

Glossary of Metalcasting Terms

This glossary provides casting users definitions of common metalcasting phrases and terms.

Acceptable quality level (AQL) A quality level established on a prearranged system of inspecting randomly selected samples.

Age hardening After rapid cooling or cold working, the process of increasing hardness and strength and decreasing ductility through aging.

Aging A change in structure by which a metal or alloy recovers from an unstable condition, resulting in precipitation and a change in physical properties.

Alloy A substance composed of two or more elements, at least one of which is metal, created to improve the material's properties or lower its cost.

Angularity The angular relationship of one surface to another; specifically, as it relates to the dimensional tolerance of such features on a casting.

Annealing A ferrous heat treatment that softens metals by heating above the critical temperature and slow cooling. Many types exist, but the process generally reduces hardness and improves machinability.

Arc furnace Used to melt metal either directly by an electric arc between an electrode and the work or indirectly between two electrodes.

As-cast Casting condition without subsequent finishing, including heat treatment.

Attrition Wearing away by friction; abrasion.

Austempered ductile iron (ADI) Ductile iron that has been austenitized, quenched and tempered for increased strength, ductility, wear resistance, design flexibility and low manufacturing cost.

Austenitizing Heating to and holding within the temperature range where austenite is stable in ferrous alloys.

Autoclave A vessel that uses super-heated steam under pressure to remove wax from invested shells and to carry out chemical reactions.

Backing sand The bulk of the sand in the flask; the sand compacted on top of the facing sand that covers the pattern.

Base metal Principal metallic material used in an alloy.

Bath Molten metal on the hearth of a furnace, in a crucible or in the ladle (Fig. 1).

Bentonite A colloidal, clay-like substance used as a binder in metalcasting sand mixtures where extra green or hot strength is required.

Binder The bonding agent used as an additive to mold or core sand to impart strength or plasticity in a dry state.



Fig. 1. Molten metal in a furnace, crucible or ladle is referred to as the bath.

Blast cleaning Removal of sand or oxide scale from castings by the impinging action of sand, metal shot or grit projected under pressure.

Bottom pouring Filling a mold cavity from a low point by means of gates from the runner.

Brinell hardness A test for determining the hardness of a material by forcing a ball of specified diameter into it under a specified load; results in the Brinell hardness number (Bhn).

Bull ladle A large container for transporting and pouring molten metal. Frequently used to designate a transfer ladle.

Burn-on sand Sand adhering to the surface of the casting that is extremely difficult to remove.

Captive foundry A division of a larger manufacturing establishment that produces parts for that parent company.

Case hardening Making the surface layer of a ferrous alloy substantially harder than the interior.

Castability A combination of liquid metal properties and solidification characteristics that promotes accurate and sound castings; the ease with which a metal flows through a mold or die.

Chaplet A small metal insert or spacer used in molds to provide core support during the casting process.

Charge A given weight of metal introduced into the furnace.

Chill A metal insert in the sand mold used to produce local chilling and equalize rate of solidification throughout the casting.

Clamp A device for holding together parts of a mold, flask, corebox, etc.

Cleaning Removal of runners, risers, flash, surplus metal and sand from a casting.

Cold shut A surface imperfection due to unsatisfactory fusion of metal.

Coldbox process A two-part organic resin binder system mixed in conventional mixers and blown into core shapes at room temperature. A vapor mixed with air sets the core.

Compacted graphite iron (CGI) Cast iron treated in the liquid state to give it a graphite shape between the flake form of gray iron and the spherical form of ductile iron.

Continuous casting A process in which molten metal is continuously solidified while being poured through a water-cooled mold; castings can be sawed off at any desired length.

Cope The top half of a horizontally-parted mold.

Core A sand or metal insert in a mold to shape the interior of the casting or that part of the casting that cannot be shaped by the pattern (Figs 2-3).

