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Welding Basics 1

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What is Welding?

Wikipedia defines welding as “a fabrication process that joins materials, usually metals.” This is done by melting the part of the materials to be joined and adding some additional molten joining material. When the molten material cools, it forms a strong bond or joint.

Welding is the most widely practiced way of joining metals together due to the efficiency and economy of the process. It has been estimated that approximately 50% of the Gross National Product of the USA arises from activities that are in some for or another related, perhaps remotely, to welding. As an example, farming may appear to have nothing to do with welding, but the equipment the framer uses to grow and harvest his crops will have used welding in their manufacturing process.

Until the advent of the 20th century, welding was confined to blacksmith shops where two pieces of metal were heated to very high temperatures in a forge and then hammered together until the joining occurred. This is what is called forge welding.

With the introduction of electricity into industrial processes, welding became both quicker and easy, and also more economical. Today there are 4 types of welding techniques that are commonly used.

- The most basic for is Arc Welding where the parts to be joined together are brought into contact with strong electrical current and heated. The molten parts are then joined together to form a

weld. This is the low technology end of welding in its cheapest and least sophisticated form.

- Gas Welding is generally used for repair work especially in the case hollow items like tubes and pipes. Hot gas is forced onto the surfaces to be welded. This procedure requires the parts to be subjected to less heat and is suitable for material that may be damaged by exposure to high temperature. For this reason it is used in the jewellery industry which has to work with soft metal with low melting points.
- Resistance Welding requires that an additional sheet of material is used to cover the pieces that are to be welded together. This provides great strength to a weld, but the process requires expensive equipment and also the use of additional material to encase the weld which makes it expensive and not suitable for all applications.
- Laser Welding is the most modern technology available. High intensity lasers can be tightly focused and produce controllable heat on the surfaces to be welded very quickly. This is perfect for material which can be damaged by prolonged exposure to extreme heat. Laser welding is very accurate and can be used to produce even the smallest of welds. However, because of the high capital cost involved in purchasing this equipment, the cost of welding is also high.

Although the perception of welding is that of a simple process of heating and joining, it is a high technology industry with huge amounts being spent of research and development to find stronger, more accurate and cheaper methods. The welding process plays a big role in

metallurgy with a constant effort underway to find newer and more weld friendly alloys.

The History of Welding

When you drive your car or look at a light fixture in the street or open your microwave, chances are that there is something in any of those items that has been welded. These products and others have been a part of the process of welding for more years than you might imagine.

Welding actually started a very long time ago during the Middle Ages. Many artifacts have been found that date back to the Bronze Age. These have been small boxes that were welded together with what is called *lap joints*; no one is exactly sure what these were used for, but this was important to that time.

The Egyptians also made a variety of tools by welding pieces of iron together. Perhaps this is where Maxwell's Hammer comes later? Who can say! Then came the rise of the Middle Ages and many people there were able to use blacksmithing for iron. Different modifications were made along the way until the welding that is used to day was developed.

There were several significant inventions in the 1800s that influenced welding included here:

- The invention of acetylene by an Englishman named Edmund Davy.
- Gas welding and cutting became known and a way to cement pieces of iron together.
- Arc lighting was a very popular part of welding after the electric

generator became known.

- Arc and resistance welding become another popular aspect of welding.
- Nikolai N. Benardos receives a patent for welding in 1885 and 1887 from America and Britain.
- C.L. Coffin receives an American patent for a arc welding process.

After the 1800s many more patents and inventions were made in order to create more ways of doing welding but one of the greatest needs would come much later during World War I because this process was needed to create arms. Because of the demand welding firms became a staple of America and Europe because the war needed welding machines and electrodes to go with them.

During the war people really got a chance to look at how welding worked and it became a very popular way of work. So much so that in 1919 the first American Welding Society was begun. This nonprofit organization came directly out of through a group of men who called themselves the *Wartime Welding Committee of the Emergency Fleet Corporation (Source: Miller Welds).*

The 1950s and 1960s were also a significant time for welding because a welding process using CO2 was discovered and a variation of this form of welding that used inert gas became very popular in the 1960s because it produced a different type of arc.

