Lesson 4: Identifying Metals

Arc welders should know the properties and characteristics of various common metals so they can adjust welding equipment and procedures to produce a sound weld. This lesson provides information on the basic categories of metals, methods of identification, and characteristics and uses of common metals.

Importance of Metal Identification

With the many different metals used in industrial applications, it is impossible to be familiar with all of their characteristics and the welding techniques recommended for each one. However, welders should be aware that not all welding procedures can be used on all metals with acceptable results. They should find out what kind of metal they are working on in order to determine which electrodes and welding procedures are needed to produce strong, functional joints. For example, when welding cast iron, steps should be taken to prevent cracking as a result of its high carbon content. Mild steel, on the other hand, does not require special welding procedures and can be welded successfully with all processes.

Basic Metal Categories

The two basic categories for metal are ferrous and nonferrous. Ferrous refers to iron and metals with a high-iron content. "Ferrous" comes from the Latin word *ferrum,* which means iron. The world's iron supply is plentiful, so it is relatively inexpensive and widely used in fabrication, including equipment and tools in agricultural mechanics. Common ferrous metals include wrought iron, all steels, and cast iron. Nonferrous refers to metals that contain little or no iron. Even though nonferrous metals are more expensive and are in more limited supply, it is not uncommon to work with them in agricultural mechanics. Common nonferrous metals include aluminum, copper, brass, and bronze.

Methods of Identifying Metals

Many metals look alike, especially different types of steel. When an individual is working on a welding repair, the metal is typically unmarked and difficult to identify. Various methods have been developed to help in the identification of different metals. Some of the most common metal identification methods are as follows.

Ferrous and Nonferrous Testing

The most basic tests determine if a metal is ferrous or nonferrous. One way is to use the magnet test. Most ferrous metals are magnetic; nonferrous metals are not. An exception is some types of stainless steel.

Color is another general way in which ferrous metals can be distinguished from nonferrous ones. Ferrous metals (irons and steels) tend to be gray, gray-white, bright silver, or black in appearance. Nonferrous metals tend to be white, yellow, or reddish in color.

Oxyacetylene Torch Testing

Applying an oxyacetylene flame to metal is used to identify the type by how quickly it melts, how the puddle looks, and how the color of the metal changes as it is heated. Torch testing of steels and steel alloys is also used to determine whether or not the metals have good welding properties. In this test, a neutral flame is used to heat the metal to its melting point and make a hole. The metal is observed as it is heated and after it cools. During the heating process, a metal with good welding characteristics does not produce excessive sparks or does not boil. Once it has solidified, a metal with good welding characteristics is smooth and shiny, not rough, dull, or porous.

Spark Testing of Ferrous Metals

Spark testing is used to identify different types of ferrous metals. By comparing sparks made by an unknown metal to those from a known type of metal, the beginning welder can learn to identify metals. To perform the spark test, the metal is held lightly against a grinding wheel and observed as small heated particles of metal oxidize or burn as the wheel throws them off.

Because metals and their alloys produce distinctive spark patterns, these patterns can be used to identify the metals. Sparks are observed for their color, length, explosions along the length of the spark, and shape of the

explosions. Regarding steel, for example, what the tester will generally find is that as the carbon content increases, the number of explosions increases and the length of the spark decreases. It is recommended to perform the test against a dark background or in low light so the sparks are more distinctive.

Spark testing is not useful on nonferrous metals because they do not produce sparks during grinding. In addition, grinding is not recommended for nonferrous metals because they can frequently clog the grinding wheel. Some types of nonferrous metals produce oxides that are toxic. If a nonferrous or suspected nonferrous metal is to be spark tested, consult the instructor before proceeding. The operator must wear an approved breathing apparatus and the grinding wheel must be equipped with an exhaust system.

Characteristics and Uses of Common Metals

Knowledge about the characteristics and uses of common metals can provide guidance in selecting metals for welding projects in agricultural mechanics and in choosing the proper welding techniques. Characteristics and uses of various ferrous and nonferrous metals are as follows.

