



Standard Terminology Relating to Refractories¹

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1. Scope

1.1 This terminology covers terms particularly related to refractories and encompasses raw materials, manufacture, finished products, applications, and testing procedures.

1.2 When any of the definitions in this terminology are quoted or published out of context, editorially insert the limiting phrase “in refractories” after the dash following the term to properly limit the field of application of the term and definition.

2. Referenced Documents

2.1 *ASTM Standards*:²

- C 24 Test Method for Pyrometric Cone Equivalent (PCE) of Fireclay and High Alumina Refractory Materials
- C 181 Test Method for Workability Index of Fireclay and High-Alumina Plastic Refractories
- C 401 Classification of Alumina and Alumina-Silicate Castable Refractories
- C 416 Classification of Silica Refractory Brick
- C 456 Test Method for Hydration Resistance of Basic Bricks and Shapes
- C 492 Test Method for Hydration of Granular Dead-Burned Refractory Dolomite
- C 860 Practice for Determining the Consistency of Refractory Castable Using the Ball-In-Hand Test
- C 909 Practice for Dimensions of a Modular Series of Refractory Brick and Shapes

3. Significance and Use

3.1 This terminology ensures that terms peculiar to refractories are adequately defined so that other standards in which such terms are used can be understood and interpreted properly.

¹ This terminology is under the jurisdiction of ASTM Committee C08 on Refractories and is the direct responsibility of Subcommittee C08.92 The Joseph E. Kopanda Subcommittee for Editorial, Terminology and Classification

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

3.2 This terminology is useful to those who are not conversant with the terms related to refractories. However, it is also a ready reference for those directly associated with refractories to resolve differences and ensure commonality of usage, particularly in the preparation of ASTM standards.

3.3 Although this terminology is intended to promote uniformity in the usage of terms related to refractories, it can never be complete because new terms are constantly arising. The existence of this terminology does not preclude the use or misuse of any term in another context.

4. Terminology

4.1 *Definitions*:

abrasion of refractories, *n*—wearing away of refractory surfaces by the scouring action of moving solids.

acid refractories, *n*— see **refractories, acid**.

alumina-chromia brick, *n*—a refractory brick, which may be burned or unburned, manufactured predominantly of a mixture of a high-alumina raw material and chromic oxide (Cr_2O_3), with the alumina (Al_2O_3) content being 50 % or greater by weight and with chromic oxide (Cr_2O_3) predominating by weight among the other constituent oxides.

angle of repose, *n*—the acute angle measured from the horizontal to the slope of a cone-shaped pile of free-flowing material.

anthracite-coal-base carbon refractory, *n*—see **carbon refractory, anthracite-coal-base**.

basic refractories, *n*— see **refractories, basic**.

bat, *v*—to reject or discard a brick or shape.

binder, *n*—a substance added to a granular material to give it workability and green or dry strength.

bloating of refractories, *v*—substantial swelling produced by a heat treatment that causes the formation of a vesicular structure.

bond fireclay, *n*—see **fireclay, plastic or bond**.

burn, *v*—the heat treatment to which refractory materials are subjected in the firing process.

burning (firing) of refractories, *v*—the final heat treatment in a kiln to which refractory brick and shapes are subjected in the process of manufacture for the purpose of developing bond and other necessary physical and chemical properties.

calcine, calcines, *n*—refractory material, often fireclay, that has been heated to eliminate volatile constituents and to produce desired physical changes.

calcined refractory dolomite, *n*—see **dolomite, calcined refractory**.

calcining of refractory materials, *v*—the heat treatment to which raw refractory materials are subjected, preparatory to further processing or use, for the purpose of eliminating volatile chemically combined constituents and producing volume changes.

carbon-ceramic refractory, *n*—a manufactured refractory comprised of carbon (including graphite) and one or more ceramic materials such as fireclay and silicon carbide.

carbon refractory, *n*—a manufactured refractory comprised substantially or entirely of carbon (including graphite).

