



# GLOSSARY OF COMMON HEAT TREAT TERMS

**AGE HARDENING** - A process of aging that increases hardness and strength and ordinarily decreases ductility. Age hardening usually follows rapid cooling or cold working.

**ALLOY** - A substance having metallic properties and composed of two or more chemical elements of which at least one is metal.

**ALLOY STEEL** - A steel to which alloying elements are added to achieve specific properties.

**ANNEALING** - Heating to and holding at a suitable temperature and then cooling at suitable rate, for such purposes as reducing hardness, improving machinability, facilitating cold working, producing a desired microstructure, or obtaining desired mechanical, physical, or other properties.

**ATMOSPHERE (PROTECTIVE)** - In metallurgical practice the gases surrounding the work in a furnace or other high temperature apparatus. The character of the atmosphere varies with the work being carried out, and in nature, may be oxidizing, reducing or neutral.

**AUSTEMPERING** - A heat treatment process that consists of quenching a ferrous alloy from a temperature above the critical range in a medium having a rate of heat abstraction (usually molten salt) sufficiently high to prevent the formation of high-temperature transformation products; and in maintaining the alloy, until transformation is complete, at a temperature below that of pearlite and above that of martensite formation.

**AUSTENITE** - A solid solution of one or more elements in face-centered cubic iron. Unless otherwise designated (such as nickel austenite), the solute is generally assumed to be carbon.

**AUSTENITIZING** - The process of forming austenite by heating ferrous alloy above the transformation range.

**BAINITE** - A constituent in the microstructure of steel; formed by the transformation of austenite below the pearlitic and above the martensitic transformation temperatures.

**BILLET** - A semi-finished piece of metal which has resulted from rolling an ingot or bloom. It may be square, but is never more than twice as wide as it is thick.

**BRAZING** - Joining metals by fusion of nonferrous alloys that have melting points above 800°F, but lower than those of the metals being joined. This may be accomplished by means of a torch (torch brazing), in a furnace (furnace brazing), or by dipping in a molten flux bath (dip or flux brazing).

**BRIGHT ANNEALING** - A process of annealing carried out in a controlled atmosphere or vacuum so that surface oxidation is reduced to a minimum and the surface remains relatively bright.

**CARBIDE** - A compound of carbon with one or more metallic elements.

**CARBON STEEL** - Steel that owes its properties chiefly to the presence of carbon, without substantial amounts of other alloying elements. Carbon content usually limited to 2.00%, silicon limited to 0.60%, and manganese to 1.65%.

**CARBONITRIDING** - Introducing carbon and nitrogen into a solid ferrous alloy by the Austenizing temperature in an atmosphere that contains suitable gases such as hydrocarbons, carbon monoxide and ammonia. The carbonitrided alloy is usually quenched hardened.

**CARBURIZING** - Adding carbon to the surface of steel by heating it in contact with carbon rich gases.

**CASE HARDENING** - A heat treatment in which the surface layer of a steel is made substantially harder than the interior by altering its composition and properties.

**CAST IRON** - An alloy of iron and carbon above 1.7% carbon.

**CASTING** - A metal shape produced by solidifying of molten metal in a mold.

**CEMENTITE** - An intermetallic compound of iron and carbon Fe<sub>3</sub>C.

**CHROMIUM** - An alloying element added to ferrous alloys to increase harden ability and corrosion resistance

**COLD ROLLED** - Products that have been finished by rolling at or near room temperature.

**CONTROLLED COOLING** - Cooling from an elevated temperature process in a predetermined manner to achieve specific properties.

**CORE** - The internal portion of a shape or part.

**CORROSION** - Gradual chemical or electrochemical attack on metal.

**CREEP** - The flow or plastic deformation of metal held for long periods of time at stresses lower than their normal yield strength.

**COUPON** - An extra piece of metal, used to determine the properties of the metal after heat treating.

**DECARBURIZATION** - Loss of carbon from the surface of a ferrous alloy, as a result of heating in a medium that reacts with the carbon.

**DEFORMATION** - Change in dimensions, as the result of an applied stress.

**DIFFUSION** - The process by which atoms migrate as a result of their random thermal motion, usually in the direction from regions of high concentration towards regions of low concentration, to achieve homogeneity of the solution, which may be either a liquid, a solid, or a gas.

## **DIRECTIONAL PROPERTIES**

**(DIRECTIONALITY)** - An isotropic relationship of mechanical and physical properties with respect to the direction or axis in which they are observed.

