Cement industry glossary

This cement plant glossary has been compiled from extracts of the following references :

PIT & QUARRY magazine Cement industry glossary original issue from April / May 1956 and updated in March / April 1965.

WORLD CEMENT magazine International Glossary 1995.

HARP Manual = Holcim Accounting and Reporting Principles.

A

ACID REFRACTORY — High-silica and alumina-silica refractories. Alumina-silica materials vary in refractoriness or resistance to high temperatures; the higher the alumina content, the greater the refractoriness.

AIR CANON — Device affixed to the external walls of hoppers, silos, or bunkers through which air is injected under pressure into the containers to prevent coatings or bridging and promote material flow.

AIR LIFT — Elevating equipment whereby slurry or dry powder is conveyed upwards through pipes by means of compressed air.

AIR-QUENCHING COOLER — Cooler in which hot clinker passes over grates with cold air forced up through the load for rapid cooling.

AIRSLIDE — Enclosed conveyor in which finely ground materials are transported by gravity over a slightly inclined porous fabric. Air flowing through the fabric keeps the powdered material fluid.

AIR-SWEPT MILL — A mill (i.e., ball mill, tube mill, rod mill, compartment mill or roller mill) in which a flow of gas transports the finely ground product out of the mill or grinding chamber.

ALITE — Impure C_3S containing various oxides such as Fe_2O_3, Al_2O_3 and MgO. Alite is the form of C_3S found in commercial portland cements. (See TRICALCIUM SILICATE)

ALKALI — A substance having marked basic properties – generally calcium, sodium, or potassium oxides or hydroxides. (see also LOW-ALKALI CEMENT)

ALUMINA Aluminium oxide – Al_2O_3. One of the major oxides in portland cement.

ALUMINA RATIO (ALUMINA MODULUS) $AR = \frac{Al_2O_3}{Fe_2O_3}$ = the proportion of alumina to iron oxide.

ALUMINA REFRACTORY Brick composed essentially of alumina and silica with the alumina in proportions ranging between 40 and 70 percent.

ANGLE OF (REPOSE The angle between the horizontal and the natural slope of loose material such as cement), below which the material will not slide on itself.

ANHYDRITE Anhydrous calcium sulfate - $CaSO_4$. Gypsum from which the water of crystallization has been removed, usually by heating above 163°C. Depending upon the degree of heating, soluble or insoluble anhydrite can be produced.

ANTHRACITE A hard, natural coal which contains approximately 85-95 percent carbon and a low percentage of volatile matter.

APRON FEEDER Short conveyor comprised of uniform overlapping pans (usually metal) attached to chains or joined by links to form an endless conveying medium over supported rollers reinforced to withstand pressure. It is used for controlled rate feeding of crushing materials. Also known as plate-belt feeder.

ARGILLACEOUS Relating to or containing clay or clay minerals. Composed primarily of clay or shale.

ASH The inorganic residue remaining after the combustion of fuel.

ASH RING Internal build-up near the kiln discharge end promoted by the fallout of ash particles on the load or lining.

ATTRITION (1) Wear and tear. (2) Grinding in which size reduction is accomplished by rubbing or friction.

AUXILIARY KILN DRIVE Stationary reserve engine, usually diesel or gasoline, connected to kiln drive in case of power failure, to prevent warping of the shell. Can also consist of a motor/generator set constituting a separate source of power.

AVAILABILITY INDEX % Measures the utilisation of the asset. Net Availability corresponds to the ratio of operating time and idle time to calendar time. Gross Availability corresponds to the ratio of operating time to calendar time. HARP manual reference = 8.3.6.2.

B

BACKSPILL The material which periodically spills out of the feed end of the kiln caused by operating or mechanical problems.

BAGHOUSE The building that houses the fabric filters used to collect dust emissions in cement manufacture.

BALL COATING Reconsolidation of finely ground, dry material on the surface of the grinding media which inhibits further comminution.

BALL MILL Horizontal, cylindrical, rotating mill containing steel or ceramic balls as grinding media.

BASIC REFRACTORY Kiln lining made from magnesite or chrome ore. These bricks exhibit greater refractoriness and better resistance to chemical attack by slags and metallic oxides than the alumina or silica types.

BAUXITE A reddish rock composed primarily of hydrous aluminium oxides together with silica and ferric oxide. It is a raw material for the manufacture of calcium aluminate cement.

BDP – Kiln (t/day) Best Demonstrated Practice – Kiln, is the highest historical kiln production rate measured in tonnes / day, achieved during the last 24 months before the budget phase. It is an equipment specific value. It is elaborated for each clinker production line and clinker type individually. HARP manual reference = 8.3.3.6.