carbon refractory, anthracite-coal base, *n*—a manufactured refractory comprised substantially of calcined anthracite coal.

carbon refractory, graphite-base, *n*—a manufactured refractory comprised substantially of graphite.

carbon refractory, metallurgical-coke-base, *n*—a manufactured refractory comprised substantially of metallurgical coke.

carbon refractory, petroleum-coke-base, *n*—a manufactured refractory comprised substantially of calcined petroleum coke.

castable, *n*—a combination of refractory grain and a suitable amount of bonding agent that, after the addition of a proper liquid, is generally poured into place to form a refractory shape or structure which becomes rigid because of chemical action (see Classification C 401).²

chemically bonded brick, *n*—see **unburned brick**.

chrome brick, *n*—a refractory brick, which may be burned or unburned, manufactured predominantly or entirely of refractory-grade chrome ore, and having a Cr₂O₃ content of 30 % or greater (see also chromic oxide brick).

chrome-magnesia brick, *n*—a refractory brick, which may be burned or unburned, manufactured predominantly of a mixture of refractory-grade chrome ore and refractory-grade magnesia in which the refractory-grade chrome ore predominates by weight; the refractory-grade magnesia may be either seawater magnesia, dead-burned magnesite, fused magnesia, or a combination of these materials.

chrome ore, refractory-grade, *n*—a refractory ore consisting essentially of chrome-bearing spinel with only minor amounts of accessory minerals and having physical and chemical properties suitable for making refractory products.

chromia-alumina brick, *n*—a refractory brick, which may be burned or unburned, manufactured predominantly of a mixture of chromic oxide (Cr₂O₃) and a high-alumina raw material, with the chromic oxide content being 50 % or greater by weight and with alumina (Al₂O₃) predominating by weight among the other constituent oxides.

chromic oxide brick, *n*—a refractory brick, which may be burned or unburned, manufactured predominantly of chromic oxide (Cr₂O₃) and having a Cr₂O₃ content of 90 % or greater by weight (may also be called chromia brick).

concrete, refractory, *n*—a hardened castable.

consistency, *n*—the degree of mobility of a refractory castable as determined by Practices C 860.

corrosion of refractories, *n*—destruction of refractory surfaces by the chemical action of external agencies.

dead-burned, *adj*—the state of a basic refractory material resulting from a heat treatment that yields a product resistant to atmospheric hydration or recombination with carbon dioxide.

dead-burned magnesite, *n*—see **magnesite, dead-burned**.

dead-burned refractory dolomite, *n*—see **dolomite, dead-burned refractory**.

diaspore clay, *n*—a rock consisting essentially of diaspore bonded by fireclay.

direct bonded basic brick, *n*—a fired refractory in which the grains are joined predominantly by a solid state diffusion mechanism.

DISCUSSION—The term “direct bond” was initially applied to fired magnesia-chrome refractories.

doloma-carbon refractory, *n*—a refractory brick manufactured predominantly from a mixture of refractory-grade doloma and 2 to 20 % by weight carbonaceous materials, with resin, tar, pitch or a combination of these materials as the bonding agent; the refractory-grade doloma may be either dead-burned dolomite, synthetic doloma, fused doloma or combinations of these materials, and the carbonaceous material may be either graphite, carbon black, or a combination of these materials.

doloma, fused, *n*—refractory-grade material consisting predominantly of lime and magnesia which has solidified from a fused or molten state.

doloma-magnesia refractory, *n*—a refractory, which may be burned or unburned, manufactured predominantly of a mixture of refractory-grade doloma and refractory-grade magnesia in which the refractory-grade doloma predominates by weight.

doloma refractory, *n*—a refractory manufactured predominantly of dead-burned dolomite, synthetic doloma, fused doloma or combinations of these materials.

doloma, refractory-grade, *n*—a dead-burned or fused refractory material consisting predominately of lime and magnesia; the three principal types are dolomite, dead-burned; doloma, synthetic; and doloma, fused.

