

TUBING TERMS

Alloy Steel

All steels contain carbon and small amounts of silicon, sulfur, manganese and phosphorous. Steels which contain intentional additions of elements other than these, or in which silicon and manganese are present in large amounts for the express purpose of improving or altering any of the physical or mechanical properties of the steel, are termed alloy steels.

Annealing

See heat treatment.

Austenitic Stainless Steel

Low carbon, iron-chromium nickel stainless alloys containing more than 16% chromium with sufficient nickel to provide an austenitic structure at normal temperatures. These alloys cannot be hardened by heat treatment, but can be hardened by cold working. They are normally non-magnetic, but can be slightly magnetic depending upon the composition and amount of cold working.

Average wall

See dimensions.

Bevel

An angular cut on the I.D. or O.D. of a tube end.

Borescope

An optical device used for inspecting under low magnification in of the inside surface of tubes.

Brinell Hardness

See hardness

Camber

The amount of curvature or deviation from exact straightness over any specified length of tubing.

Carbide

A compound consisting of carbon and other elements.

Carbide Precipitation

The phenomenon of carbides coming out of a solid solution, occurring in stainless steel when heated into the range of 800-1600 degrees Fahrenheit.

Carburizing

Adding Carbon to the surface of iron-base alloys by heating the metal below its melting point in contact with carbonaceous solids, liquids or gases. Desired hardness and toughness properties are developed in the high carbon “case” by quenching and tempering.

Case Hardening

A heat treatment in which the surface (case) of an iron-base alloy is made harder than the interior (core). Any of the following methods may be employed: flame hardening, induction hardening, carburizing, cyaniding or nitriding.

Chloride Stress Cracking

See Stress Corrosion Cracking

Cleanup

The amount of metal removal required to obtain desired dimensions and complete removal of inherent surface imperfections.

Coefficient of Thermal Expansion

A physical property value representing the change in length per unit length, the change in area per unit area, or the change in volume per unit volume per one degree increase in temperature.

Cold Drawing

A process in which tubing is drawn at room temperature through a die and over a mandrel to achieve its final size and to provide better surface finish, closer tolerances, lighter walls, smaller diameters, longer lengths, or a different combination of mechanical properties from those possible through hot finishing or direct welding.

Cold Reduction

The reduction of sectional dimensions of a tube by any of a number of types of cold-working operations.

Cold Sinking

Similar to cold drawing, except that the tube is drawn through a die, but without an internal mandrel. Usually used only for making heavy wall or small tubing, where drawing over a mandrel is impractical. Only outside diameter is closely controlled.

Cold Working

Permanent plastic deformation of a metal below its recrystallization temperatures.

Conditioning

The removal of surface defects (seams, laps, pits, etc.) from steel. Conditioning is usually done when the steel is in semi-finished condition (bottom, billet, slab). It may be accomplished after an inspection, by chipping, scarfing, grinding, or machining.

Copper-Copper Sulfate Test

An intergranular corrosion test for stainless steels. The specimen is placed in boiling copper-copper sulfate-sulfuric acid for 24 hours after which it is bent to expose any surface intergranular attack. This test is often preferred over the Huey test because it requires much less time.

Corrosion

Chemical or electrochemical deterioration of a metal or alloy

Galvanic Corrosion – Corrosion associated with the presence of two dissimilar metals in a solution (electrolyte). In principle, it is similar to bath-type plating in the sense that the anode surface has lost metal (corroded).

Integrinular Corrosion – Corrosion which occurs preferentially along the grain boundaries of the alloy.

Pitting Corrosion – Non-uniform corrosion usually forming small cavities in the metal surface.

Corrosion Resistance

The ability to resist attack by Corrosion

Creep Strength

The constant nominal stress that will cause a specified quantity of creep in a given time at a constant temperature. It is a measure of a tube's ability to withstand prolonged stress or load without significant continuous deformation. In steels it is an important factor only at elevated temperatures.

Cut Length

Refers to tubing ordered to a specified length and permitting a tolerance of a standardized fraction of an inch over but nothing under the specified length.

Decarburization

The loss of carbon from the surface of an iron-base alloy as the result of heating in an environment which removes the carbon in medium or high carbon steels decarburization leads to a pronounced lowering of the fatigue limit.

Density

The mass per unit volume of a substance, usually expressed in the tubing industry in pounds per cubic inch.

Die Line

A longitudinal depression or protrusion formed on the surface of drawn or extruded material due to imperfections on the die surface.