BDP – Mill/other (t/hour) equipment Best Demonstrated Practice – Mill/other equipment, is the highest historical production rate measured in tonnes / hour, achieved during the last 24 months before the budget phase. It is an equipment specific value. It is elaborated for each individual product type. It is the average of the five highest rates (t/hour) achieved. HARP manual reference = 8.3.3.8.

BELITE Impure C_2S Containing various oxides. Belite is the form of C_2S found in commercial clinkers. It can take 4 forms: α, α', β, and γ; the β form is the most prevalent. (see DICALCIUM SILICATE)

BELT CONVEYOR Conveyor by which dry materials are transported on a continuous flat or slightly curved belt of rubber and/or fabric travelling over rollers.

BELT WEIGHER A load-cell system mounted on the supporting frame of a belt conveyor to become an integral part of it, and through a lever system connected to a special roller set acts as a weigh-bridge for continuously measuring material flow rate on the conveyor.

BENEFICIATION Improvement of the chemical or physical properties of a raw material or intermediate product by the removal of undesirable components or impurities.

BIFURCATED A two part or two branch chamber, chute, or hopper that allows the flow of materials to proceed in two different directions

BIN INDICATOR A bin level sensor installed at various points in bins, silos, hoppers, chutes and conveyor boxes.

BITUMINOUS COAL Soft coal which contains about 50 to 80 percent carbon and about 15 to 40 percent volatile matter

BLAINE AIR PERMEABILITY TEST This test indirectly determines the fineness of portland cement by means of air flow through a packed bed and is expressed as total surface area in m^2/kg of cement.

BLAST-FURNACE SLAG The non-metallic product consisting essentially of silicates and aluminosilicates of calcium and magnesium that is developed in a molten condition simultaneously with iron in a blast furnace. (see GRANULATED BLAST-FURNACE SLAG)

BLEEDING The accumulation of water on the surface of a mortar or concrete caused by the settlement of the solid materials within the mass.

BLENDED CEMENT A combination of portland cement clinker and other cementitious or pozzolanic materials ground or blended together to produce a hydraulic cement having specific advantageous properties.

BLENDING Combining the contents of two or more bins, tanks or silos of raw materials or cement to adjust the composition of the final product.

BLENDING BED A stockpile in which bed-blending by longitudinal stockpiling and transverse reclaiming of raw materials occurs.

BUILDUPS Undesirable coating or accretion that can form in a kiln, preheater or other parts of the kiln system.

BURN, BURNING
(1) Combustion of fuel.
(2) Sintering or near-fusion in a kiln, resulting in chemical combination of the raw materials and formation of clinker.

BURNABILITY The ability of raw materials to react chemically on heating. Softer and more finely ground and intimately mixed raw materials of the proper chemical content combine into cement clinker more readily. Relatively high contents of iron and alumina facilitate burning (through fluxing action), whereas silica has the opposite effect.

BURNER PIPE The pipe through which the fuel (coal, oil, or gas), and usually part of the combustion air, is blown into the kiln.

BURNING ZONE The zone near the discharge end of the kiln in which the dried and calcined raw materials are chemically converted to portland cement clinker at temperatures near 2800 deg. F (1450 deg. C).

BY-PASS SYSTEM System for extracting trace elements such as sulphur, chlorine and alkalis from a kiln system. Usually installed between the preheater and the kiln.

C

C_3A (see TRICALCIUM ALUMINATE)

C_2S (see DICALCIUM SILICATE)

C_3S (see TRICALCIUM SILICATE)

CALCAREOUS Composed primarily of calcium carbonate.

CALCINER Vessel that utilises preheated combustion air from clinker cooler and/or kiln exit gases with separate burners to effect up to 95% calcination of the raw material before it enters the kiln. PRECALCINER, CALCINING FURANCE.

CALCINING ZONE That zone in the kiln where calcium carbonate is decomposed into CaO and CO_2 at temperatures ranging from 1380-1740 deg. F (750-950 deg. C).

CALIBRATE
(1) To determine the settings of control devices so they will operate or perform within certain limits.
(2) To determine – by measurement or standard – the correct value of each scale reading on an instrument, meter, or control knob.

CALORIMETER An instrument for measuring heat quantities generated or emitted by materials in chemical reactions, changes of physical state, or formation by the combustion of solutions. In fuel laboratories, the fuel is burned in a "bomb," suspended in a volume of water, and the heat given off during the combustion of the fuel is calculated from the resulting increase in the temperature of the water. May also be used to determine heat release associated with cement hydration.

CASTABLE REFRACTORY Refractory concrete material which is placed to form a monolithic lining in kilns, coolers, duct work, etc.