doloma, synthetic, *n*—a refractory-grade doloma which has been derived from blending magnesia and lime or dolomite and dead-burning to form a dense, hydration-resistant material; and having a MgO content of 30 % to 80 % by weight and maximum CaO content of 70 % by weight.

dolomite, *n*—a carbonate rock consisting predominantly of magnesium carbonate (MgCO₃) and calcium carbonate (CaCO₃) in approximately an equal molecular ratio.

dolomite, dead-burned, *n*—a refractory grade doloma which is obtained by burning dolomite above 1450°C long enough to form a dense hydration-resistant material composed primarily of lime and magnesia.

erosion of refractories, *n*—wearing away of refractory surfaces by the washing action of moving liquids.

firebrick, *n*—any type of refractory brick specifically fireclay brick.

firebrick, insulating, *n*—a refractory brick characterized by low thermal conductivity and low heat capacity.

fireclay, *n*—an earthy or stony mineral aggregate that has as the essential constituent hydrous silicates of aluminum with or without free silica, plastic when sufficiently pulverized and wetted, rigid when subsequently dried, and of suitable refractoriness for use in commercial refractory products.

fireclay, nodular, *n*—a rock containing aluminous or ferruginous nodules, or both, bonded by fireclay.

DISCUSSION—In some districts such clays are called “burley” or “burley flint” clay.

fireclay, plastic or bond, *n*—a fireclay of sufficient natural plasticity to bond nonplastic materials.

fireclay plastic refractory, *n*—a fireclay material tempered with water and suitable for ramming into place to form a monolithic furnace lining that will attain satisfactory physical properties when subjected to the heat of furnace operation.

flint fireclay, *n*—a hard or flint-like fireclay occurring as an unstratified massive rock, practically devoid of natural plasticity and showing a conchoidal fracture.

fused grain refractory, *n*—a refractory made predominantly from grain that has solidified from a fused or molten condition.

fused or fusion cast refractory, *n*—a solidified material made by melting refractory ingredients and pouring it into molds (see also **molten cast refractory**).

fused silica refractory, *n*—a product composed predominantly of fused, noncrystalline silica.

grain magnesite, *n*—see **magnesite, grain**.

graphite-base carbon refractory, *n*—see **carbon refractory, graphite-base**.

grog, *n*—a granular material produced from calcined or burned refractories, usually alumina-silica.

grog fireclay mortar, *n*—raw fireclay mixed with calcined fireclay, or with broken fireclay brick, or both, all ground to suitable fineness.

ground fireclay, *n*—fireclay or a mixture of fireclays that have been subjected to no treatment other than grinding or weathering, or both.

ground fireclay mortar, *n*—a refractory mortar consisting of finely ground raw fireclay.

ground refractory material, double-screened, *n*—a refractory material that contains its original gradation of particle sizes resulting from crushing, grinding, or both, and from which particles coarser and finer than two specified sizes have been removed by screening.

ground refractory material, single-screened, *n*—a refractory material that contains its original gradation of particle sizes resulting from crushing, grinding, or both, and from which particles coarser than a specified size have been removed by screening.

gunning, *v*—an application technique that uses a pneumatic

means to transport a refractory material and place it onto a cold or hot surface.

gunning materials, refractory, *n*—mixtures of refractory aggregate and bond(s) specially prepared for gunning.

hydration resistance, *n*—the degree to which a refractory material resists chemical combination with water. This resistance is measured by either Test Method C 456 or Test Method C 492, whichever is applicable.²

insulating firebrick, *n*— see **firebrick, insulating**.

ladle brick, *n*—brick suitable for lining ladles used to contain molten metal.

magnesia brick, *n*—a refractory brick, which may be burned or unburned, manufactured predominantly or entirely of either seawater magnesia, dead-burned magnesite, fused magnesia, or combinations of these materials.

