Heat-Treating

GLOSSARY

This brief glossary of heat-treating terms has been adopted by the American Foundrymen's Association, the American Society for Metals, the American Society for Testing, and the Society of Automotive Engineers. Because it is not intended to be a specification, but is strictly a set of definitions, temperatures have purposely been omitted. Published with the kind permission of Wisconsin Oven, 2675 Main St., East Troy, WI 53120; 262/642-3938; Web site www.wisoven.com.

Aging. Describes a time-temperature-dependent change in the properties of certain alloys. Except for strain aging and age softening, it is the result of precipitation from a solid solution of one or more compounds whose solubility decreases with decreasing temperature. For each alloy susceptible to aging, there is a unique range of time-temperature combinations to which it will respond.

Annealing. A term denoting a treatment, consisting of heating to and holding at a suitable temperature, followed by cooling at a suitable rate, used primarily to soften, but also to simultaneously produce desired changes in other properties or in microstructure. The purpose of such changes may be, but is not confined to, improvement of machinability; facilitation of cold working; improvement of mechanical or electrical properties; or increase in stability of dimensions. The time-temperature cycles used vary widely both in maximum temperature attained and in cooling rate employed, depending on the composition of the material, its condition, and the results desired. When applicable, the following more specific process names should be used: Black Annealing, Blue Annealing, Box Annealing, Bright Annealing, Cycle Annealing, Flame Annealing, Full Annealing, Graphitizing, Intermediate Annealing, Isothermal Annealing, Process Annealing, Quench Annealing, and Spheroidizing. When the term is used without qualification, full annealing is implied. When applied only for the relief of stress, the process is properly called stress relieving.

Baking. Heating to a low temperature in order to remove entrained gases.

Direct gas fired. A heating system where the products of combustion (a by-product of the burner system), are circulated through the work chamber.

Drawing. Drawing, or drawing the temper, is synonymous with Tempering, which is preferable.

Heat treatment. A combination of heating and cooling operations applied to a metal or alloy in the solid state to obtain desired conditions or properties. Heating for the sole purpose of hot working is excluded from the meaning of this definition.

Heat treatment solution. A treatment in which an alloy is heated to a suitable temperature and held at this temperature for a sufficient length of time to allow a desired constituent to enter into solid solution, followed by rapid cooling to hold the constituent in solution. The material is then in a supersaturated, unstable state, and may subsequently exhibit Age Hardening.

Indirect gas fired. A heating system where the products of combustion (a by-product of the burner system), are NOT circulated through the work chamber.

Normalizing. A process in which an iron-base alloy is heated to a temperature above the transformation range and subsequently cooled in still air at room temperature.

Pit type furnace. This is a vertical furnace arranged for the loading of parts in a metal basket, when lowered into place, fitting into the furnace chamber in such a way as to provide a dead-air space to prevent direct heating.

Preheating. Heating to an appropriate temperature immediately prior to austenitizing when hardening high hardenability constructional steels, many of the tool steels, and heavy sections.

Quenching. Rapid cooling. When applicable, the following more specific terms should be used: Direct Quenching, Fog Quenching, Hot Quenching, Interrupted Quenching, Selective Quenching, Slack Quenching, Spray Quenching, and Time Quenching.

Retort furnace. This is a vertical type of furnace provided with a cylindrical metal retort into which the parts to be heat-treated are suspended either individually, if large enough, or in a container of some sort. The use of a retort permits special gas atmosphere to be employed for carburizing, nitriding, etc.

Stress relieving. A process to reduce internal residual stresses in a metal object by heating the object to a suitable temperature and holding for a proper time at that temperature. This treatment may be applied to relieve stresses induced by casting, quenching, normalizing, machining, cold working, or welding.

Tempering. Heating a quench hardened or normalized ferrous alloy to a temperature below the transformation range to produce desired changes in properties. The object of tempering or drawing is to reduce the brittleness in hardened steel and to remove the internal strains caused by the sudden cooling in the quenching bath. The tempering process consists in heating the steel by various means to a certain temperature and then cooling it. When steel is in a fully hardened condition, its structure consists largely of martensite. On reheating to a temperature of from about 300°F to 750°F, a softer and tougher structure known as troostite is formed. If the steel is reheated to a temperature of from 750°F to 1290°F, a structure known as a sorbite is formed, which has somewhat less strength than troostite, but much greater ductility.

T4. Solution heat-treated and naturally aged to a substantially stable condition. Applies to products which are not cold-worked after solution heat treatment, or in which the effect of cold work in flattening or straightening may not be recognized in applicable specifications.

T5. Artificially aged only: Applied to products that are artificially aged after an elevated-temperature rapid-cool fabrication process, such as casting or extrusion, to improve mechanical properties or dimensional stability, or both.

T6. Solution heat-treated and then artificially aged: Applies to products that are not cold-worked after solution heat treatment, or in which the effect of cold work in flattening or straightening may not be recognized in applicable specifications. PC