CEMENT COOLER Equipment for cooling finished cement after grinding. May consist of water-jacketed screw conveyor with water-cooled impeller shaft and blades, or a vertical cylinder, with the outside cooled by running water and along the inner surface of which a thin layer of cement is moved.

CEMENTITIOUS Having the property of binding substances together such as portland cement, aluminous cement, lime/silica cements, etc.

CENTRALISED CONTROL Arrangement of indication, recording, and regulating instruments in a central place (panel, console) in each operating department or in one room for the entire plant.

CENTRIFUGAL PUMP A pump in which a rotating impeller inside a housing gives motion to a fluid or suspension through centrifugal force. Used especially for slurry.

CHEVRON METHOD Raw material is deposited by stacker moving to and fro over the longitudinal centre-line of a stockpile.

CIRCULAR STOCKPILE Stacking system with a round base, central column and with a trapezoidal or triangular cross-section.

CIRCULATING LOAD The proportion of separator tailings to new mill feed. Often stated in percent.

CLASSIFIERS Equipment used to separate solid particles into various size fractioning.

CLAY An important raw material for cement manufacture that contains alkalies and aluminium silicates and their conversion products, feldspar and mica. Includes the Kaolin and Montmorillonite mineral groups.

CLINKER The fused product of a kiln which is ground to make cement (see PORTLAND CEMENT).

CLINKER BREAKER A series of hammers or rollers installed at the discharge end of a clinker cooler to break lumps for more rapid cooling.

CLINKER CONVEYOR Any drag chain, bucket, belt, pan or vibrating conveyor used to move clinker from the cooler to storage.

CLINKER COOLER Equipment used to cool clinker by motion or air. Includes drag chain, air-quenching, rotary, planetary, inclined grate, vibrating and indirect cooling. There are four types of clinker coolers: a cooling drum located underneath the rotary kiln, cooling drums attached to the rotary kiln's discharge end (satellite coolers), grate coolers, and shaft coolers.

CLINKER RING A buildup in or near the back of the burning zone of a kiln in which melted or fused raw materials have adhered to the kiln lining in excessive amounts.

CLOSED-CIRCUIT GRINDING Grinding system in which the mill product is passed to a screen or separator so that fines may be removed from the circuit and oversize tailings or sands returned for further grinding.

COATING (1) Crust of raw mix, clinker, and ash deliberately formed and maintained in the burning zone of a rotary kiln for protection of the lining.
(2) (see also BALL COATING)

COMPOUND A substance whose molecules consist of unlike atoms and whose constituents cannot be separated by physical means. The four major potential compounds of portland cement are: tricalcium silicate, dicalcium silicate, tricalcium aluminate and tetracalcium aluminoferrite.

COOLER FAN Rotating fan used to force air through a clinker cooler.

COOLING HISTORY Successive time and temperature intervals through which clinker passes after burning zone in kiln. Cooling history has important influence on crystallographic and grinding properties.

COOLING ZONE Area between sintering zone and kiln outlet in which clinker is subject to pre-cooling.

COUNTERFLOW Progress arrangement whereby a fluid (gas, water) travels in contact with, but in opposite direction to, a material (clinker, slurry, raw meal) for exchange of heat or concentration.

CRUSHING Comminution in the coarse range. (see GRINDING)

CYCLING The alternate surging of load in a kiln resulting in excesses and deficiencies of heat for proper burning.

CYCLONE Unit which separates coarse, solid particles from an air flow by centrifugal action. Conical sheet steel vessel (often refractory lined) for separation of solids from fluids (air or water) by centrifugal action.

CYCLONE PREHEATER (Suspension preheater). A series of cyclones disposed vertically up to 6 stages and connected by gas pipes and meal tubes.

CYLPEBS ("Cylindrical pebbles") Cast of clipped cylindrical grinding media for tube mills, approximately ½ in. in diameter and 1in. long.

D

DAM Partition to impede the material flow in a ball mill to prolong the time the material is in the mill. Also, a refractory protuberance in a kiln lining to slow the flow of raw meal and increase residence time in the kiln.

DAMPER A valve, plate, or set of adjustable louvres in a flue used to regulate the flow of gas.

DECARBONATION (CALCINATION) Dissociation of carbonates by the introduction of heat to remove carbon dioxide.

DIAPHRAGM Partition used to separate chambers in compartment mills.

DICALCIUM SILICATE (C_2S) Chemical compound in portland cement that hardens slowly and contributes to later age strength development of cement paste. (see BELITE)

DIFFERENTIAL THERMAL ANALYSIS (DTA) Indication of chemical or physical reaction by differential thermocouple recording of temperature changes in sample under investigation compared with a thermally passive control sample, both samples heated uniformly and simultaneously.

