A Beginner's Guide to MIG Welding

MIG Welding Names

MIG welding, or MIG, is an acronym for **"Metal Inert Gas"** welding. MIG is a commonly used and accepted slang term that was appropriate when the process was first invented. In the beginning, the gasses used for shielding the weld area were known as **"Inert"** or **"Nobel"** gasses. Today the proper terminology is **"Gas Metal Arc Welding" or GMAW**. This is a better description of this welding process because most gasses or gas mixtures used are neither Inert nor Nobel gasses, and in many cases they are actually reactive gasses. Some people also refer to this process as **"Wire Wheel Welding"** because it uses a wire wheel to feed the filler metal to the weld joint. In the end, MIG welding is still the most popular term. However, when searching for information or jobs in the welding field, the term "GMAW" or "Gas Metal Arc Welding" is the correct one.

Weldability of Metals

MIG can weld almost any metal. One of the biggest attractions about the MIG process is how fast it is able to weld more than just steel. The metals that are most commonly welded are:

1. **Mild Steel**
2. **Stainless Steel**
3. **Aluminum**

This process can weld many more alloys and combination of metals. One example is welding dissimilar metals such as stainless steel to steel. Other metals that can be welded range from copper to titanium. The list of metals that can be welded is extensive and range from very common metals to the extremely exotic.

Power Supply and Equipment

The power supply and equipment are what make this type of welding process possible. Once you understand the type of equipment used then the inner workings become simple.

MIG welding power supplies are referred to as **CV or "Constant Voltage"** power supplies. What this power supply does is produce **electrical current to create an arc** to weld the metal with. The term CV means that the heat settings are controlled with voltage. When MIG welding, the machine is always set by voltage and this type of power supply keeps the voltage at a consistent level. What happens is that the amperage fluctuates, but the voltage stays in the range that it is set.

MIG welding requires a wire feed system. The wire feed system is what feeds the electrode, or filler wire, to the weld joint. This is where the term "Wire Wheel Welding" comes from. The wire feeds come in many different forms. Some are part of the power supply, and the higher-end models come in stand-alone form or are contained inside a briefcase. The wire feed is regulated in **IPM or "Inches per Minute"**. This is how the speed of the filler wire is regulated and set. The wire feed system also controls shielding gas and all welding operations that are signaled from the MIG gun.

Finally there is the MIG gun. The MIG gun has a handle with a trigger that is attached to the wire feed through a cable. The MIG gun feeds the filler wire, the shielding gas, and electricity to the joint. Once the welder hits the trigger, the MIG gun shields the weld area from the air, produces the Arc, and starts the welding process by feeding wire to the joint.

Shielding Gases

Shielding gas is what makes the MIG welding process possible. There are many types of shielding gasses used for MIG welding. Since the electrodes are a solid metal wire they always need some form of shielding from the air. The gasses range from inert gases to reactive ones. In many cases, the gasses used are a combination of two or more gasses. Some of the commonly used gasses are:

- **Argon**
- **Carbon Dioxide**
- **Helium** *(in rare cases)*
- **Oxygen** *(in small percentages)*

For most welding applications a **combination of Argon and Carbon Dioxide gasses** are used. When it comes to the welding gasses, Argon produces a cleaner weld and the Carbon Dioxide helps the weld penetrate deeper. Carbon Dioxide can be used alone for thinner metals, but it also produces a lot of smoke while welding. Some of the most commonly used gasses for welding mild steel are:

- **100% Carbon Dioxide**
- **25% Carbon Dioxide and 75% Argon**
- **2% Carbon Dioxide and 98% Argon**

The mixtures are referred to as **C25 and C2.** The C stands for Carbon Dioxide and the number is the percentage of Carbon Dioxide in the mixture. It is assumed that the rest of the gas in the mixture is Argon. Argon by itself is used for welding:

- **Aluminum**
- **Copper**
- **Nickel**
- **Titanium**

Electrodes or Filler Wire

Electrodes or the filler wire come in spool form. Filler wire comes in a variety of sizes that are rated for home use all the way to heavy industrial applications. Some popular sizes are:

- **.023** Typically used by hobbyists
- **.030** Used in industry for light welding
- **.035** The most commonly used size for manufacturing

The size of the electrode has very little to do with the thickness of the metal that will be welded, and ALL to do with the type of machine you are using (the voltage the machine can produce and wire-feed speeds available) and how it is set-up. A low-voltage machine used by a hobbyist in the garage will never be able to weld thicker

metals. The electrodes have a coding system to identify them. A commonly used electrode for mild steel is **"ER 70S-6"**

- **"ER"** stands for electrode or filler rod.
- **"70"** is the strength of the weld. In the case of mild steel, the weld has a minimum of 70,000 pounds of tensile strength per square inch of weld.
- **"S"** stands for a solid wire. Since the wire is solid it always needs a form of shielding gas.
- **"6"** represents the amount of cleaner that is added to the wire to improve weld quality.

Welding Machine Set-Up

The set-up of a MIG welder has a lot of combinations depending on the type of metal, the thickness that will be welded, the electrode available, and the capabilities of the welding machine. When it comes to MIG welding there are four types of weld transfers and they are:

1. **Short Circuit**
2. **Globular**
3. **Spray**
4. **Pulse**

Short circuit is a transfer that is used on thinner metals. This transfer type produces a **fast, high pitch crackling sound**. This type of transfer is set-up by using a high percentage of carbon dioxide shielding gas or 100% carbon dioxide. In order to have a short circuit transfer, the voltage needs to be set on the lower range. For most hobbyists, this is the type of transfer that will be used.

Globular transfer requires more voltage and a higher percentage of Argon gas. This transfer type has a **popping sound** to it. Globular transfer is used on thicker metals, and in some cases, when welding stainless steel.

