

XII. Glossary

Advanced Squarewave: The advanced AC output available from certain types of power sources. The wave is much more square than the conventional Squarewave power source. It also has expanded balance control to 90% electrode negative (max penetration) and the ability to control arc frequency (arc direction). Some have the additional ability to adjust the amount of current in the electrode negative and electrode positive cycles independently.

Air Carbon Arc Cutting: A cutting process by which metals are melted by the heat of an arc using a carbon electrode. Molten metal is forced away from the cut by a blast of forced air.

Alternating Current (AC): An electrical current that reverses its direction at regular intervals, such as 60 cycles alternating current (AC), or 60 hertz (Hz).

Amperage: The measurement of the amount of electricity flowing past a given point in a conductor per second. Current is another name for amperage.

Annealing: The opposite of hardening. A heat treating process used to soften a metal and relieve internal stresses.

Anodize: To anodize aluminum is to coat the metal by either chemical or electrical means. The coating provides improved corrosion and wear resistance. The thickness of this coating depends upon the length of the treatment. This coating is often removed from the area to be welded. This coating can be reapplied after welding.

Arc: The physical gap between the end of the electrode and the base metal. The physical gap causes heat due to resistance of current flow and arc rays.

Arc Length: Distance or air space between the tip of the electrode and the work.

Arc Voltage: Measured across the welding arc between the electrode tip and the surface of the weld pool.

Asymmetric Waveform: The output waveform of a welding power source that has the ability to modify both the amplitude and duration of the positive and negative half cycles of alternating current.

Autogenous Weld: When a TIG weld is made without the addition of filler metal.

Automatic Welding (AU): Uses equipment which welds without the constant adjusting of controls by the welder or operator. Equipment controls joint alignment by using an automatic sensing device.

Axis of Weld: Can be thought of as an imaginary line through the center of a weld, lengthwise.

Back Gouging: The removal of weld metal and base metal from the other side (root side) of a weld joint. When this gouged area is welded, complete penetration of the weld joint is assured.

Balanced Wave: An alternating current waveform that has equal negative and positive polarity current values.

Bevel Angle: An angle formed between a plane, perpendicular to the surface of the base metal and the prepared edge of the base metal. This angle refers to the metal that has been removed.

Butt Joint: A weldment where the material surfaces and joining edges are in or near the same plane.

Carbide Precipitation: Occurs when austenitic stainless steel is heated within a temperature range of 800°–1600° F, 427°–870° C for a critical period of time. Carbon moves from a solid solution to grain boundaries and combines with chromium. The metal adjacent to the grain boundaries is left with less chromium and is said to be sensitized. Corrosion resistance is therefore reduced in the grain boundary region. See Figure 12.1.

Carbon Arc Gouging: A cutting process by which metals are melted by the heat of an arc using a carbon electrode. Molten metal is forced away from the cut by a blast of forced air.

Cerium Tungsten: GTAW tungsten electrode with small amount of the rare earth and nonradioactive ceria added. Improves arc starting and provides for use of wider current range.

Characteristics: Special qualities or properties. For instance, some welding machines have certain internal characteristics which allow a welder to perform more welding applications than with other welding machines.

Circuit: The complete path or route traveled by the electrical current. A circuit for GTAW can include the welding machine, weld cables, torch assembly, arc, base metal and work clamp with cable.

Cold Lap: See preferred term Incomplete Fusion.

Conductor: An electrical path where current will flow with the least amount of resistance. Most metals are good electrical conductors.

Constant Current (CC) Welding Machine: These welding machines have limited maximum short circuit current. They have a negative volt-amp curve and are often referred to as “droopers”. The voltage will change with different arc lengths while only slightly varying the amperage, thus the name constant current or variable voltage.

