

# Metallurgical Terms

**AGING:** Aging is a structural change, usually by precipitation, that occurs in some alloys after a preliminary heat treatment or cold working operation. Aging may take place in some alloys at room temperature in moderate time (days) or in others may be done in shorter time at furnace temperatures.

**AIR HARDENING STEEL:** An alloy steel which will form martensite and develop a high hardness when cooled in air from its proper hardening temperature.

**ANNEALING:** A very general term describing the heating of metal to a suitable temperature, holding for suitable time, and cooling at a suitable rate to accomplish the objective treatment.

Annealing may be done to:

- A. Relieve stresses*
- B. Induce softness*
- C. Improve physical, electrical, or magnetic properties*
- D. Improve machinability*
- E. Refine the crystalline structure*
- F. Remove gases*
- G. Produce a specific microstructure*

**ATMOSPHERE:** The gaseous environment in which the metal being treated is heated for processing. Atmospheres are used to protect from chemical change or to alter the surface chemistry of steel through the addition or removal of carbon and nitrogen.

**AUSTENITE:** Austenite is the name given any solid solution in which gamma iron is the solvent. Austenite is a structure name and means nothing as to composition. Austenite is the structure from which all quenching heat treatments must start.

**AUSTENITIZING TEMPERATURE:** The temperature at which a steel is substantially all austenite.

**BAINITE:** The product formed when austenite transforms between 4500F and 9000F. Bainite is an acicular aggregate of ferrite and carbide and varies in hardness between Rc30 and Rc55.

**BANDED STRUCTURE:** A layering effect that is sometimes developed during the hot rolling of steel.

**BRIGHT ANNEALING:** Annealing work in a protective atmosphere so that there is no discoloration as the result of heating. In some atmospheres oxides may be reduced.

**CARBONITRIDING:** A heat treatment for steel which adds carbon & nitrogen from an atmosphere rich in such elements.

**CARBON STEEL:** Steel that is essentially iron plus carbon with no intentionally added alloy. Also known as ordinary steel, straight carbon steel, or plain carbon steel.

**CARBURIZING:** Adding carbon to the surface of steel by heating it in contact with carbon rich solids, liquids or gases.

**CASE:** The surface layer of a steel whose composition has been changed by the addition of carbon, nitrogen, chromium, or other material at high temperature.

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

**CEMENTITE:** The common name for iron carbide  $Fe_3C$ , the chemical combination of iron & carbon.

**COLD WORKING:** Plastic deformation of a metal at a temperature low enough so that re-crystallization does not occur during cooling.

**CORE:** The interior part of a steel whose composition has not been changed in a case hardening operation.

**CRITICAL POINT:** A temperature point at which a structure change either starts, is completed, or both when a material is being heated or cooled.

**CRITICAL RANGE:** The temperature range between an upper and lower critical point for a given material.

**DECARBURIZING:** The process (usually unintentional) of removing carbon from the surface of a steel, usually at high temperature, when in contact with certain types of atmosphere.

**DRAW:** The common term used interchangeably with Tempering.

**FATIGUE:** Failure by progressive fracture caused by repeated applications or reversals of stress.

**FERRITE:** Ferrite is the name given any solid solution in which alpha iron is the solvent.

Ferrite is strictly a structure name and means nothing as to composition.

**GRAIN GROWTH:** Growth of some grains at the expense of others, resulting in an overall increase in average grain size.

**HARDENABILITY:** The fundamental characteristic of a steel which determines the ease of preventing the transformation of austenite to anything else but martensite during the quench.

**HOMOGENIZING:** An annealing treatment at fairly high temperature designed to eliminate or reduce chemical segregation.

**HYDROGEN EMBRITTLEMENT:** The brittleness induced in steel by the absorption of hydrogen, most commonly from a pickling or plating operation.

**INCLUSIONS:** Particles of impurities (usually oxides, sulphides, silicates and such), which separate from the liquid steel and are mechanically held during solidification. In some grades of steel, inclusions are made intentionally high to aid machinability.

**INDUCTION HARDENING:** A form of hardening in which the heating is done by induced electrical current.

**MARTEMPERING OR MARQUENCHING:** Martempering is a form of interrupted quenching in which the steel is quenched rapidly from its hardening temperature to about 4500F, held at 4500F until the temperature is uniform, then cooled in air to room temperature. Actual hardening does not occur until the air cooling starts and is accomplished with a minimum temperature differential. Martempering is indicated for low to medium alloy steels when distortion may be a problem.

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**MARTENSITE:** The very hard transformation product which forms austenite when a steel is quenched and cooled below about 4500F. Technically, martensite can be considered to be a supersaturated solution of carbon in tetragonal (distorted cubic) iron. Under the microscope it appears as an acicular or needlelike structure. Hardness of martensite will vary from Rc30 to Rc68 depending on the carbon content.

**MICROSTRUCTURE:** The structure of a metal as revealed at high magnification, usually at 100x and higher.

**NITRIDING:** The process of adding nitrogen to the surface of a steel, usually from dissociated ammonia as the source. Nitriding develops a very hard case after a long time at comparatively low temperature, without quenching.

**NITROCARBURIZING:** Process of adding Nitrogen and carbon to the surface a steel at a comparatively low temperature. Used mainly for anti galling properties and corrosion resistance.

**NORMALIZING:** The process of heating steel to a temperature above its transformation range, followed by air cooling. The purpose of normalizing may be to refine grain structure prior to hardening the steel, to harden the steel slightly, or to reduce segregation in castings or forgings.

**QUENCHING:** Cooling from high temperature, usually at a fast rate.

**SECONDARY HARDNESS:** The higher hardness developed by certain alloy steels when they are cooled from a tempering operation. This should always be followed by a second tempering operation.

**SOLUTION TREATMENT:** Heating an alloy to high temperature to form a solution from an aggregate.

**SPHEROIDIZING:** A heat treating process used to change all of the carbides in steel to rounded particles, or spheroids. A completely spheroidized structure is the softest and most workable structure for any composition.

**TEMPERING:** Reheating quenched steel to a temperature below the critical range, followed by any desired rate of cooling. Tempering is done to relieve quenching stresses, or to develop desired strength characteristics.

**WORK HARDNESS:** Hardness developed in metal resulting from cold working.