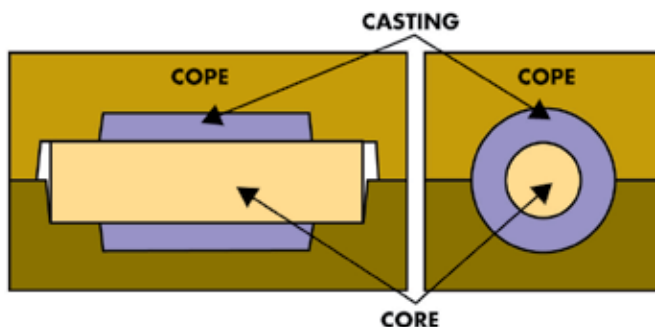


Fig. 2. These drawings illustrate the role of the core in the mold to form the internal cavities of the casting.



Fig. 3. Cores are placed into a mold.

- Core assembly** A substructure made from a number of cores.
- Corebox** The wooden, metal or plastic tool used to produce cores.
- Coreprint** A projection on a pattern that leaves an impression in the mold for supporting the core.
- Core wash** A liquid suspension of a refractory material applied to cores and dried (intended to improve surface of casting).
- Coupon** An extra piece of metal, either cast separately or attached to a casting, used to determine the mechanical or physical properties of the alloy.
- Crucible** A receptacle made of refractory materials used for melting and holding molten metal.
- Crush** The displacement of sand at mold joints.
- Cupola** A cylindrical, straight shaft furnace (usually lined with refractories) for melting metal in direct contact with coke by forcing air under pressure through openings near its base.
- Cure** To harden.
- Deburring** The removal of fins or sharp edges from castings.
- Dendrite** A treelike microstructure pattern formed during the cooling of metal.
- Dewaxing** The process of melting the expendable pattern out of an investment mold by the application of temperatures less than 250F (121C).
- Die** A metal form used as a permanent mold for die casting or for a wax pattern in investment casting.
- Dowel** A pin of various types used in the parting surface of parted patterns or dies to assure correct alignment.
- Draft** Taper on the vertical sides of a pattern or corebox that permits the core or sand mold to be removed without distorting or tearing of the sand (Fig. 4).
- Drag** The bottom half of a horizontally parted mold.
- Ductile iron** Cast iron that has the major part of its graphite carbon in nodular form.
- Dye penetrant inspection** An inspection method used to detect cracks or other surface defects in non-magnetic materials by injecting a colored liquid.
- Ejector pins** Movable pins in pattern dies that help remove patterns or die castings from the die.
- Elasticity** The property of recovering original shape and dimensions when a deforming force is removed.
- Elongation** The amount of permanent extension near the fractures in a tensile test, expressed as a percentage of original gage length.

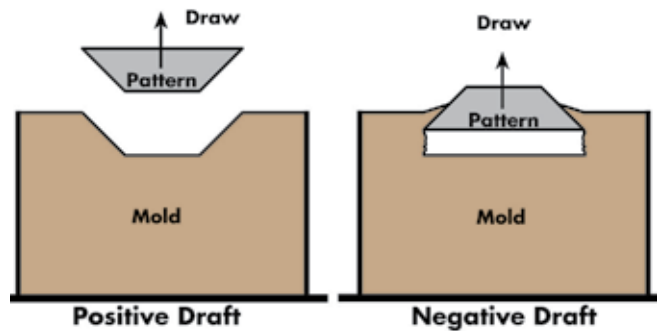


Fig. 4. Shown (from l) is proper, positive draft and incorrect, negative draft. Draft refers to the taper of the pattern, which allows it to be extended from a compacted sand mold.

- Eutectic temperature** The lowest melting temperature in a series of mixtures of two or more components.
- Expendable pattern** A pattern that is destroyed in the making of a casting, usually made of wax or foam.
- External chill** A piece of heat-conducting material (usually metal) placed in the mold wall that induces rapid cooling of the molten metal in the mold.
- Facing sand** The sand used to surround the pattern that produces the surface in contact with the molten metal.
- Fatigue** Tendency of a material to break under conditions of repeated cyclic stress.
- Feeder** Part of the gating system that forms the reservoir of molten metal necessary to compensate for losses due to shrinkage as the metal solidifies; riser.
- Ferrite** Carbon-free iron.
- Ferrostatic pressure** Force induced by a head of liquid iron or steel.
- Fettling** Loose material, as sand, thrown on a hearth to protect from shock.
- Fillet** A concave piece of material used to replace sharp corners on patterns or coreboxes; may be part of the mold (struck) or made separately (planted).
- Fin** A thin projection of metal on a casting resulting from imperfect mold or core joints.
- Fines** Sand grain sizes substantially smaller than the predominant grain size.
- Finish allowance** The amount of stock left on the surface of a casting for machining.
- Finish mark** A symbol (f_1, f_2 , etc.) appearing on the line of a drawing that represents the edge of the surface of the casting to be machined or otherwise finished.
- Flash** A thin section of metal formed at the mold, core or die joint or parting in a casting.



