Metals Glossary

Aluminum Killed Steel – Steel treated with aluminum as the deoxidizing agent in order to reduce the oxygen content to such a level that no reaction occurs between carbon and oxygen during solidification. *See Killed Steel*

Annealing – Commonly involves heating the material to a temperature near or below the lower critical temperature, and holding at that temperature for a sufficient period of time, followed by slow cooling. The process softens the steel, but not to the same degree as spheroidize annealing.

Capped Steel – A type of steel similar to rimmed steel, usually cast in a bottle-top ingot mold, in which the application of a mechanical or chemical cap render the rimming action incomplete by causing the top metal to solidify The surface condition of capped steel is much like that o rimmed steel, but certain other characteristics are intermediate between those of rimmed steel and those of semi-killed steel.

Carbon – The principal hardening element in steel, and as carbon content increases, the hardness increases. Tensile strength also increases with the carbon content up to about 0.85 percent carbon. Ductility and weldability decrease with increasing carbon. The surface quality becomes impaired as the carbon content increases in rimmed steels. By contrast, killed steels have a poorer surface in the lower carbon grades.

Chemical Cleaning – The process of removing oxide or scale by acid pickling or other means, followed by water rinsing. Chemical cleaning is almost always followed up by a supplementary coating operation.

Coating of Wire Rods – [Lime, Borax and Phosphate] Performed to provide a carrier for the lubricant necessary for subsequent processing. In lime coating, practices maybe varied by applying differing amounts of lime on the material depending upon the application. Phosphate coated material normally has a supplementary coating of lime, borax or a water soluble soap.

Controlled Cooling – In the production of wire rods, an in-line method of controlling the cooling rate of the steel rod immediately after delivery from the rod-finishing mill. Controlled cooling offers the opportunity to influence rod surface scale and the metallurgical and physical properties of the steel. *See Stelmor Process*

Copper – Sometimes specified in carbon steels for the primary purpose of improving resistance to atmospheric corrosion. It affects forge welding adversely, but does not seriously affect arc or acetylene welding. Copper tends to be detrimental to surface quality. In the small amounts used in carbon steels, copper has no significant effect on mechanical properties. Copper is not removed by any of the conventional steelmaking processes.

Grades - Of hot rolled carbon steel is commonly specified by chemical ranges and limits for carbon and other elements.

High Carbon Steel Wire Rods – Include grades of steel with a maximum carbon content exceeding 0.44 percent.

Killed Steel – Steel treated with a strong deoxidizing agent such as silicon or aluminum in order to reduce the oxygen content to such a level that no reaction occurs between carbon and oxygen during solidification.

Low Carbon Steel Wire Rods – Encompass grades of steel to 0.15 percent maximum carbon content, inclusive.

Manganese – Contributes to strength and hardness, but to a lesser degree than carbon. The amount of increase in these properties is dependent upon the carbon content; that is, higher

carbon steels are affected more by manganese than lower carbon steels. Increasing the manganese content decreases weldability, but to a lesser extent than carbon. Another function of manganese is to increase hardenability. Manganese tends to increase the rate of carbon penetration during carburizing. Manganese is beneficial to surface quality in all but the extremely low carbon rimmed steels.

Mechanical De-scaling – The process of removing oxides or mill scale by mechanical means. Frequently used to prepare hot rolled wire rods prior to cold rolling or drawing.

Medium High Carbon Steel Wire Rods – Encompass grades of steel with a maximum carbon content exceeding 0.23 to and including 0.44 percent.

Medium Low Carbon Steel Wire Rods – Encompass grades of steel with a maximum carbon content exceeding 0.15 to and including 0.23 percent.

Patenting – In wire making a heat treatment usually applied to medium-carbon or high-carbon steel before the drawing of the wire or between drafts. The process involves heating the steel well above the upper critical temperature followed by rapid cooling in air, or a molten lead bath, salt bath, or a fluidized bed.