Dimension

O.D. – Outside Diameter. Specified in inches and fractions of an inch, or inches and decimals of an inch.

I.D. – Inside Diameter. Specified in the same units as the O.D.

Mean Diameter – The average of two measurements of the diameter taken at right angles to each other.

Wall – Wall Thickness or Gage. Specified in either fractions or decimals of an inch or by a “wire gage” number in the United States, the most common gage used for tubing is the Birmingham wire gage, designated B.W. G.

Nominal – The theoretical or stated value of the O.D., I.D., or wall dimension as specified by the customer.

Maximum and Minimum – The dimensions resulting after applying the proper tolerances to the nominal dimensions.

Minimum Wall – Generally, the lightest wall permitted within specified tolerances. A minimum wall tube is one whose wall thickness is not permitted to fall below the specified nominal measurement.

Average Wall – A tube whose wall thickness is permitted to range over and under the specified nominal wall measurement within certain defined tolerances.

Mean Wall – The average of two measurements of the wall thickness of a tubular product taken opposite each other.

Ductility

The ability of a tube to deform plastically. Frequently, elongation during tensile testing is used as a measurement of this property.

Dye Penetrant Inspection

Non-destructive test employing dye or fluorescent chemical and sometimes black light to detect surface defects.

The displacement of the I.D. of the tube with respect to its O.D. i.e. Deviation from a common center. The permissible degree of eccentricity can be expressed by a plus or minus wall-thickness tolerance.

Eddy Current

Non-destructive testing method using eddy current flow for the purpose of recognizing a discontinuity in the piece being tested.

Elastic Limit

A measure of the maximum stress that may be applied to a tube without leaving a permanent deformation of strain after the stress is released.

Electrical Conductivity

The capability of a material to conduct electric current. For aluminum, this capacity is expressed as a percentage of the international Annealed Copper Standard which has a resistivity of $1/58 \text{ ohm/mm}^2$ metre at 20C and an arbitrarily designed conductivity of unity.

Electric Furnace Process

One of the common methods used for melting and refining stainless and some alloy steels. It involves the use of electric power as the sole source of heat, thereby preventing contamination of the steel by impurities in the fuel as in other melting processes.

Electric Resistance Welded Steel Tube

Tubing made from strip, sheet or bands by electric resistance heating and pressure, the strip being part of the electrical circuit. The electric current, which may be introduced into the strip through electrodes or by induction, generates the welding heat through the electrical resistance of the strip.

As Welded Hot Rolled – EWR tubing exhibiting the pickled or shot blasted surface of hot rolled strip.

As Welded Cold Rolled – EWR tubing exhibiting the surface of cold rolled strip.

As Drawn – Tubing is unheat-treated, cold drawn tubing and has a scale free cold drawn surface.

Bright Annealed – Welded tubing normalized in a controlled atmosphere furnace and which exhibits a bright surface.

Pickled – Tubing has had the scale from hot fabrication or heat treatment removed by one of several types of acid solutions.

Gun Metal Finish – Welded tubing normalized, annealed, or stress relieved in a controlled atmosphere furnace, which exhibits a gunmetal finish.

Flash-In Tubing – Is weld tubing, which still retains the I.D. bead, or flash formed during the welding operation. It can be furnished in either the as-welded, sunk, or heat-treated condition.

Flash-Removed – Welded tubing from which the I.D. flash formed during the welding operation has been removed by some mechanical method. It can be furnished in either the as-welded, sunk, or heat-treated condition.

Special Smooth I.D. – A cold drawn tube in which special attention is paid to the internal surface. Depth of pits and scores in I.D. are guaranteed to be below published maximum depths. Micro inch finish is guaranteed in ERW tubes.

Electrical Resistivity

The electrical resistance of a body of unit length and unit cross-sectional area or weight. The value of 1/58 ohm-mm (2) metre at 20C is the resistivity equivalent to the International Annealed Copper Standard (IACS) for 100 percent conductivity.

Elongation

The amount of permanent stretch, usually referring to a measurement of a specimen after the fracture in a tensile test. It is expressed as a percentage of the original gage length.

Endurance Limit

The maximum stress below which a material can presumably endure an infinite number of stress cycles.

Etch Test

Exposure of a specimen to acid attack for the purpose of disclosing the presence of foreign matter, defects, segregation pattern, or flow lines.

Extrusion Seam

A seam in aluminum tube, pipe, or hollow shape resulting from the pressure bonding at two or more edges in the course of extruding through a bridge/porthole die.