Ferrous Metals

- Wrought iron: This metal is almost pure iron and contains very little carbon. Its low-carbon content causes wrought iron to have low strength and hardness, but it has the positive characteristic of being very ductile (easy to shape without fracturing). It rusts slowly and is easily welded. Once an important structural metal, wrought iron is now used mostly in ornamental work.
- Carbon steel: This is the most common type of steel (about 90% of all manufactured steel) and it is cheaper than alloy steel. Generally, as carbon increases, so do hardness, tensile strength, resistance to wear, and cost. As carbon increases, ductility is lost and the melting point is lowered. The three basic types of carbon steel are as follows.
    - Low-carbon steel, including mild steel: This steel cannot be hardened. It is easy to machine, can be used with all welding processes, and produces high-quality welds. Uses include wire, pipe, auto bodies, and storage tanks.
    - Medium-carbon steel: This steel can be strengthened and hardened with heat treatment. Heat treatment before and after welding generally produces the best results with this steel. Uses are similar to low-carbon steel, but medium-carbon steel can withstand greater stress than low-carbon steel. Medium-carbon steel is used in crankshafts, gears, and hammerheads.
    - High-carbon steel: This steel can be heat treated to produce high strength and hardness. It is more difficult to weld than low- and medium-carbon steel because of the hardening effect of the heat treatment. High-carbon steel is used in making tools, dies, and train wheels.
- Alloy steel: These are metals to which other elements besides carbon have been added in large enough amounts to produce qualities not found in carbon steel. Common alloying elements include manganese, nickel, and tungsten. Manganese strengthens steel and increases its resistance to shock. Nickel adds strength and corrosion resistance. Tungsten makes steel self-hardening and able to withstand high temperatures. As the amount of alloying elements increases, the welding difficulty generally increases.
- Stainless steel: Stainless steel basically refers to steels with enough chromium alloy to resist corrosion. This metal is available in over 100 different kinds and has many uses. It is valued for its ability to resist rust and to be sterilized. Stainless steel has good welding characteristics, but it is more difficult to weld than carbon steel.
- Cast iron: This metal contains more carbon than steel, which helps it withstand high-compression loads. The high-carbon content also lowers the melting point, making it good for casting; however, it makes cast iron more brittle than steel. Most cast iron can be welded with oxyacetylene and shielded metal arc welding processes. The exception is white cast iron, which is considered almost impossible to weld. Cast iron is used to make brake drums, engine blocks, and furnace grates.

Nonferrous Metals

- Aluminum: In its pure state, aluminum is much weaker than steel, but the addition of alloys, heat treatment, and cold working can make it, pound for pound, stronger than structural steel. Aluminum alloys are valued because they are more lightweight than most metals and resistant to corrosion. Aluminum can be welded, but aluminum oxide must be removed to ensure a good-quality weld. Another consideration when welding aluminum is it does not change color before reaching its melting point. To determine if the metal is softening, the welder can scratch the surface of the metal as it is heated. Its uses include wheels, airplane parts, cans, and castings.
- Copper: Pure copper is very soft, but processes such as the addition of alloys and cold working can increase its ductility and malleability (ability to be forged, hammered, or rolled). It is corrosion resistant and is second only to silver as an electrical conductor. Most copper and copper alloys can be joined by common welding methods, brazing, and soldering. Like many nonferrous metals, copper has a tendency toward hot shortness (easily distorting when heated to its melting point). Because of this property, copper must be firmly clamped when heated to this temperature. Copper is used to make wire, pipe, and radiator parts.
- Brass: This metal is an alloy of copper and zinc. It has working characteristics similar to those of copper. It is valued for its resistance to acids, ability to be easily formed, attractive appearance, and its ability to be a good brazing alloy. Brass is used in plumbing parts, castings, and ornamental work.
- Bronze: This metal is an alloy of copper and tin. It resists corrosion like copper, but is stronger and easier to cast. Like brass, bronze has an attractive appearance. It behaves similarly to brass when welded. Uses include gears, castings, and decorative parts.

Summary

Metals should be identified before welding to aid in selecting the correct electrode and welding procedure. One of the basic categories of metal is ferrous, which describes metals with high-iron content, including wrought iron, carbon steel, alloy steel, stainless steel, and cast iron. The other category is nonferrous, which refers to metals with little or no iron, including aluminum, copper, brass, and bronze. Common methods of identifying metal are ferrous and nonferrous testing, oxyacetylene torch testing, and spark testing.

Credits

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