Phosphorus – Increases strength and hardness of steel, but at the sacrifice of ductility and impact toughness, particularly in higher carbon steels that are quenched and tempered. Consequently, for most applications, phosphorus is maintained below a specified maximum. In lower carbon free machining steels, higher phosphorus is sometimes specified, since it enhances machinability. Phosphorus has a pronounced tendency to segregate, and it helps the adherence of hot dip zinc coatings on wire.

Quality Descriptors – *See Wire Rod Quality Descriptors*

Reduction of Area – (1) Commonly, the difference expressed as a percentage of original area between the original cross-sectional area of a tensile test specimen and the minimum cross-sectional area measured after complete separation. (2) The difference expressed as a percentage of original area, between the original cross sectional area and that after straining of the specimen.

Rimmed Steel – A low-carbon steel containing sufficient iron oxide to give continuous evolution of carbon monoxide while the ingot is solidifying resulting in a case or rim of metal virtually free of voids Sheet, strip and wire rods made from rimmed steel ingots usually have very good surface quality.

Semi-Killed Steel – Steel that is incompletely deoxidized and contains sufficient dissolved oxygen to react with the carbon to form carbon monoxide and thus offset solidification shrinkage. *See Killed Steel*

Silicon – One of the principal deoxidizers used in steelmaking; therefore, the amount of silicon present is related to manufacturing practice and the type of steel. Silicon increases strength and hardness in hot rolled products and increases the rate of work hardening during cold forming processes. Silicon promotes increased coating weight and zinc adherence in hot dip wire galvanizing operations.

Silicon Killed Steel – Steel treated with silicon as the deoxidizing agent in order to reduce the oxygen content to such a level that no reaction occurs between carbon and oxygen during solidification. *See Killed Steel*

Spheroidize Annealing – Involves prolonged heating at a temperature near or slightly below the lower critical temperature, followed by slow cooling, with the object of producing a globular (spheroidal) condition of the carbide to obtain maximum softness.

Stelmor Process – A thermal treatment process that develops a microstructure in hot rolled wire rods that permits direct drawing into wire of medium or high carbon grades of steel that would otherwise require patenting. It is the predominate method used in North America to produce controlled cooled wire rods.

Sulfur – Increased sulfur content in steel lowers transverse ductility and notched impact toughness, but has only a slight effect on longitudinal mechanical properties. Weldability decreases with increasing sulfur. Sulfur is very detrimental to surface quality, particularly in the lower carbon and lower manganese steels. For these reasons, a maximum sulfur content is generally specified for most steels.

Wire Rods – A Hot rolled semi-finished round product Produced in coils of one continuous length. Intended primarily for the manufacture of wire.

Wire Rod Quality Descriptors –

Chain Quality Wire Rods – Wire rods for the manufacture of wire intended to be used to produce electric-resistance welded chain. Good butt-welding and uniformity of internal soundness are essential for this product.

Cold Finishing Quality Wire Rods – Are intended for the manufacture of cold drawn bars. The rods are expected to be substantially free from slivers, laps and abrupt changes in section, which can impair the desired appearance of the cold drawn bars.

Cold Heading Quality Wire Rods – Wire rods used for heading, forging or cold extrusion. These wire rods are produced by closely controlled manufacturing practices and frequently are subject to mill testing and inspection to ensure internal soundness and freedom from surface defects, which may adversely affect the cold heading process.

Concrete Reinforcement Wire Rods – Are smooth wire rods without re-bar type surface deformations. They are produced from steel of chemical compositions selected to meet the mechanical properties as described in ASTM A615 for Grade 40 and Grade 60 or ASTM A615M for Grade 300 and Grade 400. These rods are produced in coils.

Fine Wire Quality Wire Rods – Are suitable for direct drawing from 7/32" (5.5 mm) into wire sizes as fine as 0.035" without intermediate annealing. These rods are generally rolled from the steel grades 1005 and 1006.

High Carbon and Medium Carbon – These types of wire rods are intended to be drawn into wire for use in products such as tire bead wire, upholstery springs, mechanical springs, wire rope, screens, ACSR core wire, pre-stressed concrete wire, and strand. This class of wire rods is not intended for use in the higher quality wire commodities such as music wire or valve spring wire.