Fatigue Limit – (Synonymous with Endurance Limit)

Ferritic Stainless Steels

The designation used for certain straight chromium steels which exhibit microstructures consisting mainly of ferrite at ordinary temperatures. Ferritic stainless steels are divided into two classifications; hardenable and

non-hardenable. When rapidly cooled from elevated temperatures the non-hardenable grades (ferritic) have a ferritic microstructure. The hardening grades (martensitic) will exhibit a martensitic microstructure when rapidly cooled.

Finish

Refers to the type of surface condition desired or existing in the finished tubular product.

Finish Anneal – See Heat Treatment

Finish Machine Size

Normally specified in terms of the maximum machined O.D. and the minimum machined I.D. as applied to tubular parts. Finish machine size represents the size of the part as it comes from the final machining operation. From this size the tube mill can calculate a tube size, which will be guaranteed to cleanup upon machining.

Flame Hardening

A process of heating the surface layer of an iron-base alloy above the transformation temperature range by means of the flame of a high temperature torch, followed by quenching.

Flanged End

In a flanged end, the tube has been belled or expanded and a flange turned over until the wall of the tube end is at right angles to the wall of the tube.

Flash-in Tubing

See Electric Resistance Welded Tubing

Flash Removed

See Electric Resistance Welded Tubing

Flux Leakage Test

Non-destructive test, which uses magnetic lines of force to recognize any discontinuity in the test piece.

Forging

Used as a general term to describe the rolling, pressing or hammering of steel, which displaces the metal under compression by a local applied force, usually at hot working temperatures.

Fracture Strength

As usually related to the tensile test, fracture strength or true breaking strength is defined as the load on the specimen at the time of fracture

Full Anneal – See Heat Treatment

Full Finished

Refers to stainless tube in which the weld has been processed to produce uniform strength and dimensions and subsequently annealed to obtain proper corrosion resistance.

Gages, Gauges

A measurement of thickness. There are various standard gages such as United States Standard Gage (USS), Galvanized Sheet Gage (GSG), Birmingham Wire Gage (BWG).

Grain Size

A measurement of the size of individual metallic crystals usually expressed as an average. Grain size is reported as a number in accordance with procedures described in ASTM grain size specifications.

Apparent Ferrite Grain Size – is the average of the size of the ferrite grains as microscopically viewed in the normalized or annealed condition.

Austenitic Grain Size – which is usually measured by the McQuaid-Ehn method, represents the austenitic grain size of a material at a prescribed temperature above the upper critical, frequently 1700 degrees Fahrenheit. For austenitic stainless steels the grain size does not change upon cooling and is that observed microscopically at room temperature.

Hardenability

The property in steel that determines the depth and distribution of hardness induced by cooling from a suitable elevated temperature. The hardness can vary with the cooling rate.

Hardness

A measure of the degree of a material's resistance to indentation. It is usually determined by measuring resistance to penetration by such tests as Brinell, Rockwell and Vickers.

Heat Analysis

Formerly known as ladle analysis

Heat Treatment of Steel

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. See various types below.

Age hardening – An aging process that increases hardness and strength. Ordinarily ductility decreases. Age hardening usually follows rapid cooling or cold working. Hardening is a result of a precipitation process, often sub-microscopic, which occurs when a supersaturated solid solution is naturally aged at atmospheric temperature or artificially aged in some specific range of elevated temperature. Aging occurs more rapidly at higher temperatures (Synonymous with precipitation hardening)

Air Hardening – Heating a suitable grade of steel with high hardening ability above the critical temperature range and then cooling in air for the purpose of hardening.

Anneal – The annealing process is a combination of a heating cycle, a holding period, and a controlled cooling cycle. Annealing is used to obtain a variety of results, among which are: to soften or alter the grain structure of steel, to develop formability, machinability, and required mechanical properties, or to relieve residual stresses. The temperatures and cooling rates used depend on which results are desired. It is generally desirable to use more specific terms in describing the anneal.

Bright Anneal – Carried out in a controlled furnace atmosphere, so that surface oxidation is reduced to a minimum and the tube surface remains relatively bright.

Dead Soft Anneal – A heat treatment applied to achieve maximum softness and ductility.

Finish Anneal – See stress relief anneal.

Full Anneal – Heating to a temperature above the upper critical (above 1650 degrees Fahrenheit) and slow cooling below the lower critical, usually in a furnace.