**DUCTILE IRON (NONDULAR IRON)** - Gray iron treated with a special alloy while in the liquid state so that the graphite is spheritic rather than flake. Also called spheritic graphite or S.G.iron.

**DUCTILITY** - The ability of a material to deform plastically without fracturing, being measured by elongation or reduction of area in a tensile test, by height of cupping in an Erichsen test or by other means.



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**ELASTIC DEFORMATION** - Temporary changes in dimensions caused by stress. The material returns to the original dimensions after removal of stress.

**ELASTIC LIMIT** - Maximum stress that a material will withstand without permanent deformation.

**ELONGATION** - In tensile testing, the increase in the gage length, measured after fracture of the specimen within the gage length. Usually expressed as a percentage of the original gage length.

**EMBRITTEMENT** - Loss of ductility.

**FATIGUE** - The phenomenon leading to fracture under repeated or fluctuating stresses having a maximum value less than the tensile strength of the material.

**FATIGUE STRENGTH** - The maximum stress that can be sustained for specified number of cycles without failure, the stress being completely reversed within each cycle unless otherwise stated.

**FERRITE** - A solid solution in which alpha iron is the solvent, and which is characterized by a body-centered cubic crystal structure.

**FILE HARDNESS** - Hardness determined by the use of a file of standardized hardness using the assumption that a metal which cannot be cut is as hard as, or harder than the file.

**FILLET** - A concave junction of two surfaces.

**FLAME HARDENING** - Process of hardening the surface of metals by heating it above the transformation range with a high-temperature flame followed by rapid cooling.

**FLUX** - (1) In metal refining, a material used to remove undesirable substances, like sand, ash or dirt, as a molten mixture. It is also used as a protective covering for certain molten metal baths. Lime or limestone is generally used to remove sand, as in iron smelting; sand, to remove iron oxide in copper refining. (2) In brazing, cutting, soldering or welding, material used to prevent the formation of, or to dissolve and facilitate removal of, oxides and other undesirable substances.

**FORGING** - Forming hot metal into the desired shape by hammering or pressing.

**GRAIN** - A grain is a particle of metal or alloy in which the space lattice pattern is continuous except for small irregularities.

**GRAIN SIZE** - For metals, a measure of the areas or volumes of grains in a polycrystalline material, usually expressed as an average when the individual sizes are fairly uniform. Grain sizes are reported in terms of number of grains per unit area or volume, average diameter, or as a grain-size number derived from area measurements.

**HARDENABILITY** - In a ferrous alloy, the property that determines the ability of the metal to harden.

**GRAPHITE** - One of the crystal forms of carbon; also the uncombined carbon in cast irons.

**HARDNESS** - The property of a substance determined by its ability to resist abrasion or indentation by another substance. For metals, hardness is usually defined in terms of the size of an impression made by a standard indenter. (Brinell, Rockwell, Diamond, Pyramid, tests.)

**HEAT TREATMENT** - Heating and cooling a solid metal or alloy in such a way as to obtain desired conditions or properties.

**IMPACT TEST** - A test to determine the energy absorbed in fracturing a test bar at high velocity.

**INDUCTION HARDENING** - A process of hardening the surface of steel by heating it above the transformation range by electrical induction, followed by rapid cooling.

**ISOTHERMAL ANNEALING** - Austenitizing a ferrous alloy and then cooling to and holding at a temperature at which austenite transforms to a relatively soft ferrite carbide aggregate.

**KNOOP HARDNESS** - Microhardness determined from the resistance of metal to indentation by a pyramidal diamond indenter, having edge angles of 1720 3~' and 130°, making a rhombohedral impression with one long and one short diagonal.

**LAMELLAR STRUCTURE** - A constituent microstructure composed of an intimate mixture of platelets of two phases, typically resulting from a eutectoid reaction. The structure of pearlite in the iron-carbon system.

**MACROGRAPH** - A photographic reproduction of any object that has been magnified not exceeding ten diameters.

**MACROSTRUCTURE** - Structure of metals as revealed by macroscopic examination.

**MALLEABILITY** - The property that determines the ease of deforming a metal.

**MARQUENCHING** - Quenching of steel at a temperature between the Ms and Mf temperature, allowing it to air cool to room temperature.

**MARTENSITE** - A body centered tetragonal structure of steel. This structure occurs when steel is quenched from its austenite range fast enough to suppress upper transformation products. This transformation product occurs only on cooling.

**Ms** - Martensite start. Temperature at which martensite starts to form.

**Mf** - Martensite finish. The temperature at which the materials transformation is vertically complete.

**MECHANICAL PROPERTIES** - Those properties of a material that reveal the elastic and inelastic reaction when force is applied.