Industrial or Standard Quality Wire Rods – Are produced from low or medium low carbon steel and are generally intended for drawing into industrial, merchant or standard quality wire. Rods of this type are usually available as rolled, or in thermally treated conditions. Generally speaking there are practical limitations on drawing this quality of steel rods without intermediate annealing. As an example, low carbon rods starting at 7/32" (5.5 mm) can be drawn to 0.80" in five drafts without annealing. See *Fine Wire Quality Wire Rods*

Lead – Can be specified in most steels to improve it machining characteristics.

Medium Carbon and High Carbon – These types of wire rods are intended to be drawn into wire for use in products such as tire bead wire, upholstery springs, mechanical springs, wire rope, screens, ACSR core wire, pre-stressed concrete wire, and strand. This class of wire rods is not intended for use in the higher quality wire commodities such as music wire or valve spring wire.

Mesh Quality Wire Rods – Are generally produced from low or medium low carbon steel and are intended for drawing or cold rolling into smooth or deformed wire, which will subsequently be

cross-wire resistance welded in to wire mesh for use as concrete reinforcement. Rods of this type are usually available as rolled and are frequently mechanically de-scaled in-line with the rolling or wire drawing process. Generally speaking there are practical limitations on drawing this quality of steel rods without intermediate annealing. As an example, low carbon rods starting at 7/32" (5.5 mm) can be drawn to 1.06" (2.69 mm) in four drafts without annealing. See ASTM A82 0r ASTM A496

Music Spring Wire Quality Wire Rods – These are high carbon wire rods with restrictive requirements for chemical analysis, cleanliness, segregation, decarbonization and surface defects. This steel is intended to be drawn into wire that can be manufactured into springs subject to high stress that require good fatigue properties. Steel grade 1086 with a restricted chemistry is usually used to produce music and spring quality wires.

Scrapless Nut Quality Wire Rods – Wire rods that are used to produce wire for Scrapless nuts. Rods for Scrapless nuts are supplied in low-carbon, re-sulfurized and aluminum killed non re-sulfurized steels. The wire rods are produced to be free from detrimental segregation, and surface imperfections. The steel must have satisfactory cold-heading, cold expanding, cold punching, and threading and tapping characteristics. It is customary to order this type of steel to a specified sulfur range.

Standard or Industrial Quality Wire Rods – Are produced from low or medium low carbon steel and are generally intended for drawing into industrial, merchant or standard quality wire. Rods of this type are usually available as rolled, or in thermally treated conditions. Generally speaking there are practical limitations on drawing this quality of steel rods without intermediate annealing. As an example, low carbon rods starting at 7/32" (5.5 mm) can be drawn to 0.80" in five drafts without annealing. See *Fine Wire Quality Wire Rods*

Thermal Treatment – Involves heating and cooling the steel in such a manner as to achieve desired properties or structures.

Tire Cord Quality Wire Rods – Are high carbon wire rods with restrictive requirements for chemical analysis, cleanliness, segregation, de-carbonization and surface imperfections. This steel is intended to be drawn into very fine wire (0.006" to 0.015") buy employing a series of patenting process steps. Multiple fine wires are then taken to be bunched (twisted) into tire cord used for the manufacure of "steel belted" radial automobile tires. Special rod and steel making practices are used to prevent non-deformable inclusions lager than 5 microns in size. Tire cord quality wire rods are usually supplied "austenitic coarse grain" in steel Grade 1069 with restrictions on carbon and manganese ranges. Steel Grades 1075 and 1080 are also commonly used to produce high strength tire cords.

Welding Quality Wire Rods – Are produced with care to provide for electric arc welding, gas welding, submerged arc welding and metal inert gas welding. These rods are generally supplied from low or medium-carbon killed steel. Rods for welding are produced as restricted chemistry steels. The chemical composition for wire rods used for welding wires must be established for each application. Additional requirements for the rods include that precautions are taken to prevent detrimental segregation, so that uniform steel compositions are obtained.