Soft Anneal – When maximum softness and ductility are required without change in grain structure, tubing should be ordered soft annealed. This process consists of heating to a temperature slightly below the critical temperature and cooling in still air. Usually performed in 1250-1350 degrees Fahrenheit range for carbon steel.

Solution Anneal – heating steel into a temperature range wherein certain elements or compounds dissolve, followed by cooling at a rate sufficient to maintain these elements in solution at room temperature. The expression is normally applied to stainless and other special steels.

Spherodizing Anneal – A treatment applied to austenitic stainless steels wherein carbides of various forms are deliberately precipitated. Sufficient

additional time is provided at the elevated temperature to diffuse chromium into the areas adjacent to the carbides (usually grain boundaries). This treatment is intended to lessen the chance of intergranular corrosion.

Stress Relief Anneal – Often referred to as “finish annealing” involves heating to a suitable temperature, holding long enough to reduce residual stresses and then cooling slowly enough to minimize the development of new residual stresses. Stress relieving normally takes place in the 950 degrees Fahrenheit – 1150 degrees Fahrenheit temperature range for carbon steels.

Normalize – Normalizing is a process, which consists of heating to a temperature approximately 100 degrees Fahrenheit.

Quenching – A process of rapid cooling from an elevated temperature by contact with liquids or gases. Quenched hardenable steels usually are extremely brittle and are not suitable for use unless subsequently tempered.

Tempering – Reheating quenched or normalized steel to a temperature below the transformation range (lower critical) followed by any desired rate of cooling. Tempering reduces brittleness and develops the desired hardness, structure and properties.

Huey Test

A corrosion test for stainless steels. The weight loss per unit area is measured after each of the five 48-hour boils in 65% nitric acid. The test results are calculated to and reported as the average corrosive rates of the five oils in inches per month (ipm) corrosion rates. The test is used to determine the suitability of a material for nitric acid service. Since most of the weight loss is due to intergranular attack, the Huey test can be used as an indication of the resistance of a stainless steel to intergranular corrosion.

Impact Test

There are several methods of determining the toughness of a steel, but the izod and Charpy notched-bar tests are used quite widely. In both tests, the samples are cooled or heated to the desired test temperature, then struck once with a pendulum, which fractures the specimen. The energy required to fracture the specimen, the impact strength, is measured in foot-pounds.

Inclusions

Particles of nonmetallic impurities usually oxides, sulphides, silicates, which are mechanically held in metals and alloys during solidification.

Ingot

A cast metal shape suitable for subsequent rolling or forging.

Intergranular Corrosion

A type of electrochemical corrosion that progresses preferentially along the grain boundaries of an alloy, usually because the grain boundary regions contain material anodic to the central regions of the grain.

Internal Soundness

Refers to condition of inside of material – lack of defects, pipe segregation, non-uniformity of composition.

Isothermal Anneal – See Heat Treatment

Izod Impact Test – See Impact Strength Testing

Jominy Test

Hardenability test performed usually on alloy steels to determine depth and degree of hardness resulting from a standard end quenching method with cold water.

Killed Steel

Steel deoxidized with an agent such as silicon or aluminum to reduce the free oxygen content so that no harmful reaction occurs between carbon and oxygen during solidification.

Ladle

A large vessel in which molten steel or molten slag is received and hardened.

Ladle Analysis

Chemical analysis obtained from a sample taken during the pouring of the steel, i.e. heat analysis.

Laminations

Defects resulting from the presence of blisters, seams, or foreign inclusions aligned parallel to the worked surface of a metal.

LAP

A surface defect caused from folding the surface of an ingot, bloom or bar during hot rolling operations and then rolling or forging the fold into the surface.

Machinability

A measure of the relative ease with which steel may be machined.

Machining

The deliberate removal of metal by one or more of several processes.

Macrotech

A testing procedure for locating and identifying porosity, pipes burst, unsoundness, inclusions, segregations, carburization, flow lines from hot working, etc. Surface of the test piece should be reasonably smooth or even polished. After applying a suitable etching solution, the structure developed by the action of the reagent may be observed without a microscope.

Magnaflux Test

This test is conducted by suitable magnetizing the material and applying a prepared wet or dry magnetic powder or fluid, which adheres to it along lines of flux leakage. It shows the existence of surface and slightly subsurface non-uniformities.

Malleability

The property that determines the ease of deforming a metal when the material is subjected to rolling or hammering. The more malleable metals can be hammered or rolled into thin sheet more easily than others.

Mandrel

(1) A device used to retain the cavity in hollow metal products during working. (2) A metal bar around which other metal may be cast, bent, formed or shaped.