magnesia-carbon brick, *n*—a refractory brick manufactured predominantly of a mixture of refractory-grade magnesia and 5 to 30 % by weight carbonaceous material, with resin, tar, pitch, or a combination of these materials as the bonding agent; the refractory-grade magnesia may be either seawater magnesia, dead-burned magnesite, fused magnesia, or a combination of these materials; and the carbonaceous material may be either flake or vein graphite, carbon black, or petroleum or metallurgical coke, or a combination of these materials.

magnesia-chrome brick, *n*—a refractory brick, which may be burned or unburned, manufactured predominantly of a mixture of refractory-grade magnesia and refractory-grade chrome ore in which the refractory-grade magnesia predominates by weight; the refractory-grade magnesia may be either seawater magnesia, dead-burned magnesite, fused magnesia, or a combination of these materials.

magnesia-doloma refractory, *n*—a refractory, which may be burned or unburned, manufactured predominantly of a mixture of refractory-grade magnesia and refractory-grade doloma in which the refractory-grade magnesia predominates by weight.

magnesia, fused, *n*—a refractory material consisting predominantly of crystalline magnesium oxide which has solidified from a fused or molten state.

magnesia, refractory, *n*—a dead-burned refractory material consisting predominantly of crystalline magnesium oxide.

magnesia, refractory-grade, *n*—a dead-burned or fused refractory material consisting predominantly of crystalline magnesium oxide; the three principal types are magnesia, sea water; magnesite, dead-burned; and magnesia, fused.

magnesia, sea water, *n*—a deadburned refractory-grade magnesia which has been derived from the treatment of sea water or other brines.

magnesia-spinel brick, *n*—a refractory brick whose predominant component is sintered or fused magnesia and whose lesser component is sintered, fused, or in situ formed magnesium aluminate spinel ($MgO \cdot Al_2O_3$).

magnesite, dead-burned, *n*—the granular product obtained by burning (firing) magnesite or other substances convertible to magnesia, upon heating above 1450°C long enough to form

dense, weather-stable granules suitable for use as a refractory or in refractory products.

magnesite, grain, *n*—dead-burned magnesia in granular form of size suitable for refractory purposes.

magnesite, seawater, *n*—dead-burned magnesia made by a chemical process using seawater or other saline solutions.

*metallurgical-coke-based carbon refractory, *n**—see **carbon refractory, metallurgical-coke-based.**

mold flux, *n*—a mold powder in its liquid state which protects the steel from re-oxidation, lubricates the solidifying steel shell as it passes through the mold, absorbs inclusions, and controls the heat transfer from the steel shell to the mold.

mold powder, *n*—a powder or granular material added to the top of molten steel in the continuous casting mold which melts, forming a mold flux or liquid layer over the molten steel.

molten cast refractory, *n*—a solidified material made by melting refractory ingredients and pouring into molds (see also **fused or fusion cast refractory**).

monolithic refractory, *n*—a refractory which may be installed *in situ*, without joints to form an integral structure.

monolithic refractory construction, *n*—a refractory installation utilizing monolithic refractories.

mortar, air-setting, *n*—a composition of finely ground materials, marketed in either a wet or dry condition, which may require tempering with water to attain the desired consistency and which is suitable for laying refractory brick and bonding them strongly upon drying and upon subsequent heating at furnace temperatures.

mortar, heat setting, *n*—a refractory mortar of finely ground materials whose potential strength is dependent on use at furnace or process temperatures.

mortar, refractory, *n*—a finely ground preparation which becomes plastic and trowelable when tempered with water, and is suitable for laying and bonding refractory brick.

mullite refractories, *n*—refractory products consisting predominantly of mullite ($3\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2$) 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.

*neutral refractories, *n**—see **refractories, neutral.**

*nodular fireclay, *n**—see **fireclay, nodular.**

nozzle refractory, *n*—a refractory shape containing an orifice for the purpose of transmitting molten metal from a refractory-lined container.

periclase grain, *n*—a crystalline magnesium oxide in granular form; this contains at least 85 % by weight magnesia.

permanent linear change, *n*—the percent dimensional change in length (based on original length) of a refractory specimen free of externally applied stresses, after being subjected to a prescribed heat treatment.

permeability of refractories, *n*—the capacity of a refractory for transmitting a fluid (gas or liquid).