There have been a number of improvements in the welding trade over these years and today the process has added two areas, friction and

laser welding. These two have created a more specialized field and therefore more opportunities for learning.

One interesting point about laser welding is that those people who use it have found that is a tremendous heat source so it can actually weld both metal and non-metal objects.

Welding Terminology / Welding Glossary of Terms

If you are interesting in welding there are many different terms that you will want to familiarize yourself with in order to read magazines or books on the topic. Here is a list of common terms that are important to know:

ACETYLENE -- this is a gas that you will be working with to do welding. It is a very flammable gas so you have to be careful with it. This gas is made up of carbon and hydrogen and it is used in the oxyacetylene type of welding process.

AIR-ACETYLENE -- this is a flare that you can produce using low temperature. It is created when you burn acetylene with air and not oxygen.

AIR-CARBON ARC CUTTING (CAC-A) -- this is a way of arc cutting where you melt metals through the heat of a carbon arc.

ALLOY -- this is a mix that has metallic properties because it has at least one element that is metal, but it can have several other things in the mix as long as one is metal.

ALTERNATING CURRENT -- a current that goes backward and forward at regular intervals (see DC Current).

BACK FIRE -- this is the popping sound that you hear when you turn on the acetylene torch when you connect it with fire. It is created because the flame turns back into the tip for a moment and then comes back out of the torch as a flame.

BACKHAND WELDING -- this is a special welding technique where you point the flame at the weld that is already completed.

BACKING STRIP -- this is a strip of material that you will use when you need to keep metal that is melted at the bottom of the weld. You may also use this strip to add strength to the thermal load of a joint so you can stop the base of the metal from warping too much.

BASE METAL -- this is what you call the metal that you are going to weld or that you are going to cut. If this is an alloy, it will be the metal that you have in the highest amount.

BRAZING -- this is actually several welding processes. You will use this when you have a groove, fillet, lap or flange joint that you need to bond. This will require a nonferrous filler metal that has a melting point higher than 800 degrees F (427 degrees C) but less then your base metals. Then, the filler metal will be distributed throughout the joint using capillary attraction.

DIRECT CURRENT (DC) -- a current that only flows in one direction -- forward.
- Flows in one direction and does not reverse its direction of flow.

DEFECT -- there can be defects in your weld after you create it. The main defects you can find are things like cracks, porosity, places where the metal has been undercut, or where you have a slag inclusion.

EDGE JOINT -- this is where you set two plates and put them together at a 90 degree angle with their outer edges.

Types of Welding

When you think about welding you might think that there is only one type of welding. This is a common idea because most people only see the finished product. However, there are many different types of welding that you might find interesting.

Welding is a way of joining metals to each other to make them firm and the metal forms a bond that is tight. There are a variety of bonds that are done depending on the types of welding you use.

Types of welding fit under categories as listed here:

Gas welding

This type of welding creates a flame from a burning gas and this creates the welding heat that is needed. You will see this in the following types of welding:

Propane torches -- people use this when they want to sweat a joint or when they want to solder two pieces of metal together. This is one of the lowest heats and can be used for small things.

Oxyacetylene torch-- this heat gets a bit hotter and many people say this is the most universal type of welding tool you can find. This is used when you need a very hot flame. This type of torch will weld a variety of things as long as you have the right metals and tools for it. It is generally used when you want to cut, braze, weld or solder something that requires a higher heat. You have to be careful though

because it is a type of heat that can be difficult to control and it can sometimes overheat the area.

Oxy-propane -- this type of welding is used when you want to solder, braze or heat something. This is a cheaper form of both of the types of welding that was first listed.

Arc welding

This type of welding creates the heat through the use of an electric arc. The types of welding that are done through this type of welding include:

Basic AC & DC arc welders -- when you are looking for a way to weld either heavy gauge steel or cast iron this is the type of welding to use. It uses rods that you guide along the place to be weld and these are made of flux coated steel or other materials.

MIG (Metal Inert Gas) -- this is a very quick way of welding and some say it is easier to do than regular arch welding. It is done through the use of a DC arc and it uses filler metal that is used with a spool of thin wire. You use inert gas instead of flux. This is usually used with steal bodywork and is a good choice when you need to weld sheet metal.