Maraging

A process of improving the mechanical strength of certain ferrous alloys. The name was derived from two hardening reactions: martensite and aging. The maraging strengthening mechanism is based on the age hardening (precipitation hardening) of extra-low carbon martensite.

Martensite

A constituent in quenched steel formed without diffusion and only during rapid cooling below the martensitic start (M_s) temperature. Martensite is the hardest of the transformation products of austenite.

McQuaid-Ehn Test

A special test for revealing the austenitic grain size of ferritic steels when the steel is heated to 1700 degrees Fahrenheit and carburized. There are eight standard McQuaid-Ehn grain sizes – sizes 5 to 8 are considered fine grain and sizes under 5 are considered coarse grain.

Mechanical Properties

Those properties of a material that reveal the elastic and in-elastic reaction when force is applied, or that involve the relationship between stress and strain—for example, the modulus of elasticity, hardness, tensile strength, and fatigue limit. These properties have often been referred to as “physical properties” but the term “mechanical properties” is correct.

Mechanical Tubing

Used for a variety of mechanical and structural purposes, as opposed to pressure tubing, which is used to contain or conduct fluids or gases under pressure. It may be hot finished or cold drawn. It is commonly manufactured to consumer specifications covering the chemical analysis and mechanical properties.

Metallography

The science dealing with the constitution, and structure of metals and alloys as revealed by the unaided eye or by such tools as low powered magnification, optical microscope, electron microscope, and diffraction or X-Ray techniques.

Microcleanliness

Refers to the extent or quality of nonmetallic inclusions observed by examination under a microscope.

Micro-etch

Micro-etching is used for the examination of a sample under a microscope. Etching solutions tend to reveal structural details because of preferential chemical attack on the polished surface.

Minimum Wall

Any wall having tolerances specified all on the plus side.

Modulus of Elasticity

The ratio of stress applied to a material and the resulting strain occurring at the stresses below the elastic limit.

Nitriding

A process of case hardening in which a ferrous alloy, usually of special composition, is heated in an atmosphere of cracked ammonia or in contact with nitrogenous material to produce surface hardening without quenching by the absorption of nitrogen. Nitriding is normally conducted in a range from 900 to 1000 degrees Fahrenheit.

Non-Destructive Testing

Methods of detecting defects without destroying or permanently changing the material being tested. Test methods include ultrasonic, eddy current, flux leakage, magnetic particle, liquid penetrant and X-Ray.

Notch Brittleness

Susceptibility of a material to brittle fracture at points of stress concentration.

Notch Sensibility

A measure of the reduction in strength of a metal caused by the presence of stress concentration.

Ovality

The difference between the maximum and minimum outside diameters of any one cross section of a tube. It is a measure of deviation from roundness.

Oxalic Acid Etch Test

A quick metallographic test which is sometimes used to screen stainless steels before intergranular corrosion testing. This test is specified with a referee test such as the Copper-Copper Sulfate or Huey Test.

Oxidation

In its simplest terms, oxidation means the combination of any substance with oxygen. Scale developed during heat treatment is a form of oxidation.

Oxide

A compound consisting of oxygen and one or more metallic elements.

Passivate

The changing of the chemically active surface of a metal to a much less active state by the application of the proper chemical treatment or by applying an induced electrical current and voltage for cathodic or anodic protection from corrosion. An example of chemically passivating stainless steel would be to immerse stainless in a hot solution of approximately 10 to 20 percent by volume nitric acid and water.

Photomicrograph

A photographic reproduction of an object magnified more than ten times used to show microstructure characteristics of steel.

Physical Properties

Those properties not specifically related to reaction to external forces. These include such properties as density, electrical resistance, co-efficient of thermal conductivity.

Pickling

Use of solutions, usually acids, to remove surface oxides from a tube, may also be used to produce a desired surface finish.

Piercing

A seamless tubemaking method in which a hot billet is gripped and rotated by rolls or cones and directed over a piercer point which is held on the end of a mandrel bar.

Pit

A sharp, usually small, depression in the surface of metal.

Porosity

Unsoundness caused in cast metals by the presence of blowholes or shrinkage cavities.

Profilometer

An instrument used for measuring surface finish. The vertical movements of a stylus as it traverses the surface are amplified electromagnetically and recorded (or indicated) as the surface roughness.

Proof Stress

The load per square inch of the original cross-sectional area which, when removed, has caused a permanent elongation not exceeding a defined amount (usually 0.0001" per inch of gage length). A test of this type is more commonly used in Europe than in this country, where it largely has been rejected by yield strength measurements.