Fig. 5. Cut off sprues, runners and gates are saved as foundry returns to be remelted for more castings.

- Flask** A rigid metal or wood frame used to hold the sand of which a mold is formed and usually consisting of two parts, cope and drag.
- Floor molding** Used when pattern sizes prohibit the use of a molding machine; the pattern is bolted to the floor, and the assembled mold is moved by crane.
- Fluxing** Applying a solid or gaseous material to molten metal in order to remove oxides and other foreign material.
- Foundry returns** Metal (of known composition) in the form

of gates, sprues, runners, risers and scrapped castings returned to the furnace for remelting (Fig. 5).

Furan Generic term for a family of chemical compounds, including furfural and furfuryl alcohol, used as binders for core sands.

Gage A device for determining the dimensional size of an object (also spelled *gauge*).

Galvanize To coat iron or steel with zinc.

Gas porosity A condition existing in a casting caused by the trapping of gas in the molten metal or by mold gases evolved during the pouring of the casting.

Gate (ingate) The portion of the runner where the molten metal enters the mold cavity (Fig. 6).

Grain An individual crystal in a metal or alloy. Also an individual component of aggregate when referring to metalcasting sands.

Grain fineness number (GFN) A system for expressing the average grain size of a given sand.

Graphite One of the soft, crystal forms of carbon.

Green sand Moist, clay-bonded molding sand.

Heat A single furnace charge of metal.

Heat treatment A combination of heating and cooling operations timed and applied to a metal or alloy in the solid state in a manner that will produce desired mechanical properties.

High pressure mold A strong, high-density mold made by air or hydraulic pressure or another squeeze process.

Holding furnace A furnace for maintaining molten metal supplied from a larger melting furnace at the proper pouring temperature.

Hotbox process A resin-based process that uses heated metal coreboxes to produce cores.

Hot isostatic pressing (HIP) A process used to improve the internal soundness, increase the density and improve the properties of a casting. Castings are placed in an inert atmosphere in a pressure vessel, where the temperature is raised to near the solidus. The pressure is increased in the vessel, causing plastic deformation that collapses the internal porosity.

Hot tear Irregularly shaped fracture in a casting resulting from stresses set up by steep thermal gradients within the casting during solidification.

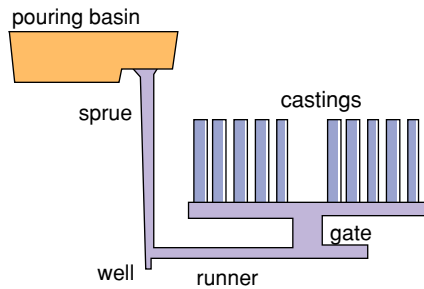


Fig. 6. The gating system, which brings the molten metal to the mold cavity, is illustrated in its simplest form. The design of this system is critical in the introduction of clean metal to the mold cavity.

Impregnation Treatment of castings with a sealing medium to stop pressure leaks.

Inclusions Particles of slag, refractory materials, sand or deoxidation products trapped in the casting during pouring solidification.

Ingot A mass of metal cast to a convenient size and shape for remelting or hot working.

Injection molding The injection of molten metal under pressure into molds.

Inoculation Addition to molten metal of substances designed to change the physical and mechanical properties of the structure.

Inserts Parts formed from a secondary material and placed in the mold to function as integral structural parts of the casting.

Investment casting A pattern casting process in which a wax or thermoplastic pattern is used. The pattern is invested (surrounded) by a refractory slurry. After the mold is dry, the pattern is melted or burned out of the mold cavity, and molten metal is poured into the resulting cavity.

Jobbing foundry A metalcasting facility that manufactures castings not intended for use in its own product.

Ladle A container used to transfer molten metal from the furnace to the mold (Fig. 7).