*petroleum-coke-based carbon refractory, *n**—see **carbon refractory, petroleum-coke-based.**

pitch-bonded basic brick, *n*—unburned basic refractory

shapes bonded with pitch; if subsequently heat-treated sufficiently to minimize softening of the bond on reheating, they are referred to as *tempered*.

pitch-impregnated basic brick, *n*—burned basic refractory shapes impregnated with pitch after firing.

*plastic or bond fireclay, *n**—see **fireclay, plastic or bond.**

plastic refractory, *n*—a refractory material, tempered with water, that can be extruded and that has suitable workability to be pounded into place to form a monolithic structure.

porosity, *n*—the percentage of the total volume of a material occupied by both open and closed pores.

pouring pit refractory, *n*—a refractory associated with the transfer or flow control of molten steel between furnace and mold.

pyrometric cone equivalent (PCE), *n*—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 Test Method C 24.²

DISCUSSION—The terms “fusion point,” “softening point,” “deformation point,” and “melting point” have heretofore been loosely used for “pyrometric cone equivalent.”

pyrometric cones, *n*—elongated trigonal pyramids of standard size made from specified mixtures of ceramic materials which when heated under stated conditions, may be used as an index of heat treatment.

quartzite, ganister, *n*—for refractories, a rock consisting predominantly of the mineral quartz suitable for the manufacture of silica brick and characterized by a high silica (SiO_2) content and a low percentage of impurities (see Classification C 416).²

DISCUSSION—Confusion sometimes results from the use of the term ganister because it is also applied in some parts of the United States to crushed firebrick or to a mixture of crushed firebrick or silica rock with clay for use in tamped linings.

ramming mix, *n*—a refractory material, usually tempered with water, that cannot be extruded but that has suitable properties to permit ramming into place to form a monolithic structure.

*raw refractory dolomite, *n**—see **dolomite, raw refractory.**

rebonded fused grain refractory, *n*—a fired refractory brick or shape made predominantly or entirely from fused grain.

rebound, *n*—the gunned material not adhering to the gunned or shotcreted surface during the gunning process.

refractories, acid, *n*—refractories containing a substantial amount of silica that may react chemically with basic refractories, basic slags, or basic fluxes at high temperatures.

refractories, basic, *n*—refractories whose major constituent is lime, magnesia, or both, and which may react chemically with acid refractories, acid slags, or acid fluxes at high temperatures.

DISCUSSION—Commercial use of this term also includes refractories made of chrome ore or combinations of chrome ore and dead-burned magnesite.

refractories, neutral, *n*—refractories that are resistant to chemical attack by both acid and basic slags, refractories, or fluxes at high temperatures.

refractoriness, *n*—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 (pl. -ies), *n*—nonmetallic materials having those chemical and physical properties that make them applicable for structures, or as components of systems, that are exposed to environments above 1000°F (538°C).

refractory, *adj*—resistant to high temperature.

refractory block, *n*—a generally rectangular refractory shape of a size larger than usually can be laid with one hand. All sides may not be plane and parallel.

refractory brick, *n*—a generally rectangular refractory shape with one dimension greater than the other two and of a size that usually can be laid with one hand. All sides may not be plane and parallel such as wedges, arches, keys, and circle brick, as shown in Specification C 909.²

refractory fibers, *n*—nonmetallic, inorganic, continuous, or non-continuous filaments having those chemical and physical properties that make them applicable for structures, or as components of systems, that are exposed to environments above 1000°F (538°C).

refractory shape, *n*—any refractory piece forming a stable mass with specific dimensions.

reheat behavior, *n*—the changes in length or volume taking place in a fired refractory when subjected to a reheat test.