**METALLOGRAPHY** - Study or science of structures of metals and alloys, particularly visual examination by means of the microscope.

**METALLURGY** - The science of metals.

**MICROHARDNESS TEST** - That hardness test used to test small parts on micro constituents in metals.

**MICROSTRUCTURE** - The structure of polished and etched metal and alloy specimens as revealed by the microscope at a magnification over ten diameters.



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**NITRIDING** - A process of surface hardening a ferrous alloy by the absorption of nitrogen in the surface at sub-critical temperatures.

**NORMALIZING** - Heating a steel to a temperature about 1000F above the critical range and cooling in still air. This process is used to eliminate all effects of prior processes and to render the part uniform in structure.

**PEARLITE** - A lamellar aggregate of ferrite and cementite, often occurring in steel and cast iron.

**PHYSICAL PROPERTIES** - Those basic properties of metals such as, density, electrical conductivity, coefficient of thermal expansion, etc.

**PICKLE** - To clean metal surfaces by chemical or electrochemical means.

**PLASTIC DEFORMATION** - Permanent distortion of a material under the action of applied stress.

**POROSITY** - Fine holes or pores within a metal.

**POST HEATING** - Heating welded metal immediately after welding for tempering, stress relieving or providing a controlled rate of cooling to minimize formation of a hard or brittle structure.

**PRECIPITATION HARDENING** - The hardening of a metal caused by precipitation of a constituent from a supersaturated solid solution.

**PREHEATING** - Heating of parts to a temperature below the austenitizing temperature prior to austenitizing. Used to minimize thermal shock on complex parts.

**PROCESS ANNEALING** - Heating a ferrous alloy to a temperature close to, but below, the lower limit of the transformation range and then cooling, in order to soften the alloy for further cold working.

**PSI** - Pounds per square inch.

**QUENCHING** - A process of rapid cooling from an elevated temperature.

**REDUCTION IN AREA** - The difference between the original cross-sectional area of a tensile test piece and that of the smallest area at the point of fracture. Usually stated as percentage of the original area.

**SCALE** - The oxide formed on a metal by heating in air or other oxidizing atmospheres.

**SEAM** - A surface defect on rolled products that has been closed but not welded.

**SEGREGATION** - Non-uniform distribution of alloying elements, impurities or micro phases.

**SHEAR STRENGTH** - Maximum shear stress that a material is capable of withstanding without failure.

**SOAK** - The holding time at temperature to assure that all parts are at required temperature for sufficient time for the metallurgical reaction to occur.

**SOLDERING** - Joining metals by fusion of alloys that have relatively low melting points, most commonly lead-based or tin base alloys, which are the soft solders.

**SPHEROIDIZING** - Heating and cooling to produce a spheroidal or globular form of carbide in steel.

**STEEL** - An alloy of iron and carbon which may contain other elements in which the carbon content does not exceed about 2.0% and which is malleable at some temperature in the solid state.

**STRAIN** - The change per unit of length in any material as a result of stress. Strain is measured in inches per inch of length.

**STRESS** - The load per unit area.

**STRESS RELIEVING** - A process of reducing residual stresses in a metal object by heating to a temperature below the lower critical and holding for a sufficient time. This treatment may be applied to relieve stresses induced by casting, quenching, normalizing, machining, cold working or welding.

**STRESS CORROSION CRACKING** - Spontaneous failure of metals by cracking under combined conditions of corrosion and stress, either residual or applied.

**STRESS RISERS** - Factors such as sharp changes in contour or surface defects, which concentrate stresses locally

**RESIDUAL STRESSES** - Stresses set up as a result of a non-uniform plastic deformation.

**SUB-CRITICAL ANNEAL** - Heat treating to a temperature below that which austenite is formed and above the temperature normally used for stress relieving of the material that is being treated.

**SUPERSATURATED** - Metastable solution in which the dissolved material exceeds the amount the solvent can hold in normal equilibrium at the temperature and under the other conditions that prevail.

**TEMPERING** - A process of reheating quenched steel to a temperature below the transformation range to achieve specific mechanical properties and hardness.

**TENSILE STRENGTH** - The value obtained by dividing the maximum load by the original area in tensile testing.

**THERMAL STRESSES** - Stresses in metal resulting from non-uniform heating and cooling.

**TOUGHNESS** - The amount of energy absorbed before fracturing.

**THERMAL EXPANSION** - The increase in linear dimensions of a material accompanying an increase in temperature.