C).
- **Zirconia**: Zirconium oxide; ZrO_2. Specific gravity 5.8. Melting point 4890°F (2700°C). Its chief source is the mineral baddeleyite.