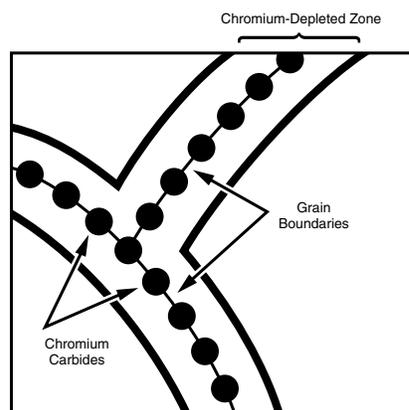


Figure 12.1 Carbide precipitation.

Constant Voltage (CV), Constant Potential (CP) Welding

Machine: “Potential” and “voltage” are basically the same in meaning. This type of welding machine output maintains a relatively stable, consistent voltage regardless of the amperage output. It results in a relatively flat volt-amp curve as opposed to the drooping volt-amp curve of a typical GTAW (TIG) welding machine.

Consumable Insert: Preplaced filler metal that is completely fused into the joint root and becomes part of the weld.

Contact: An electrical switch that is used to energize or de-energize output terminals of a welding machine. In some types of welding machines they can be of solid state design, with no moving parts and thus no arcing of contact points.

Corner Joint: Produced when the weld members meet at approximately 90° to each other in the shape of an “L”.

Crater: A depression at the end of a weld bead.

Current: Another name for amperage. The amount of electricity flowing past a point in a conductor every second.

Current Density: The amount of current per square inch of cross-sectional area in an electrode. For any electrode diameter, find the current density by dividing the current value by the electrode cross-sectional area in square inches.

Cycle: One cycle equals 360 electrical degrees. For alternating current, current flow is in one direction through a circuit for 180° and in the opposite direction for the other 180°. For 60 cycle power, a cycle is repeated 60 times per second. Some welding machines, especially outside the United States, require 50 cycle (hertz) power. Hertz stands for cycles per second.

Defect: One or more discontinuities that exceed the acceptance criteria as specified for a weld.

Depth of Fusion: The depth or distance that deposited weld metal extends into the base metal or the previous pass.

Direct Current: Flows in one direction and does not reverse its direction of flow as does alternating current.

Direct Current Electrode Negative (DCEN): The specific direction of current flow through a welding circuit when the electrode lead is connected to the negative terminal and the work lead is connected to the positive terminal of a DC welding machine.

Direct Current Electrode Positive (DCEP): The specific direction of current flow through a welding circuit when the electrode lead is connected to a positive terminal and the work lead is connected to a negative terminal to a DC welding machine.

Discontinuity: Any change in a metal’s typical structure. It is the lack of consistence in mechanical, metallurgical or physical characteristics. Discontinuities are found in all metals and welds because they have some degree of inconsistency in them. However, this is acceptable as long as the discontinuities do not exceed the acceptance criteria of the weld or metal in question. If a discontinuity exceeds the acceptance criteria, they are defects and must be repaired.

Distortion: The warpage of a metal due to the internal residual stresses remaining after welding from metal expansion (during heating), and contraction (during cooling).

Duty Cycle: The number of minutes out of a 10-minute time period an arc welding machine can be operated at maximum rated output. An example would be 60% duty cycle at 300 amps. This would mean that at 300 amps the welding machine can be used for 6 minutes and then must be allowed to cool with the fan motor running for 4 minutes. (Some imported welding machines are based on a 5-minute cycle).

Edge Joint: A joint that occurs when the surfaces of the two pieces of metal to be joined are parallel or nearly parallel, and the weld is made along their edges.

Electrode Extension: While welding, the length of electrode extending beyond the end of the gas cup. Also referred to as electrical stickout.

Electron: A very small atomic particle which carries a negative electrical charge. Electrons can move from one place to another in atomic structures. It is electrons that move when electrical current flows in an electrical conductor.

Etching: When a weld specimen is cut through a weld, an acid or similar solution can be applied to the weld area to bring out the features of the weld. These include the deposited weld metal, heat affected zone, penetration and weld profile. Many different etching solutions and techniques exist for the various kinds of metals.