TIG (Tungsten Inert Gas) -- this type of welding uses an AC arc that is of high frequency and it is combined with a tungsten electrode that is shielded by inert gas. This comes together to create a torch that is controllable. This is a good choice to weld very thin metals

together. If you are working with aluminum or stainless steel this is a good choice.

TIG(GTAW) Welding Process Overview

The acronym TIG stands for Tungsten Inert Gas Arc Welding and the acronym GTAW stands for Gas Tungsten Arc Welding this is the same process but it is referred to by these two different names.

In the situation you will be welding using an electric arc that generates the heat. You then have a tungsten non-consumable electrode that then produces the weld you are attempting to make.

One of the things that have to happen in this type of welding is that the particular metal that you are welding has to be shielded from contamination in the atmosphere or you will get a poor weld. Because of this, the area is shielded using an inert gas like argon; this is used with a filler metal where necessary.

This type of welding needs constant current to flow across the arc using an ionized gas called plasma. Plasma also has metal vapours within it. You will usually use GTAW if you have to weld thin metals like stainless steel, aluminium, magnesium or copper allows. GTAW also gives the person who is operating the welding process more control of the weld.

What this means to the weld is that it is a stronger weld and has a higher quality than many other types of welding. Many experts say

that it is harder to learn, is complex and can be slower than other welding techniques.

Some welders like using a different kind of torch to produce plasma arc welding which is very much like this one but a little different. This type of welding will give a more focused welding arc, but usually this is done through automation.

How It Operates

The reason this welding process is the most complicated or difficult to master is because the welder has to use a smaller arc length; they have to be able to have a very steady hand. If they aren't able to keep a distance between the electrode and the piece they are working on, the piece can become contaminated and there can be problems with the weld.

This is also a two handed process because you have to be able to hold the torch in one hand and feed a filler metal into the space that you are welding. You can see that this is a very intricate process and one that requires high skill.

There are a few types of welding that will not require this type of weld and the individual will not have to use filler material these types include: edge, corner and butt joints. These types of welds are called *autogenous* or *fusion* welds (Source: Wikipedia).

A welder who is highly skilled in this process is able to alternate between using the torch and then using the filler material in a pretty fast way. As they do this the filler rod can be taken out as the

electrode moves forward, and it doesn't have to be taken out of the gas shied. This is a highly developed process for those who can do it well.

GTAW can operate using several different currents: positive direct current, negative direct current or alternating current. This will all depend on how they set up the power supply in the beginning.

TIG(GTAW) Welding Tips and Basics

Since TIG(GTAW) welding can be difficult there is all kinds of information that will help you understand it better and how to do it more effectively. In order to do the most effective welding using TIG you will need to prepare several things before you start.

What to prepare

The first thing you want to do is prepare the area where you are going to do your welding because you want it to be kept free of contamination. This means that you will have to really clean the area to make sure you have no grease, moisture or dust. You will also want to make sure there are no air drafts in this area because this could bring more problems.

The next thing to prepare is the metal that you are going to use for welding. You will need to make sure that the joints are as clean as you can make them and you do this by using a stainless steel wire brush. Many welders will dedicate one brush to whatever metal they have so they don't have to worry about cross contamination.

If have slag on any of the metal you can remove it with a file. Next, you will want to clean the base metal. The reason you want everything to be so clean is that if contaminated, the metal can either break down or make a bad connection. Of course, it depends on the metal which it will do, so cleaning everything can stop this from happening.

Beginning to weld

Many things can happen to contaminate your weld so you want to make sure that you have a shield gar to stop this from happening. Most welders will use Argon because it seems to work best with TIG(GTAW) welding. By using this gas, you are protecting the area from oxygen which can contaminate what you are doing.

If you are using thicker aluminum, you can also add helium to the Argon because it ionizes hotter than Argon and you will need the hotter temperature in these types of welds. If you need helium you can get these already premixed, this is available with your gas supplier.

A note about suppliers: they are not the same so you will want to make sure you use someone who is reputable. You will also want to make sure you have all the seals checked for leaks before you buy.

When you are checking for leaks as you weld the best way is to use water and soap and a small acid type brush. These together will produce bubbles if there are any gas leaks. All you do is apply this solution of water and soap on the joint to and if you see air bubbles, you know you have a leak.

