

Welding Facts (Summary of Welding Notes)

1. **Definition.** A *weld* is made when separate pieces of material to be joined combine and form one piece when heated to a temperature high enough to cause softening or melting. Additional *filler* material is typically added to strengthen the joint. Welding is a dependable, efficient and economic method for permanently joining similar metals. In other words, you can weld steel to steel or aluminum to aluminum, but you cannot weld steel to aluminum using traditional welding processes.
2. **Common Welding Processes.** The most common processes are shielded metal arc welding (**SMAW**), gas metal arc welding (**GMAW**) and gas tungsten arc welding (**GTAW**). All of these methods employ an electric power supply to create an arc which melts the base metal(s) to form a molten pool. The filler wire is then either added automatically (GMAW) or manually (SMAW & GTAW) and the molten pool is allowed to cool. All three methods use flux or gas to create an inert environment in which the molten pool can solidify without rapidly oxidizing.
3. **SMAW.** Uses a variable power supply to provide the voltage source and flux covered metal electrode “sticks” to carry the electrical current. The current forms an arc that jumps a gap from the end of the electrode to the work. The electric arc creates enough heat to melt both the electrode and the base material(s). Molten metal from the electrode travels across the arc to the molten pool of base metal where they mix together. As the arc moves away, the mixture of molten metals solidifies and becomes one piece. The molten pool of metal is surrounded and protected by a fume cloud and a covering of slag produced as the coating of the electrode burns or vaporizes. Due to the appearance of the electrodes, SMAW is commonly known as ‘stick’ welding. SMAW is one of the oldest and most popular methods of joining metal. Moderate quality welds can be made at low speed with good uniformity. SMAW is used primarily because of its low cost, flexibility, portability and versatility. Both the equipment and electrodes are low in cost and very simple. SMAW is very flexible in terms of the material thicknesses that can be welded (materials from 1/16” thick to several inches thick can be welded with the same machine and different settings). It is a very portable process because all that’s required is a portable power supply (i.e. generator). Finally, it’s quite versatile because it can weld many different types of metals, including cast iron, steel, nickel & aluminum. Some of the biggest drawbacks to SMAW are (1) that it produces a lot of smoke & sparks, (2) there is a lot of post-weld cleanup needed if the welded areas are to look presentable, (3) it is a fairly slow welding process and (4) it requires a lot of operator skill to produce consistent quality welds.
4. **GMAW.** In the GMAW process, an arc is established between a continuous wire electrode (which is always being consumed) and the base metal. Under the correct conditions, the wire is fed at a constant rate to the arc, matching the rate at which the arc melts it. The filler metal is the thin wire that’s fed automatically into the pool where it melts. Since molten metal is sensitive to oxygen in the air, good shielding with oxygen-free gases is required. This shielding gas provides a stable, inert environment to protect the weld pool as it solidifies. Consequently, GMAW is commonly known as MIG (metal inert gas) welding. Since fluxes are not used (like SMAW), the welds produced are sound, free of contaminants, and as corrosion-resistant as the parent metal. The filler material is usually the same composition (or alloy) as the base metal. GMAW is extremely fast and economical. This process is easily used for welding on thin-gauge metal as well as on heavy plate. It is most commonly performed on steel (and its alloys), aluminum and magnesium, but can be used with other metals as well. It also requires a lower level of operator skill than the other two methods of electric arc welding discussed in these notes. The high welding rate and reduced post-weld cleanup are making GMAW the fastest growing welding process.

5. **GTAW.** In the GTAW process, an arc is established between a tungsten electrode and the base metal(s). Under the correct conditions, the electrode does not melt, although the work does at the point where the arc contacts and produces a weld pool. The filler metal is thin wire that's fed manually into the pool where it melts. Since tungsten is sensitive to oxygen in the air, good shielding with oxygen-free gas is required. The same inert gas provides a stable, inert environment to protect the weld pool as it solidifies. Consequently, GTAW is commonly known as TIG (tungsten inert gas) welding. Because fluxes are not used (like SMAW), the welds produced are sound, free of contaminants and slags, and as corrosion-resistant as the parent metal. Tungsten's extremely high melting temperature and good electrical conductivity make it the best choice for a non-consumable electrode. The arc temperature is typically around 11,000° F. Typical shielding gasses are Ar, He, N, or a mixture of the two. As with GMAW, the filler material usually is the same composition as the base metal. GTAW is easily performed on a variety of materials, from steel and its alloys to aluminum, magnesium, copper, brass, nickel, titanium, etc. Virtually any metal that is conductive lends itself to being welded using GTAW. Its clean, high-quality welds often require little or no post-weld finishing. This method produces the finest, strongest welds out of all the welding processes. However, it's also one of the slower methods of arc welding.
6. **Selection of the welding process.** The selection of the joining process for a particular job depends upon many factors. There is no one specific rule governing the type of welding process to be selected for a certain job. A few of the factors that must be considered when choosing a welding process are:
 - a. Availability of equipment
 - b. Repetitiveness of the operation
 - c. Quality requirements (base metal penetration, consistency, etc.)
 - d. Location of work
 - e. Materials to be joined
 - f. Appearance of the finished product
 - g. Size of the parts to be joined
 - h. Time available for work
 - i. Skill experience of workers
 - j. Cost of materials
 - k. Code or specification requirements
7. **Benefits of each process.**
 - a. **SMAW:** cheap; portable; versatile (can weld various metals & thicknesses)
 - b. **GMAW:** fast; versatile; requires little post-weld cleanup; easiest of 3 methods to learn
 - c. **GTAW:** highest quality; versatile; requires no post-weld cleanup
8. **Drawbacks of each process.**
 - a. **SMAW:** slow; requires major post-weld cleanup; "dirty" method of welding; requires a lot of skill to produce acceptable welds
 - b. **GMAW:** requires shielding gas; requires minor post-weld cleanup
 - c. **GTAW:** slow; requires shielding gas; requires high degree of skill