Excessive Melt-Through: A weld defect occurring in a weld joint when weld metal no longer fuses the base metals being joined. Rather, the weld metal falls through the weld joint or “burns through”. Also referred to as excess penetration.

Face: The surface of the weld as seen from the side of the joint on which the weld was made.

Face Rotation: Can be thought of as an imaginary line from the axis of the weld through the center of the welds face. This face rotation angle along with the axis angle determine the actual welding position. Face rotation is measured in a clockwise direction starting from the 6 o’clock position. A weld with the face rotation at 12 o’clock would have the face rotation at 180°.

Ferrous: Refers to a metal that contains primarily iron, such as steel, stainless steel and cast iron.

Filler Metal: The metal added when making a welded, brazed, or soldered joint.

Fillet Weld: A weld that is used to join base metal surfaces that are approximately 90° to each other, as used on T-joint, corner joint or lap joint. The cross sectional shape of a fillet weld is approximately triangular.

Fit-Up: Often used to refer to the manner in which two members are brought together to be welded, such as the actual space or any clearance or alignment between two members to be welded. Proper fit-up is important if a good weld is to be made. Tacking, clamping or fixturing is often done to ensure proper fit-up. Where it applies, base metal must be beveled correctly and consistently. Also, any root openings or joint angles must be consistent for the entire length of a joint. An example of poor fit-up can be too large of a root opening in a V-groove butt weld.

Flat Position: When welding is done from the top side of a joint, it is in the flat position if the face of the weld is approximately horizontal. Sometimes referred to as downhand welding. The axis angle can be from 0° – 15° in either direction from a horizontal surface. Face rotation can be from 150° – 210° .

Flux Cored Arc Welding (FCAW): An arc welding process which melts and joins metals by heating them with an arc between a continuous, consumable tubular electrode wire (consumable) and the workpiece. Shielding is obtained from a flux contained within the electrode's tubular core. Depending upon the type of flux-cored wire, added shielding may or may not be provided from externally supplied gas or gas mixture.

Freeze Lines: The lines formed across a weld bead. They are the result of the weld pool freezing. In appearance they sometimes look as if one tiny weld was continuously laid upon another.

Frequency: The number of double directional changes made by an alternating current in one second. Usually referred to as "hertz per second" or "cycles per second". In the United States, the frequency or directional change of alternating current is usually 60 hertz. Some Advanced Squarewave power sources allow the arc frequency to be adjusted. As arc frequency is increased the arc becomes more directional.

Gas Metal Arc Welding (GMAW): An arc welding process which joins metals by heating them with an arc. The arc is between a continuously fed solid filler wire (consumable) electrode and the workpiece. Externally supplied gas or gas mixtures provide shielding for GMAW. Sometimes called MIG welding (Metal Inert Gas) or MAG welding (Metal Active Gas).

Gas Nozzle: That part of the GTAW torch that directs the shielding gas flow over the weld area. Made of ceramic, glass, or metal in various styles.

Gas Tungsten Arc Welding (GTAW): Sometimes called TIG welding (Tungsten Inert Gas), it is a welding process which joins metals by heating them with a tungsten electrode which should not become part of the completed weld. Filler metal is sometimes used and argon inert gas or inert gas mixtures are used for shielding.

Groove Angle: When a groove is made between two materials to be joined together, the groove angle represents the total size of the angle between the two beveled edges and denotes the amount of material that is to be removed.

Ground Connection: A safety connection from a welding machine frame to the earth. Often used for grounding an engine driven welding machine where a cable is connected from a ground stud on the welding machine to a metal stake placed in the ground. See Work Connection for the difference between work connection and ground connection.

Ground Lead: When referring to the connection from the welding machine to the work, see preferred term Work Lead.

Heat Affected Zone (HAZ): The portion of a weldment that has not melted, but has changed due to the heat of welding. The HAZ is between the weld deposit and the unaffected base metal. The physical makeup or mechanical properties of this zone are different after welding.