DIRECT COAL-FIRING After combined drying and grinding of coal in a mill, pulverised fuel is supplied to the kiln burner with the mill exit gas, without intermediate storage of fuel. Blowing powdered coal directly into kiln from a UNIT PULVERISER without BIN SYSTEM.

DRY PROCESS Process for cement manufacture in which the raw materials are ground, conveyed, blended and stored in a dry form.

DUCT An enclosed passage or pipe for the flow of gases.

DUST The following types of dust (particulate matter) are generated in cement manufacture: raw material dust, raw mix dust, coal dust, exit dust from raw meal dryers, kiln dust, clinker dust, gypsum dust, and cement dust. Dusts can be divided into stack effluents, or process dusts, and fugitive dusts.

DUST CHAMBER The chamber or housing at the feed end of a kiln where coarse dust is trapped or deposited through changes in gas velocity or direction.

DUST COLLECTORS Equipment used to entrap and control dust effluent form a process. Types used to control dust emissions in cement manufacture include: cyclone collectors, gravity settling chambers, fabric filters, gravel bed filters, and electrostatic precipitators.

E

ELECTROSTATIC PRECIPITATOR
Collector for dust, whose operation is based on gas ionization in strong electrical field. Dust-laden air is passed through a large chamber where the dust particles are ionised by contact with chains or rods connected to one pole of high-voltage rectifier, and then attracted to and collected on the sides of ducts or collector plates connected to the other (grounded) pole. Collectors are rapped periodically to discharge dust.

ELEVATOR
Roller chain on which are attached steel or plastic buckets which carry loads to higher elevations. Usually driven by a pair of toothed sprockets at the head end and equipped with automatic brakes to prevent reversal. Some elevators use conveyor belting in place of roller chain.

ENDOTHERMIC
Chemical reaction requiring the continued absorption of heat such as the calcination or decomposition of limestone.

EXOTHERMIC
Chemical reaction in which heat is given off after the action commences. Examples: hydration of cement, and clinkering in the burning zone in kilns.

EXPERT SYSTEM
A system used to determine the optimum conditions for a process by linking process values and expert knowledge from cement plant operators into an "auto-pilot" control system.

F

FEED PIPE
The pipe through which the feed material to a mill, kiln or tank is passed by gravity.

FINENESS
The sizing of the particles of raw meal and/or cement generally measured by air permeability (Blaine test), turbidity (Wagner turbidimeter), or sieve analysis. Fineness of cement affects the rate of hydration. The greater the fineness the faster the rate of hydration and the more accelerated the strength development.

FINISH GRINDING
The grinding of clinker into finished cement usually with addition of 3 to 6 percent gypsum.

FLASH SET
Rapid hardening of freshly mixed cement paste with considerable amount of heat evolved.

FLUX
A material used to promote fusion or melting.

FLY ASH
Residue of fused spherically shaped particles from burning of powdered coal in power stations which is precipitated in dust collectors. May be used:
(1) as an argillaceous-siliceous component of cement raw mix; and
(2) as an addition to concrete, depending on carbon content and uniformity.
As a cement replacement can replace up to 30% of cement in a concete mix.

FREE LIME
CaO in clinker and cement which has not combined with SiO_2, Al_2O_3 or Fe_2O_3 during the burning process, usually because of under burning, insufficient grinding of the raw meal, or the presence of traces of inhibitors.

G

GAS ANALYSER An instrument in which a sample of gas may be collected and analysed for oxygen, carbon dioxide and combustible materials, sulphur dioxide, etc. (see also ORSAT)

GRATE COOLER The grate consists of several horizontal or slightly inclined plates upon which clinker falls from the kiln. The clinker moves along the grate while being cooled by air blown from beneath. Clinker movement is achieved by the reciprocating action of the plates or travelling grate.

GRINDABILITY The response of a material to grinding effort. One grindability index is expressed in grams per mill revolution of ground material, passing the 200 mesh sieve. Other grindability indeces include: Hardgrove, Bond, etc.

GRINDING Size reduction of raw materials and cement clinker to a fine powder, nominally all passing 200 microns.

GRINDING AIDS Certain chemical additives which aid in tube mill grinding by reducing ball coating or by dispersing the finely ground product.

GRINDING MEDIA Hard, free-moving charge in a ball or tube mill between which particles of raw material, coal, or clinker are reduced in size by attrition or impact. Usually of steel, and spherical in shape with graded sizes, the maximum in a ball mill being about 3 to 4 times the maximum feed size.

GRIZZLY Screen for large rocks made of heavy steel bars or rails.

GYPSUM $CaSO_4$ $2H_2O$ – Hydrated calcium sulfate added to portland cement clinker and interground in the ratio of about 3 to 6 percent to control the setting time of the cement paste.