reheat test, *n*—the prescribed heat treatment of a fired refractory free of externally applied stresses to determine its linear or volume stability by measurements before and after the heating.

sample, *n*—a portion of a material or product randomly selected to be representative of the whole.

self-flow, *n*—the characteristic of a refractory castable to flow readily under its own weight without showing signs of segregation or separation.

setting time, *n*—the elapsed time from the first addition of liquid during the mixing of the refractory castable until the time that the refractory castable has developed enough strength so that forms can be removed without any slumping or deformation.

shotcreting, *n*—an installation technique using a pump to convey tempered refractory castable to a nozzle where an admixture and air pressure are injected, spraying the castable stream onto a substrate where the castable becomes sufficiently stiff to withstand the force of gravity.

shrinkage, *n*—the decrease in dimension of a refractory material during manufacture or service.

silicon carbide refractories, *n*—refractory products consisting predominantly of silicon carbide.

slagging of refractories, *n*—destructive chemical reaction between refractories and external agencies at high temperatures resulting in the formation of a liquid.

sleeves, *n*—the tubular fireclay shapes that encase an immersed metal rod in the valve assembly of a bottom-pouring ladle.

solidification temperature of a mold flux, *n*—the temperature at which, on cooling at a defined rate, there is a sudden

change in the shape of the viscosity versus temperature curve and at which the mold flux starts to solidify.

spalling of refractories, *v*—the cracking or rupturing of a refractory unit, which usually results in the detachment of a portion of the unit.

spalling of refractories, mechanical, *n*—the spalling of a refractory unit caused by stresses resulting from impact or pressure.

spalling of refractories, structural, *n*—the spalling of a refractory unit caused by stresses resulting from differential changes in the structure of the unit.

spalling of refractories, thermal, *n*—the spalling of a refractory unit caused by stresses resulting from nonuniform changes of the unit produced by a difference in temperature.

specimen, *n*—a piece or portion of a sample selected and prepared for performing a test.

spinel, *n*—(1) a group of natural or synthetic minerals with the general formula $R''R'''_2O_4$ (or the general oxide formula $R''O \cdot R'''_2O_3$) in which the R'' is one or more bivalent cations such as magnesium or ferrous iron and R''' is one or more trivalent cations such as aluminum, chromium, or ferric iron. *Spinel* in this usage refers mainly to the crystalline structure of the material rather than the specific cations included. (2) specifically the magnesium aluminate spinel, $MgAl_2O_4$ (or $MgO \cdot Al_2O_3$), which is 28.3 % MgO and 71.7 % Al_2O_3 by weight.

stopper head, *n*—a rounded refractory shape, usually made from clay and graphite, providing a valve head seating into a nozzle brick, this assembly forming a metal flow control for bottom-pouring ladles.

tar or pitch bearing basic ramming mix, *n*—a tar or pitch bearing refractory that has suitable properties to permit ramming into place to form a monolithic structure.

tar or pitch bearing basic refractories, *n*—refractories consisting principally of basic grains to which either tar or pitch has been added during manufacture.

temper, *v*—to bring a refractory mixture to a usable state by mixing with a liquid.

tempered refractory castable, *n*—a refractory castable to which liquid has been added and sufficiently mixed to produce the desired consistency for placement.

thermal expansion, *n*—in refractories, the reversible change in size of materials due to temperature changes.

unburned brick, *n*—brick manufactured by processes that do not involve firing of the finished product.

workability index, *n*—a measure of the moldability of plastic refractories, determined in accordance with Test Method C 181.²

working time, *n*—the elapsed time from the first addition of liquid during mixing of the refractory castable until the first indication that it can no longer be placed by the desired placement method; the total of the mixing time and placement time.

zircon refractory, *n*—refractory products consisting substantially or entirely of crystalline zirconium orthosilicate ($ZrSiO_4$).

zirconium oxide refractory, *n*—refractory products consisting substantially of zirconium dioxide.

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