Locating pad A projection on a casting that helps maintain alignment of the casting for machining operations.

Locating surface A casting surface to be used as a basis for measurement in making secondary machining operations.

Lost foam A casting process in which a foam pattern is placed in a flask filled with loose sand, and molten metal is poured onto the pattern, replacing its shape and forming a casting.

Machinability Index or rate of removal by machining methods, usually expressed as cutting speed in surface ft./minute or depth of cut.

Master pattern The object from which a die can be made; generally a metal model of the part to be cast with process shrinkage added.

Martempering The process of quenching an austenitized ferrous alloy to the upper portion of the martensitic formation temperature range and holding it until the temperature throughout the alloy is uniform.

Mechanical properties Those properties of a material that reveal the elastic and inelastic properties when force is applied. This term should not be used interchangeably with "physical properties."

Melting range Pure metals melt at one definite temperature, but constituents of alloys melt at different temperatures; the variation from the lowest to the highest is called the melting range.

Metal lot A master heat that has been approved for casting and given a sequential number by the metalcaster.

Misrun Denotes an irregularity of the casting surface caused by incomplete filling of the mold so that the casting is not fully formed.

Mold Normally consists of a top and bottom form, made of sand, metal or any other investment material. It contains the cavity into which molten metal is poured to produce a casting of definite shape.

Mold cavity The impression in a mold produced by removal of the pattern. It is filled with molten metal to form the casting.

Mold coating (See core wash.)

Nobake process Molds/cores produced with a resin-bonded,



Fig. 7. Molten metal is poured from a ladle into a mold.

air-setting sand. Also known as the airset process because molds are left to harden under atmospheric conditions.

Nodular iron (See ductile iron).

Normalizing A heat treatment in which ferrous alloys are heated to a suitable temperature above the transformation range and then cooled in still air to room temperature.

Offal Material that is trimmed off of a die-casting to separate it from the shot and/or clean the parting line.

Orientation The position of a part or tool in a production operation.

Overaging Aging a nonferrous, precipitation-hardening alloy under conditions of time and temperature greater than those required to obtain maximum strength and hardness.

Oxidation a) A reaction of an element with oxygen. b) Any process which increases the proportion of oxygen or acid-forming element or radical in a compound.

Parting line The line showing the separation of the two halves of the mold.

Pattern The wood, metal, foam or plastic shape used to form the cavity in the sand. A pattern may consist of one or many impressions and would normally be mounted on a board or plate complete with a runner system.

Pattern draft (See draft.)

Pattern injection In investment casting, the process of filling the pattern die with expendable material, usually in the liquid or plastic state.

Pattern layout Full-sized drawing of a pattern showing its arrangement and structural features.

Patternmaker's shrinkage The shrinkage allowance made



Fig. 8. In this form of shakeout, castings are tumbled out of their sand molds while workers wait at the end to detach the gates, runners and sprues with pneumatic wedges.

on all patterns to compensate for the change in dimensions as the solidified casting cools in the mold from freezing temperature of the metal to room temperature. The pattern is made larger by the amount of shrinkage characteristic of the particular metal in the casting and the amount of resulting contraction to be encountered.

Pearlitic Pearlitic ductile iron is higher in alloy than ferritic ductile iron. A pearlitic matrix lends higher strength.

Permeability The property of a mold material to allow passage of mold/core gases during the pouring of molten metal.

Physical properties Properties of matter such as density, electrical and thermal

conductivity, expansion and specific heat. This term should not be used interchangeably with "mechanical properties."

Pig iron Blocks of iron to a known metal-chemical analysis that are used for melting (with suitable additions of scrap, etc.) for the production of ferrous castings.

Pilot or sample casting A casting made from a pattern produced in a production die to check the accuracy of dimensions and quality of castings that will be made.

Pinhole porosity Very small holes scattered throughout a casting, possibly caused by microshrinkage or gas evolution during solidification.

Plaster molding Molding method where gypsum or plaster is mixed with talc and water to form a slurry that is poured around a pattern. After the slurry hardens, the pattern is removed and the mold is baked at an elevated temperature to remove all moisture prior to use.

Porosity Holes in the casting due to gases trapped in the mold, the reaction of molten metal with moisture in the molding sand or the imperfect fusion of chaplets with molten metal.