H

HAC = Holcim Assett Code A standard identification/numbering system for cement plant machinery/assets used worldwide in all Holcim plants.

HAMMER MILL Secondary crusher in which rapidly rotating bars or hammers pass between grates to crush material by impact. The tolerance between hammers and grate usually is 1 inch or less.

HEAT BALANCE A method of accounting for all the heat units supplied, transferred, utilised in, and lost from a kiln.

HEAT EXCHANGER In kilns, equipment such as chains, quadrants, lifters, etc., which facilitates the transfer of heat from the gases to the load. In general, any device which transfers heat from one substance to another.

HEAT OF HYDRATION The heat given off by cement paste during the chemical combination of cement with water, which is an exothermic process.

HEMIHYDRATE A hydrate which contains one-half a molecule of water to one molecule of compound. In cement, $CaSO_4.\frac{1}{2}H_2O$ (partially dehydrated gypsum, or Plaster of Paris) is most commonly known.

HOT SPOT An exterior area of the kiln shell, usually in the burning zone which becomes heated to a temperature sufficient to cause the shell to be red hot or to glow. Usually caused by the loss of coating or lining.

HYDRATION Chemical combination of cement with water.

I

IGNITION LOSS The percentage loss in weight when an as-received sample is ignited to constant weight at 900-1000 deg. C for short periods of time

IMPACT CRUSHER An apparatus for coarse size reduction which occurs in three stages; impact of the impeller bars; impact against the breaker plate; and impact of material against material.

IMPACT FLOW METER A device that senses the passage of fine or granular dry material and whose output is in weight per unit of time. The force of falling material on an impact sensor is translated into an electric signal.

INDIRECT COAL-FIRING After drying and grinding of coal, the pulverised fuel is stored in a hopper. The extraction of fuel from the hopper for kiln burner feed is independent of the mill operation. Also known as central grinding.

INDUCED DRAFT The negative pressure created by a suction fan.

INSOLUBLE RESIDUE The material remaining after cement is treated successively with hydrochloric acid and sodium hydroxide solutions of specific concentrations for designated periods of time.

INSUFFLATION Practice of adding dust to the kiln by blowing it into the burning zone.

INSULATING REFRACTORY A refractory with a large percentage of open pore space having a low rate of heat transmission. This type of refractory may be in the form of bricks or refractory concrete. Used to conserve heat in kilns, ducts, preheater vessels, etc.

IRON OXIDE One of the major oxides in Portland cement. (Fe_2O_3).

K

KILN Equipment in which properly ground and proportioned cement raw mix is dried, calcined, and burned into clinker at a temperature of 2600 to 3000 deg. F. Can be of the rotary or shaft type; fuel may be coal, oil, gas or other combustibles.

KILN GUN Special industrial gun used for shooting down clinker rings or for breaking up large clinker balls in rotary kilns.

KILN HOOD Refractory-lined steel plate housing around discharge end of rotary kiln, furnished with openings for fuel pipe, radiation pyrometers, television cameras, observation openings, and cleanout and access doors.

KILN LINING A layer of refractory, brick or concrete, placed inside a rotary kiln to protect the steel shell against heat and abrasion.

KILN PEIR Concrete or steel support for rotary kiln, one pier located under each set of supporting rollers for the kiln tires.

KILN SEAL Adjustable plates or rings installed around feed end or discharge end of rotary kiln for prevention of infiltration of air.

KILN SHELL The cylindrical outer mantle of a rotary kiln made of steel plate. Shipped in sections and riveted or welded together during erection. Rarely equipped with stiffener rings to maintain cylindrical shape.

KILN SPEED Speed of rotation of rotary kiln stated in revolutions per hour (rph), less frequently in revolutions per minute.

L

LAMINAR FLOW — In laminar flow, particles of a substance move in parallel layers without the layers mixing with each other.

LAZY FLAME — Kiln flame characterized by slow undulating movements, approximately following the velocity of the flow of surrounding air. Long and low temperature.

LIME — Calcium oxide – CaO.

LIME RATIO — $\frac{CaO}{SiO_2+R_2O_3}$ Ratio of lime to silica plus alumina and iron. Used in design or control of raw mix.

LIME SATURATION FACTOR — The ratio of the theoretical effective lime content to the maximum possible lime content of a given clinker. The lime saturation factor (LSF) is defined in British Standard 12:1958 as:

$$LSF = \frac{CaO - 0.7\ SO_3}{2.8\ SiO_2 + 1.2\ Al_2O_3 + 0.65\ Fe_2O_3}$$

LIMESTONE — Calcium carbonate ($CaCO_3$); a raw material of portland cement.

LITER WEIGHT TEST — Method of determining the bulk density in grams per 1000 cc of clinker of uniform, screened size. Indicates degree of burning and, by correlation, the free lime.