Heat Sink: A good weld needs a certain amount of base metal to absorb the high heat input from the welding arc area. The more base metal, or the thicker the base metal, the better heat sink effect. If this heat sink is not present, too much heat will stay in the weld area, and defects can occur.

High Frequency: Covers the entire frequency spectrum above 50,000 Hz. Used in GTAW welding for arc ignition and stabilization.

Horizontal Position: Occurs when the axis of the weld is from 0° – 15° from the horizontal, and the face rotation is from either 80° – 150° or 210° – 280° for groove welds, or from either 125° – 150° or 210° – 235° for fillet welds.

Impedance: In electricity, impedance will slow down, but not stop, amperage flowing in a circuit. It is the resistance in an alternating current circuit. Impedance is the combination of the natural resistance to current flow in any conductor and the inductive or capacitive reactance in an electric circuit. It is brought about by the building and collapsing field of alternating current. This building and collapsing induces a counter electromotive force (CEMF) (voltage) that holds back, but does not stop, current flow.

Included Groove Angle: See preferred term Groove Angle.

Incomplete Fusion: Molten filler metal rolling over a weld edge but failing to fuse to the base metal. Also referred to as cold lap.

Inductance: Inductance (an inductor) will slow down the changes in current, as if the electrons were sluggish.

Inert Gas: A gas that will not combine with any known element. At present 6 are known; argon, helium, xenon, radon, neon, and krypton. Only argon and helium are used as shielding gases for welding.

Inverter: Power source which increases the frequency of the incoming primary power, thus providing for a smaller size machine and improved electrical characteristics for welding, such as faster response time and more control for waveshaping and pulse welding.

Joint Design: A cross-sectional design and the given measurements for a particular weld. Generally includes included angles, root opening, root face, etc.

Joint Root: That part of a joint that comes closes together where the weld is to be made. This maybe an area of the joint or just a line or point of that joint.

Lanthanum Tungsten: GTAW tungsten electrode with small amount of the rare earth and nonradioactive lanthana added. Improves arc starting and provides for use of wider current range.

Lap Joint: A joint that is produced when two or more members of a weldment overlap one another.

Lift Arc: An arc starting method built into the GTAW power source to allow contact type starts. Tungsten contamination is virtually eliminated.

Load Voltage: Measured at the output terminals of a welding machine while a welder is welding. It includes the arc voltage (measured while welding), and the voltage drop through connections and weld cables.

Machine Welding (ME): Uses equipment which welds with the constant adjusting and setting of controls by a welder or operator.

Microprocessor: One or more integrated circuits that can be programmed with stored instructions to perform a variety of functions.

Nonferrous: Refers to a metal that contains no iron, such as aluminum, copper, bronze, brass, tin, lead, gold, silver, etc.

Open Circuit Voltage (OCV): As the name implies, no current is flowing in the circuit because the circuit is open. The voltage is impressed upon the circuit, however, so that when the circuit is completed, the current will flow immediately. For example, a welding machine that is turned on but not being used for welding at the moment will have an open circuit voltage applied to the cables attached to the output terminals of the welding machine.

Output Control: An electrical switch that is used to energize or de-energize output terminals of a welding machine. In some types of welding machines they can be of solid state design, with no moving parts and thus no arcing of contact points.

Overhead Position: When the axis angle is from $0^\circ - 80^\circ$ and the face rotation is from $0^\circ - 80^\circ$ or $280^\circ - 360^\circ$ for groove welds or from $0^\circ - 125^\circ$ or $235^\circ - 360^\circ$ for fillet welds, the weld position is considered to be in the overhead position.

Parameters: The welding settings on a welding machine such as voltage and amperage, normally read on a volt meter and an amp meter. It may also include things as travel speed, electrode size, torch angle, electrode extension and weld joint position and preparation.

Penetration: The nonstandard term used to describe the following:

Depth of Fusion: The distance from the surface melted during welding to the extent of the fusion into the base metal or previous weld bead.