Quenching

See heat treatment.

Random Length

Tubing produced to a permissible variation in length. (Frequently seven feet).

Recrystallization

The reversion of distorted cold worked microstructure to a new, strain-free structure during annealing.

Reduction of Area

A measure of ductility determined in a tensile test. It is the maximum reduction, at the fracture, of the cross section area of a specimen, as compared with its original cross section area.

Rimmed Steel

A steel which forms a relatively clean outer layer (rim) during solidification. Sheet and strip made from such steel has good surface quality and is frequently used for ERW tubing.

Rockwell Hardness

See Hardness.

Roto-Rock (Tube Reducing or Rockrite)

A method of cold finishing tubing in which a machine rolls or rocks a split die over a tube. The tube is supported on the inside by a tapered mandrel.

Scale

An oxide of iron, which forms on the surface of hot steel.

Seam

A tight, but unwelded imperfection on the surface of a wrought metal product.

Segregation

Nonuniform distribution of alloying elements, impurities, or microphases.

Semi-Killed Steel

Steel that is incompletely deoxidized to permit the evolution of carbon monoxide, thereby offsetting solidification shrinkage.

Sensitization

Sensitization of stainless steel is defined as a susceptibility to preferential grain boundary attack. Material which exhibits grain boundary carbide precipitation may or may not be sensitized.

Special Smooth I.D. (SSID) – See Electric Resistance Welding Tubing

Specification

A document defining the measurements, tests, and other requirements to which a product must conform—typically covering chemistry, mechanical properties, tolerances, finish, reports, marking and packaging.

Spheroidize Anneal

See Heat treatment

Spinning

A type of forming (hot or cold) which involves rotating a tube at a high speed against fixed or rolling tools for the purpose of altering shape, size, etc.

Stabilizing Anneal -See Heat Treatment

Strain

A measure of the change in size or shape of a body under stress, referred to its original size and shape.

Strain Hardening

Modification of metal structure by cold working resulting an increase in strength and hardness with loss of ductility.

Stress

Force per unit of area measured in pounds per square inch (ps). The three kinds of stresses are tensile, compressive, and shear. Flexure involves a combination of tensile and compressive stress. Torsion involves shear stress.

Stress Corrosion Cracking

Cracking of metals under combined action of temperature, corrosion and stress. The stress can be either applied or residual. Austenitic stainless steels are especially susceptible to cracking in chloride containing and some caustic environments.

Stress Relief Anneal – See Heat Treatment

Strip

A flat-rolled steel product which serves as the raw material for welded tubing.

Sunk or Sink Drawn

Tubing drawn through a die with no inside mandrel to control I.D. or wall thickness.

Swaged

A mechanical reduction of the cross sectional area of a metal performed hot or cold by forging, pressing or hammering.

Tapping

The act of pouring molten metal from a furnace into a ladle.

Teeming

Act of pouring molten metal from a ladle into an ingot mold.

Tempering – See Heat Treatment

Tensile Strength

The maximum load per square inch of original cross-sectional area carried during a tension test to failure of the specimen. This term is preferred over the formerly used ultimate strength.

Thermal Conductivity

A measure of the ease with which heat is transmitted through a material.

Tolerance

Permissible variation.

Torsion

A twisting action resulting in shear stresses and strains.

Toughness

A measure of ability to absorb energy and deform plastically before fracturing.

Transformation Temperature

The temperature at which a change in phase occurs in steels. The term is sometimes used to denote the limiting temperature of a transformation range.

Traverse Tension Test

A tension test for evaluating mechanical properties of material in a direction transverse to that of rolling.

Turning

A method for removing the surface from a work piece by bringing the cutting edge of a tool against it while the piece or tool is rotated.

Ultimate Strength – See tensile strength

Ultrasonic Testing

The method of detecting defects in tubes or welds by passing high frequency sound waves into a material then monitoring and evaluating the reflected signals.

Upsetting

A metalworking operation similar to forging generally used to thicken the ends of tubes prior to threading.

Vickers Hardness Test – See Hardness

Work Hardening

Hardness developed in metal as a result of cold working. See cold working.

Yield Point

The first stress in a material measured as load per unit of original cross-sectional area at which an increase in strain occurs without an increase in stress.

Yield Strength

The stress at which a material exhibits a specified deviation from proportionality of stress and strain. An offset of 0.2% is most frequently used.