You will want to check all your supply hoses and gas connections to make sure there are no leaks before you get started. Make sure the torch insulators and your o-rights are fitting properly and that the seals are intact.

It's also a good idea to use a gas lens on your torch because it makes the job easier to see and you have fewer problems.

MIG(GMAW) or Wire Feed Welding Process Overview

This process is called by many names and it basically is a welding process that uses an arc to heat metal that needs to be joined. The welder uses a continuous feed filler metal (a consumable) electrode and this is used on the work-piece. This type of welding also must use a shielding that is provided by a gas or a mixture of gasses.

This type of welding is also called short circuit transfer. In the MIG process, when the wire actually touches the metal to be connected, it lets go of the metal that does the welding. This makes sure that metal doesn't transfer across an arc so there is no puddling.

Also known as gas metal arc welding, the MIG(GMAW) process uses a metal gun to provide this service instead of a torch so that you get a direct current going to the metal. You can use both constant current and alternating current systems to also produce this method of welding.

GMAW uses four ways to transfer metal. These are:

Globular -- this method is difficult and used the least because it has a tendency to spatter because the gun will move to a high heat without warning. This makes the welding surface come out with flaws. This method uses carbon dioxide so the electrode tends to produce a ball of melted metal that cases irregular shapes that are bigger than the

electrode. They then drop and falls onto the piece you are working on which causes a spatter. This is difficult to control as you would imagine.

Short circuiting -- this uses a smaller current than the globular method but it still uses carbon dioxide. Because of the lower current you can actually weld thinner metals together with this method. This method is similar to the globular method because drops of melted metal from the electrode still forms, but it causes the electrode to short circuit instead of the drops falling on the work. This closes off the arc but comes back again because the surface tension pulls the metal goblet from the tip.

Spray -- this was the first method for transfer used with GMAW and used to weld aluminium and stainless steel. The difference with this process is that the electrode metal passes through an electric arc that is stable and goes all the way to the workplace. This stops spattering and you get a weld finish that is higher quality than in other methods. You also will watch as the current and voltage increases so you get small, vaporized steam droplets instead of large globules.

Pulse spray -- this last one is a newer way of doing this type of welding that uses a continuous current that pulses and melts the filler wire. In each pulse a small droplet of metal will fall.

This also allows the welder to use a lower current. The welder gets a more stable arc and this stops spatter and the short circuiting process. Because this process is slower, argon gas is used instead of carbon dioxide as the shielding gas.

MIG (GMAW) or Wire Feed Welding Process Tips and Basics

When you are looking for tips on how to make your MIG(GMAW) welding better and safer it is important to remember why you are using this method. It is also important to know some advantages and limitations of this method before you get started.

Some of the advantages of using this method include:

- You can use it with any commercial metals so you don't' have to worry about compatibility.
- You are doing a continuous weld and it pulls electrode wire off a spool.
- You can perform this method in many different positions.
- Your weld deposition rate will be higher than any other alternative process.
- You make more money because you can work faster.
- You can learn to manipulate the gun fairly easily.
- You can also adapt the process to other types of applications like mechanical and robotic.

There are a few limitations to this method however. These are things you need to know:

- You are going to pay more for your equipment and it can be more complex to work with.

- You might have a little difficulty in hard to reach places because the torch is bulky and has several cables.
- If you have wind or drafts around while you are using this method you can compromise your gas shielding.
- You'll need to dedicate some time to training to get the correct parameter selection.

With these things in mind, here are a few tips to make your welding process better:

1. Remember that most MIG (GMAW) applications will use a direct current polarity. This means that once you set the correct parameters you won't have to change anything in the process because it regulates itself.
2. The electrode extension is important because its length will determine the arc you will have when you are working. You have to set the length before you start. The current will flow in the wire and it will heat the length of your wire; then the current will heat your arc.
3. The short circuit method of transfer should be used if you want to weld thin materials or large gaps in a joint. This method uses the lowest range of current and small electrodes. This will insure that you have low head and a small, quick weld pool that will freeze.
4. The Globular method of transfer should not be used if you can get away from it because it is so difficult to control. You can use it on flat services but there are other methods that work better. It also makes spatter uncontrollable.
5. If you need to weld thicker sections use the spray transfer

method because you can use a higher current and a higher deposition rate than other methods. You can get a spatter free stream of drops and this method can be used in all of the welding positions.