Spray transfer uses a high percentage of Argon gas or pure Argon depending on the type of metal welded. True spray transfer has a **hum or hissing sound** to it. When it comes to welding thicker metals, spray transfer is sometimes defined by a minimum voltage and amperage setting. In this case, it will have a **deep, fast crackling sound** when welding. It may seem like short circuit, but the fact is the wire is being sprayed into the weld joint.

Pulse or pulse spray transfer is a special setting on high end MIG welders. What this does is create a pulsing action with the voltage and amperage while welding. This helps control the puddle when welding out of position and is commonly used when MIG welding pipe.

When setting up the welder you need to choose the proper electrode and shielding gas for the metal that will be welded. The best way to go about this is to **ask your local welding supply store or a welding instructor** for a recommendation.

MIG welders have three main settings:

1. **Shielding Gas Flow Rate**
2. **Voltage Setting**
3. **Wire Feed Speed.**

To set-up your shielding gas flow rate you need to take into account any drafts or windy conditions that may affect where you will be welding. This makes predicting an exact flow rate impossible because an open door or even a ventilation fan can change the gas requirements. This is true even when welding in the same shop. Shielding gas flow rates can range from as little as 10 **CFH (Cubic Feet per Hour)** to over 50 CFH. It comes down to finding what works best for your specific conditions.

Voltage setting is the main part of MIG welding. As noted earlier, voltage settings vary depending on the electrode size and metal thickness that will be welded. **Voltage settings can make possible the welding a variety of metal thicknesses using a single electrode size.**

Wire feed speed is what controls how fast your wire is feeding to the weld joint. It also controls transfer types and amperage settings. A lower wire feed speed produces more of a spray transfer and at the same time lowers the amperage. The higher the wire feed speed, the greater the amperage and this is because the electrode is having more direct contact with the weld joint.

Setting up to weld should start by using the recommended manufactures settings. In some cases, they can be found on the inside panel of the wire feed. Some general guidelines for an ER 70S-6, .035 thick electrode using C25 gas are:

- **12 Gauge** mild steel requires 18.5 volts and 180 IPM wire feed speed.
- **3/16"** mild steel requires 19 volts and 225 IPM wire feed speed.
- **1/4"** mild steel requires 20 volts and 260 IPM wire feed speed.
- **3/8"** mild steel requires 21 volts and 310 IPM wire feed speed.

Remember **these are just guidelines** and each machine runs differently. This is also true of two identical machines bought at the same time. It all comes down to how well they are calibrated. When welding thicker metals you need to use at least the minimum recommended voltage and wire feed speed. If not, you will "cold lap" the weld and that means it has not penetrated the metal properly. It looks as though it is welded, but the weld is just lying on top of the metal. Hit it with a hammer and the joint breaks in half.

What's More Important Than MIG Welding Techniques?

Machine Set-Up! MIG welding is one of the easiest types of welding to learn. If you want to master MIG welding techniques then **learn how to set-up any MIG welding machine correctly**. Learning how to set-up the machine can make or break a weld and the welder. If you are in school, do NOT get in the habit of using the same machine every day. If you do, chances are that when you go for a weld test you are going to have trouble with set-up. MIG welding is easy but machine set-up is not!

MIG Welding Technique Basics

The welding techniques used for MIG welding are typically **forehand and you push the puddle** in the direction of the weld. This creates a flat weld that has a shallow, but wide penetration pattern. **Back hand welding** can be done but it is not common used. Back hand welding produces a narrow bead with a high profile and deep penetration.

How far your electrode sticks out of the MIG gun is extremely important. With MIG you want **¾ of an inch or less stick-out**. If you have a longer stick-out you are likely to lose your shielding gas. This will result in porosity in the weld. A shorter stick-out is always better because it provides better gas coverage.

Structural MIG Welding Techniques

Welding in the flat position is the easiest. This position requires pushing the MIG gun with an angle up to 35 degrees toward the direction of the weld. The techniques used can be whipping, circles or a weave. Choosing the technique depends on the type of joint and metal thickness.

Horizontal is similar to flat welding except weaving should not be used. Always use stringer beads and keep them narrow by increasing your travel speed. The angle of the MIG gun should be pointed up between 35 to 45 degrees and you should lean toward the direction of travel up to 35 degrees. The best technique for this position, in most cases, is a whipping motion.

Vertical welding is the most difficult position for this welding process. Vertical welding requires pointing the MIG gun upward with a maximum of 45 degrees. If you exceed 45 degrees chances are air will enter the weld area from the bottom because of the turbulence of the shielding gas. Vertical welding can travel up or down. **Vertical down is most suitable for thinner metals**. The trick with vertical down is to stay ahead of the puddle. Otherwise the weld will roll over the joint and not penetrate properly. Vertical down requires a very fast side to side weave. **Vertical up is the most difficult position for MIG**. The issue is that the bead always crowns up and has a high profile. Vertical up is best done inside of a groove joint. If you need to run a small bead it is always a good idea to grind a groove for the weld to follow. Vertical up is done using a side to side weave with a slight pause at the edges of the weld.

Overhead is not much harder then horizontal welding. The angle of the MIG gun needs to be toward the direction of the weld with a maximum angle of 35 degrees. The trick to welding overhead is to keep the machine set hot. Overhead welding techniques are whipping, circles and weaves.

Techniques for Various Joint Types

When it comes to various joints there are different techniques used. For fillet welds, whipping works best. Groove welds require a bit of a weave to get proper penetration. It all boils down to adapting your techniques for the position and joint type. In the end **the most important MIG welding technique is learning to set-up your equipment correctly**. MIG welding really does not require a lot of practice, but machine set-up certainly does as it is what makes the weld.

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