Joint Penetration: The depth that a weld extends from the weld face into the joint, minus reinforcement. Joint penetration may include root penetration.

Root Penetration: The depth that a weld extends into the root of a joint.

Complete Joint Penetration: Occurs when the “filler” metal completely fills the groove, and good fusion to the base metal is present.

Incomplete Joint Penetration: A condition in the root of a groove weld when the weld metal does not extend through the joint thickness. This is generally considered a defect when the joint by design was to have complete joint penetration.

Partial Joint Penetration: A condition in the root of a groove weld when the weld metal does not extend through the joint thickness. By design this is acceptable and not a defect, because it will carry the load for which it was intended.

Plasma: The electrically charged, heated ionized gas which conducts welding current in a welding arc.

Plug Welding: A weld made by filling (or partially filling) a hole in one member of a joint, fusing that member to another member.

Pool: The weld pool is the liquid state of a weld prior to its becoming solid weld metal. It indicates no limit to depth as the nonstandard term puddle tends to note a shallower depth.

Porosity: A cavity type discontinuity formed by gas entrapment during solidification.

Positioner: A device which moves the weldment when a stationary arc is used. Positioners include turning rolls, head and tail stocks and turntables.

Pounds Per Square Inch (psi): A measurement equal to a mass or weight applied to one square inch of surface area.

Primary Power: Often referred to as the input line voltage and amperage available to the welding machine from the shop’s main power line. Often expressed in watts or kilowatts (kw), primary input power is AC and may be single- or three-phase. Welding machines with the capability of accepting more than one primary input voltage and amperage must be properly connected for the incoming primary power being used.

Puddle: More properly referred to as molten weld pool, the weld puddle is the liquid state of a weld prior to its becoming solid weld metal.

Pulsing: Varying the current from a high peak amperage level to a lower background amperage level at regular intervals. Pulse controls also adjust for the number of pulses per second and the percent of time spent at the peak amperage level. Pulsing is used to control heat input and allow for improved weld profile.

Purging: Cleaning, purifying or removing something from a container. Such as applying shielding gas to the inside of a piping structure prior to welding it with the GTAW process.

Quenching: The dipping of a heated metal into water, oil or other liquid to obtain necessary hardness.

Rectifier: An electrical device that allows the flow of electricity in basically only one direction. Its purpose is to change alternating current (AC) to direct current (DC).

Residual Stress: The stress remaining in a metal resulting from thermal or mechanical treatment or both. When welding, stress results when the melted material expands and then cools and contracts. Residual stresses can cause distortion as well as premature weld failures.

Resistance: The opposition to the flow of electrical current in a conductor. This opposition to current flow changes electric energy into heat energy. Resistance is measured in ohms with an ohm meter.

Resistance Spot Welding (RSW): A process in which two pieces of metal are joined by passing current between electrodes positioned on opposite sides of the pieces to be welded. There is no arc with this process, and it is the resistance of the metal to the current flow that causes the fusion.

Reverse Polarity: An old nonstandard term denoting electron flow from the workpiece to the electrode.

Root: A nonstandard term to denote joint root or weld root.

Root Opening: The separation of the members to be welded together at the root of the joint.

SCR: Silicon Controlled Rectifier. Used to change AC current to DC. Functions as an output control device for regulating the current/voltage and arc off-on ability.

Secondary Power: Refers to the actual power output of a welding machine. This includes the load voltage while welding, measured at the output terminals and the current (amperage) flowing in the circuit outside the welding machine. Secondary amperage can be measured at any point along the secondary circuit.

Sensitization: The changing of a stainless steel's physical properties when being exposed to a temperature range of 800° – 1600° F, 427° – 870° C for a critical period of time. See also Carbide Precipitation.

Sequencing: The control over all aspects of the weld. This would include the weld start, initial current, initial current time, upslope time, weld current level, weld current time, final slope, final current level and final current time.

Shielded Metal Arc Welding (SMAW): An arc welding process which melts and joins metals by heating them with an arc, between a covered metal electrode and the workpiece. Shielding gas is obtained from the electrodes outer coating, often called flux. Filler metal is primarily obtained from the electrodes core.