Finally, when you are purchasing MIG(GMAW) supplies make sure that you purchase them from a reputable dealer. Also check all of the parts to see if they are working before you make the final purchase.

Stick Welding Process Overview

Stick welding is a process that uses a covered electrode that is also called a stick. The full name for stick welding is Shielded Metal Arc Welding (SMAW) and is more widely used than many other methods of welding.

This works by melting the flux that covers the electrode as the welder welds a work-piece. As this process continues it forms gas and slag and these two things shield the arc and the weld pool of molten metal. After the work-piece is welded the welder must chip off the slag. The flux also adds scavengers, deoxidizers and other types of alloy elements to the metal during the weld.

There are many advantages of using this method. First of all this is one of the most inexpensive ways to weld because the equipment is easy to use, portable and inexpensive. You don't have to worry about regulating the flux because the electrode does the regulating of the flux. This method is also less susceptible to wind and drafts than other methods, especially the welding processes that are gas shielded. You can also use this method in any position.

The Stick welding process overview shows that this process is used more than any other form of arc welding. It is also versatile, flexible and used by a wider variety of individual. As an example, you can use this method to make small repairs around your home, you can repair equipment and it is used in the erection of still and other commercial types of joining metal.

Sometimes there can be problems with stick melding but they are relatively easy to fix. Some of the most common problems you may run into include:

- Spatter -- this basically makes the metal look messy and it is expensive to clean. There are many things you can do to fix this and we will talk more about this in the tips article.

- Undercutting -- this also changes the appearance of the metal and can weaken the weld especially when it has tension or fatigue.

- Wet Electrodes -- if you see that your arc is erratic or it is acting rough, then the electrodes can be wet.

- Cracking -- there are different types of cracks can happen in different spaces in the weld, and it can be caused by high carbon or high alloy content.

When you are looking for flux coated electrodes you can find them in many different sizes and lengths. The best way to tell which ones you need is to match the base metal with the properties of the electrodes. You can usually find them in bronze, aluminum bronze, nickel and stainless steel.

Of all the electrical welding methods, stick welding is the most versatile because it can be used to weld more metals together than many of the other methods. It is also one of the easiest to do though it

will take practice if you are truly a beginner to welding. However, even when you are a beginner it is quick to learn and with practice you will do a very good weld using this method.

Stick Welding Tips and Basics

If you want to learn stick welding it will take practice and a little patience to learn to do it in a way that will produce fine welds. This is an important thing to remember although some people may say they never had to practice much.

Stick welding is one of the basic methods of welding that many students learn as they are just beginning to learn welding. This is also a method of welding that is high in demand because people need this help whether they are working iron, pie, boilers or building ships.

You will find that you will need the skills of all types of positions including flat and horizontal and ventricle or overhead welding. All of these will take some time to learn and some will be more challenging than others.

Here are some tips to help you make a better weld:

- The right electrode for the job -- many people aren't sure of the size of the electrode they should use and this is important to know. The size of the electrode will depend on the situation you are welding within. In this situation you will be fighting against gravity if you are doing the weld vertically so you will want to use an electrode that is AWS classified as 7018 because they are low in their powder content.
- A weld shelf makes a good guide -- if you are doing vertical or horizontal welding you will need something that the electrode

can follow so you don't loose any of it to gravity. You can do this by creating a serious of little shelves so you can do a section at a time so that you can continue to work above a weld that you have already laid. This will create a situation where one puddle will freeze in time to hold the next weld.

- Don't undercut if possible -- this can happen because you have to weave the electrode and sometimes your work may be gouged and not have enough fill metal. When this occurs, you will be working against gravity because it will work to pull your fill metal away from the space you are working. You can reduce your puddle size to help you have more control in this situation.
- Stay away from weird sizes for your metal -- most metal will come in specific sizes that are always common. These metals will be easier to find and you can weld them fester. Stick with the ones that are AISI-SAE 1015 to 1025 so that you can be sure that you have what you need.
- Make sure you know your arc length -- a good rule of thumb is to use an arc length that is the same distance from the metal as your electrode's thickness. As an example, if you have an electrode that is ¼" thick, then have your arc ¼" thick. Also remember that as you use the electrode, you will have to move it closer to the metal.