LONG ROTARY KILN — Mainly used for the wet process, where kiln feed is a slurry with 30 to 45% water content, but can also be used in the dry process.

LONGITUDINAL STOCK-PILE — Stacking system, with a rectangular base and trapezoidal or triangular cross-section, which disposes incoming raw material longitudinally.

LOUVRE DAMPER — Damper, for control of kiln draft, consisting of a set of horizontal rectangular plates which, like venetian blind, can be adjusted to various angles through a gear mechanism. Installed in the duct between kiln and draft fan.

LOW-ALKALI CEMENT — Cement containing less than 0.60 percent alkalies, calculated as percent Na_2O + 0.658 times percent K_2O. Specified in some cases for use in concrete made with reactive aggregates. Alkalies originate from raw materials and./or fuel.

LUMINOSITY — Quality of flam which produces light and heat through radiation.

M

MILL CHARGE — Grinding media (balls, cylpebs, concavex, slugs or flint pebbles) with which a grinding mill is partially filled.

MILL LINERS — Heavy cast or rolled alloy steel plates mounted inside grinding mills to
(1) protect mill shell against abrasion and impact from load and charge,
(2) improve grinding action, and
(3) sometimes classify griding media.

MINERALISER — A material added to the raw mix that aids in the production of calcium silicates in the clinkering process.

MONLITHIC — A structure cast entirely in solid concrete.

MTBF = Mean Time Between Failure — MTBF = Total hours / Number of stops in period

N

NATURAL DRAFT Draft in kiln created only by the difference in the densities of the hot exit gases and ambient air. It is dependent upon the temperature and volume of exhaust gases and height and inside diameter of the stack.

NEUTRON ACTIVATION ANALYSIS Determination of trace components in a sample by detecting and interpreting beta or gamma radiation induced by irradiating the sample with thermal velocity or high energy neutrons.

NO_x Notation used to represent two toxic gaseous nitrogen oxides, nitric oxide (NO) and nitrogen dioxide (NO_2), emitted during combustion of fuels in air, etc.

NOSE CASTINGS Heat resistant metal segments for holding kiln lining at discharge end.

O

OEE = Overall Equipment Efficiency Indicates the potential performance of a kiln.
Net OEE% = Net Availability Index% x Production Rate Index% x Quality Index %. HARP manual reference = 8.3.6.3.

Gross OEE% is a measure of the potential performance of a kiln, excluding periods when the kiln was unable to run. Gross OEE% = Gross Availability Index% x Production Rate Index% x Quality Index%. HARP manual reference = 8.3.6.4.

OVERBURDEN Layer of soil or unusable rock or other earth formation on top of raw materials in quarries. May vary in thickness from a few inches to many feet, necessitating removal (stripping)

OVERBURNED Cement clinker is considered "overburned" if it has been exposed to too high a temperature. This results in mineralogical changes which can lead to lower strength potential and harder grinding.

OXIDISING FLAME Kiln flame to which more primary and secondary air is supplied than required for complete combustion.

P

PACK SET A condition of finished cement exhibiting failure to flow under gravity after being stored in a silo or transported in a bulk container. It can be caused by interlocking of particles, mechanical compaction, electrostatic attraction between particles or chemical interactions.

PAN FEEDER (1) Rugged, slow-moving conveyor consisting of over-lapping, heavy, cast steel or manganese steel pans, used for evenly feeding large-sized lumps of rock to a primary crusher.

(2) Short, vibrating, trough-type feeder for dry materials.

PAT A small laboratory-prepared neat cement sample, on glass backing, with a flat surface for setting time tests using Gillmore or Vicat Needles.

PERSONNEL PRODUCTIVITY (manhours / t) Is a measure of the efficiency of own and subcontracted personnel working in the plant. Corresponds to the total worked and paid hours including overtime to produce one tonne (at the related stage of production), by own and subcontracted personnel. HARP manual reference = 8.3.12.3.

pH The negative logarithm (to the base 10) of the hydrogen ion concentration of a solution. A pH of 7.0 is a neutral solution.

PHASE Portion of a physical system (liquid, gas solid) that is homogenous throughout, has definable boundaries, and can be separated physically from other phases.

PITOT TUBE Apparatus for measuring the velocity of flow of air, water, or other fluids.

PLANETARY COOLER A cooler consisting of a number of cylinders built around and parallel to the shell at the discharge end of a rotary kiln; the hot clinker leaves the kiln through these cylinders in counterflow with cooling air which then enters kiln as secondary combustion air.

PNEUMATIC CONVEYOR Equipment for transport by pressurised air of pulverised or granular dry material such as coal, raw-meal, or cement.