Shielding Gas: Protective gas used to prevent atmospheric contamination of the weld pool.

Single-Phase: When an electrical circuit produces only one alternating cycle within a 360° time span, it is a single-phase circuit.

Slot Welding: A weld made by filling (or partially filling) an external hole (slot) in one member of a joint, fusing that member to another member. The hole (slot) may be completely enclosed, or it may be open at one end of the metal.

Solenoid: An electrical device which either stops or permits the flow of gas used to shield the weld pool and arc or the flow of water used to cool a welding torch.

Spatter: Metal particles blown away from the welding arc. These particles do not become part of the completed weld.

Squarewave: The AC output of a power source that has the ability to rapidly switch between the positive and negative half cycles of alternating current. Advanced Squarewave is an enhanced version of this output waveform.

Stabilizer: A device used in AC welding to assist re-ignition of the arc as current passes through the sine wave zero point.

Straight Polarity: An old nonstandard term denoting electron flow from the electrode to the workpiece.

Submerged Arc Welding (SAW): A process by which metals are joined by an arc or arcs between a bare solid metal electrode or electrodes and the work. Shielding is supplied by a granular, fusible material usually brought to the work from a flux hopper. Filler metal comes from the electrode and sometimes from a second filler wire or strip.

T-Joint: A joint produced when two members are located approximately 90° to each other in the shape of a "T".

Thoriated Tungsten: GTAW tungsten electrode with small amount of thorium added. Improves arc starting and provides for use of wider current range.

Three-Phase: When an electrical circuit delivers three cycles within a 360° time span, and the cycles are 120 electrical degrees apart, it is a three-phase circuit.

TIG: The abbreviation for Tungsten Inert Gas. A shop term for the Gas Tungsten Arc Welding process.

Torch: A device used in the GTAW process to control the position of the electrode, to transfer current to the arc, and to direct the flow of shielding gas.

Transverse: A measurement made across an object, or basically at or near a right angle to a longitudinal measurement.

Travel Angle: The angle at which the torch is positioned from the perpendicular as the weld progresses. Travel angles are usually 5° to 15°.

Tungsten: Rare metallic element with extremely high melting point (3410° C). Used in manufacturing GTAW electrodes.

Undercut: A groove melted into the base metal usually along the toes of a weld. Undercut can also occur on either side of the first pass of a full penetration weld, such as an open groove butt weld. Undercutting produces a weak spot in the weld, if it exceeds the acceptance criteria for undercut it is considered a defect, and must be repaired. GTAW is an excellent process used for dressing this type of defect.

Vertical Position: When the axis of the weld is between 15° – 80° and the face rotation is between 80° – 280° for groove welds or 125° – 235° for fillet welds, the weld position is considered to be in the vertical position. When the axis angle is increased to between 80° – 90° , the face rotation can be any angle from 0° – 360° for both groove and fillet welds.

Voltage: The pressure or force that pushes the electrons through a conductor. Voltage does not flow, but causes amperage or current to flow. Voltage is sometimes termed electro-motive force (EMF) or difference in potential.

Weld Metal: The filler wire and base metal that was melted while welding was taking place. This forms the welding bead.

Weld Root: When looking at the weld profile or cross section, it is the deepest point or points the weld fused into the joint root.

Welder: A person who performs manual or semiautomatic welding. Sometimes incorrectly used to describe a welding machine.

Welding Operator: A person who operates a machine or automatic welding equipment.

Workpiece Connection: A means to fasten the work lead (work cable) to the work (metal to be welded on). Also, the point at which this connection is made. One type of work connection is made with an adjustable clamp.

Workpiece Lead: The conductor cable or electrical conductor between the arc welding machine and the work.

Zirconiated Tungsten: GTAW tungsten electrode which combines desirable effects of pure tungsten and starting characteristics of thoriated tungsten.