Pouring basin The enlarged mouth of the sprue into which molten metal is poured.

Precision casting A casting of high dimensional accuracy produced via investment casting, plaster mold casting, diecasting, permanent mold casting or shell mold casting.

Pressure casting Making castings with pressure applied to the molten charge material, as in diecasting, centrifugal casting and injection molding, as opposed to gravity pouring.

Quenching Rapid cooling from an elevated temperature for hardening, normally achieved by immersion of the object in water, oil, or salt or organic compound solutions.

Recovery rate Ratio of the number of saleable parts to the total number of parts manufactured, expressed as a percentage.

Refractory Heat-resistant ceramic material.

Reject rate Ratio of the number of parts scrapped to the total number of parts manufactured, expressed as a percentage.

Rheocasting Metalcasting process where liquid metal is agitated during initial stages of solidification to produce a semi-solid structure that remains highly fluid after 60% solidification.

Riser (See feeder.)



Fig. 9. In investment casting, wax patterns are dipped into a mixture of refractory materials, called a slurry, which is then fired and dried before molten metal is poured into the mold.

Runner system or gating The set of channels in a mold through which molten metal is poured to fill the mold cavity. The system normally consists of a vertical section (downgate or sprue) to the point where it joins the mold cavity (gate) and leads from the mold cavity through vertical channels (risers or feeders).

Sand inclusions Cavities or surface imperfections on a casting caused by sand washing into the mold.

Scrap **a)** Any scrap metal melted (usually with suitable additions of pig iron or ingots) to produce castings. **b)** Reject castings.

Segregation A casting defect in which alloying elements are concentrated in specific regions, usually as a result of the primary crystallization of one phase with the subsequent concentration of other elements in the remaining liquid.

Semi-permanent mold A permanent mold in which sand, plastic or graphite cores are used.

Shakeout The process of separating the solidified casting from the mold material (Fig. 8).

Short run **a)** Insufficient metal in ladle to fill the mold. **b)** When metal freezes at the gates before filling the mold.

Shrinkage Contraction of metal in the mold during solidification. The term also is used to describe the casting defect, such as shrinkage cavity, which results from poor design, insufficient metal feed or inadequate feeding.

Slag A fused nonmetallic material that protects molten metal from the air and extracts certain impurities from the melt.

Slag inclusions Casting surface imperfections similar to sand inclusions but containing impurities from the charge materials, silica and clay eroded from the refractory lining, and ash from the fuel during the melting process. May also originate from metal-refractory reactions occurring in the ladle during pouring of the casting.

Slurry A flowable mixture of refractory particles suspended in a liquid (Fig. 9).

Sodium silicate/CO₂ process Molding sand is mixed with sodium silicate and the mold is gassed with CO₂ to produce a hard mold or core.

Sprue (downsprue-downgate) The channel, usually vertical, through which molten metal enters the mold.

Stress relieving A process of reducing residual stresses in a casting by heating it to a suitable temperature and holding it for a sufficient time.

Superalloy An alloy developed for very high temperature use where relatively high stresses are encountered and where oxidation resistance is needed.

Surface treating Any method of treating the surface of a metal to make it more resistant to weather or chemical attack.

Test bar Standard specimen bar designed to permit determination of mechanical properties of the metal from which it was poured.

Test lug A lug cast as a part of the casting and later removed for testing purposes.

Thermal expansion The increase in a linear dimension and volume of a material accompanying a change of temperature.

Tilt-pouring In permanent molding, when the mold is moved from a low angle to a vertical position during pouring.

Vent An opening or passage in a mold or core to facilitate escape of gases when the mold is poured.

Warpage **a)** Deformation other than contraction that develops in a casting between solidification and room temperature. **b)** Distortion occurring during annealing, stress relieving and high-temperature service.

Wax pattern A precise duplicate, allowing for shrinkage, of the casting and required gates, usually formed by pouring or injecting molten wax into a die or mold (Fig. 10).

Yield or casting yield The percentage of quality degated castings produced in relation to the amount of molten metal poured.

ECS



Fig. 10. Wax patterns are affixed to an investment tree. These patterns will eventually be coated in a slurry and burned out to leave hollow cavities.

Courtesy American Foundry Society