PORTLAND CEMENT A hydraulic cement produced by pulverising clinker consisting of hydraulic calcium silicates, usually containing one or more of the forms of calcium sulphate as an interground addition.

PRECALCINER KILN SYSTEM A rotary kiln system which includes an external furnace in which raw meal is heated to calcination temperature. The system generally includes a multistage cyclonic preheater.

PRECALCINING Process which increases decarbonation of the raw meal by the addition of fuel in a separate chamber before inlet to the kiln.

PREHEATER Installation for heating raw meal or slurry ahead of their entry into rotary kiln proper to improve over-all fuel economy. Preheaters for raw meal can be of the following types:

(1) suspension parallel flow cyclonic,
(2) suspension counter flow,
(3) fixed bed,
(4) travelling bed or grate,
(5) fluidised bed, and
(6) spouted bed.

Slurry preheaters can be:

(1) heated tumbling bodies,
(2) chains, or
(3) crosses.

PREHOMOGENISATION Preliminary stacking of crushed materials to ensure homogeneity. Mostly applied to limestone to reduce fluctuations in the $CaCO_3$ content prior to raw mill.

PREVENTIVE MAINTENANCE System of planned maintenance based on foreknowledge of necessity of repairs and past history of performance, to forestall undue deterioration of equipment, buildings, roads, fences, etc., and prevent breakdown and interruption of production.

PRIMARY AIR That part of the combustion air in a rotary kiln which is blown in with the fuel.

PRIMARY BLOWER Centrifugal blower delivering primary air to kiln. In case of direct coal firing, it also draws air through the unit pulveriser.

PRODUCTION RATE INDEX % Used to identify production rate losses. Eg Rate Index = 100 x Actual Production / Theoretical Production at BDP rates. HARP manual reference = 8.3.6.1.

PULVERISED FUEL (PF) PREPARATION Comminution and drying of coal prior to kiln firing.

PYROPROCESSING Manufacturing a product by using very high temperatures.

R

RATE INDEX % Used to identify production rate losses. Eg Rate Index = 100 x Actual Production / Theoretical Production at BDP rates. HARP manual reference = 8.3.6.1.

RAW MATERIALS Naturally occurring rocks or materials, or waste products, suitable for cement manufacture. Includes limestone, chalk, marl, clay, shale, silica, sand, iron ore, bauxite, dolomite, etc.

RAW MEAL Finely ground mixture of raw materials as used for kiln feed in dry-process plants.

REDUCING FLAME Kiln flame to which insufficient combustion air is supplied. At the high temperature in the kiln this condition may tend to convert some iron in the clinker to a reduced state giving the cement a light, tannish colour.

REFRACTORY Ceramic material which can withstand high temperature.

REFRACTORY LINING A layer of refractory materials inside a kiln which protects the kiln shell from the influence of hot gases, the flames and hot kiln feed.

ROLLER CRUSHER Crusher consisting of one or two rolls, sometimes equipped with manganese steel teeth. Pieces of rock are crushed between the rotating rolls or between one roll and a stationary breaker plate.

ROLLER MILL An air-swept grinding mill in which two to four grinding rollers, with shafts carried on hinged arms, ride a horizontal grinding tale to pulverise raw material or clinker.

ROLLER PRESS Also known as 'high pressure grinding roll'. Consists of two contra rotating rolls. One roll is forced by hydraulic pressure onto the other. A deep bed of feed material is ground by compression, producing a 'cake' discharge.

ROTARY KILN Cylindrical rotating kiln, inclined approximately 4% toward its discharge end; for burning cement raw meal into clinker. Lined with refractory bricks and often equipped with internal heat-exchangers, it is divided into the following process zones: drying zone (for wet process), preheating zone, calcining zone, burning zone, and cooling zone. When the rotary kiln is used in conjunction with a preheater, and/or pre-calciner, the first three kiln zones are virtually eliminated.

ROTARY VALVE A mechanism consisting of series of blades or pockets revolving about a central axis and enclosed in a gas-tight housing. Regulates the flow of pulverised material while blocking the flow of air or gas through the valve.

S

SCREEN Large sieve of suitably mounted wire cloth, bars or perforated sheet steel, used to sort rock or aggregate according to size.

SCREW CONVEYOR Conveyor for dry material or slurry consisting of a steel or concrete casing enclosing a continuous helical strip projecting from a rotating shaft.

SECONDARY AIR That part of the combustion air in a rotary kiln which is not blown in with the fuel. Usually derived from heated clinker cooler quench air.

SECONDARY COMBUSTION Burning which takes place in the kiln beyond the actual burning zone. May be caused by too coarsely ground coal or inadequate mixing of fuel and combustion air.

SEGREGATION Separation of coarse and fine particles. May occur in stockpiles for crushed rock or clinker, or in slurry conveyors and tanks.

SEPARATOR Machine for separating materials of different specific gravity by means of water or air. In the cement industry, generally refers to an air classifier, which classifies mill discharge material into coarse grits (recycled to the mill for further grinding) and fine finished product.

SETTING TIME The time required for a neat cement paste to attain a certain degree of rigidity as measured by the Gillmore or Vicat needles.

SHORT ROTARY KILN Mainly used in the semi-dry or dry process where feed is dry or semi-dry raw meal.

SILICA RATIO

$$SR = \frac{SiO2}{Al_2O_3 + Fe_2O_3}$$

Ratio of silica to alumina plus iron. It is used in the design or control of raw mix.

SILO SET A disadvantageous property of cement manifested after period of hot storage in silos (or other), in which cement lacks flowability. Generally attributed to the development of syngenite in the cement.

SINTERING ZONE The burning zone of the rotary kiln in which the sintering reaction takes place at around 1450°C.

SNOWMAN Formation of sticky clinker following discharge from the rotary kiln found in the cooler.

SPECIFIC THERMAL ENERGY CONSUMPTION KILN (MJ/t clinker) Corresponds to the amount of thermal energy consumed in order to produce one tonne of clinker, not including energy consumption in fuel preparation, drying of raw materials, raw meal preparation and preheating of fuel. HARP manual reference = 8.3.7.1.

SPECIFIC ELECTRIC ENERGY CONSUMPTION CEMENT (kWh/t cement) A measure of the efficiency of electric energy used in cement production. Ie the total amont of electric energy consumed in order to produce one tonne of cement. HARP manual reference = 8.3.8.1.

SPLASH PLATE Refractory or high alloy steel shelf located in a preheater riser duct below the raw meal entry pipe. It is used to disperse raw meal into the flowing gases in the riser duct.

STABILITY Uniformity of operation. Lack of fluctuation loads or cycling. Production of a continuously uniform product.

SUSPENSION PREHEATER A system of cyclones and riser ducts in which dry process kiln feed is preheatered in contact with kiln exit gases.

T

TEE % = Thermal Economic Equivalent A measure of the economic benefit of substituting traditional fuel with alternative fuel. TEE% = (1-(Actual cost of thermal energy x (1-TSR)) / Actual cost of traditional thermal energy) x 100. HARP manual reference = 8.3.7.2.

TEMPERING AIR Cold air mixed with hot gases to reduce their temperature for protection of draft fan, dust collector, etc.

TERTIARY AIR Hot air taken from the clinker cooler to support combustion in precalcining furnace.

TETRACALCIUM ALUMINOFERRITE (C_4AF) Chemical compound in portland cement that acts as a flux in the burning of clinker. Contributes very small amount of hydraulic potential.

TRANSITION ZONE Rotary kiln area between the calcining and sintering zone.

TRICALCIUM ALUMINATE (C_3A) Chemical compound in portland cement that liberates a large amount of heat during the first few days of hardening. It also adds to early strength development. Cements low in C_3A are more resistant to sulfates found in soils and water.

TRICALCIUM SILICATE (C_3S) Chemical compound in portland cement that hardens rapidly and is mainly responsible for early strength. (see ALITE)

TSR % = Thermal Substitution Rate A measure of the degree of substitution of traditional fuels by alternative fuels, based on thermal energy consumption in the kiln system. TSR% =100 x Alternative thermal energy consumption (MJ) / Traditional thermal energy consumption (MJ). HARP manual reference = 8.3.7.3.

V

VISCOSITY Resistance to flow. An inverse measure of the fluidity of slurry.

VOLATILE MATTER The hydrocarbons contained in coal which are readily vaporised and burn earliest during the combustion in kilns.

VORTEX Any flow possessing a rotary motion as an eddy or whirlpool. Found in the gas flows within cyclones.

W

WET PROCESS The cement manufacturing method whereby grinding, blending, mixing and pumping cement raw materials is done with water, (cf. DRY PROCESS). Wet process is chosen where raw materials are extremely wet and sticky, which would make drying before crushing and grinding difficult and costly.

WHITE CEMENT Cement, conforming to portland cement specifications, made from low-iron raw materials (such as KAOLIN) and burned with special methods to reduce the colouring effects of trace elements.

X

X-RAY DIFFRACTION ANALYSIS (XRD) Qualitative or quantitative analysis of crystalline compounds using an X-ray beam, diffracted from a flat surface of powdered sample, and comparing the angles of diffraction with the angles produced by known compounds.

X-RAY FLUORESCENCE ANALYSIS Determination of elemental composition of a sample by identification and measurement of secondary or characteristic radiation, caused by exposing a sample to high-energy X-rays.