These tips will help you develop a more even weld and keep things more controlled.

Flux Core Welding Overview

According to Wikipedia, Flux core welding is a semi-automatic or automatic welding process. This means that the welder needs a way to continuously feed a tubular electrode (consumable) that has flux with a constant voltage. Sometimes the welder may use a shielding gas but it is not necessary; the flux will protect the process from contamination.

Because this is a process that is quick, it is used in construction. This is also a portable process.

There are basically two types of Flux Core Welding overview that are used: one type uses a shielding gas and the other one does not. With the first type a shielding gas is not used because the flux already has characteristics to resolve a contamination problem so it acts as its own shield. Most welders prefer this type because it penetrates well with the base metal and because it is portable.

The second type uses an outside source for its shielding gas and generally is used to weld different steels together. This type of welding process is used when you have very thick metals to join together or when you have metals that are out of position for some reason. You will have to be wary of outside air conditions when using this one because too much wind could make slag on your metal.

There are many advantages of using this type of welding process. Some of them include:

- You can generally use this in every position if you use a consumable electrode for the filler metals.
- You can use it outside and in windy conditions if you use the first type of welding because you don’t need a shielding gas.
- The deposition rate is high
- Some of the processes, like when you are using it in the automotive industry, are higher speed than other processes.
- You don't have to pre-clean the metal as much as in other processes.
- The operator doesn't need a high level of skill to operate this procedure.

There are also a few disadvantages with this process too, and some of them include:

- Sometimes you can have an incomplete fusion that happened between your base metals.
- When a welder's hand isn't quite steady they may touch the base metal with the electrode and this can result in a melted contact tip.
- If the machine isn't feeding the wire properly it will result in having an irregular feed of the wire.
- You can have a condition called porosity if the gases aren't releasing properly before the metal you are working with hardens. This will cause holes to be made inside your metal that has been welded.
- This can't be used when the metal you are going to weld needs painted.

The good news is that you can use this on most steels. It is good for some of the higher nickels, stainless steels and some of the wearfacing or surfacing metals.

If you need to understand more about how to do this process there are a variety of websites that have step-by-step videos of how to do many aspects of this process.

Submerged Arc Welding (SAW) Overview

One of the most common welding techniques is the Submerged Arc Welding (SAW). It is important to note that this was one of the first types of welding to get a patent. To do this type of welding there needs to be an electrode that is either tubular or solid (consumable). This will need a continuous feed as well.

In order to protect the weld and the arc zone they are "submerged" to protect them from contamination from the atmosphere. Fusible flux that includes lime, silica, manganese oxide or calcium fluoride is used under a blanket. Other compounds can be used as well.

As it melts the flux acts as a conductor and creates a path for the current that moves between the electrode and the work that is being done. This creates a thicker layer of the flux and it covers the metal as it melts. By doing this process there is no spatter or sparks because the flux is covering everything. This process will also suppress any ultraviolet radiation or fumes that will from this Submerged Arc Welding (SAW) process.

Most welders will do this process in either an automatic or mechanized mode of operation but some of the other types of guns like the semi-automatic ones (that are hand held) can be used since they have a pressurized or a gravity type of flux feed. Usually you will have to use this in either the flat or horizontal fillet positions.

The SAW technique of welding uses a standard wire and it can also use some of the specialty forms. A good wire for this filler material will be between 1/16 and ¼ inches thick. Sometimes welders have used a wire that is twisted so the arc will begin to oscillate. Sometimes this will be helpful to fuse the bottom of the weld and the base metal together.

There are several advantages to using SAW which include:

- It has a high deposition rate and it can penetrate the weld deeply.
- When you have designed a good process and you have control over what you are doing you can be sure that you get a strong weld.
- You can actually do this with thin sheets of steel and they can be done at a higher speed.
- There are very minimal fumes or arc lights which makes this a safer process.
- You can do this indoors or outdoors.
- You don't have a lot of distortion.
- You don't get any spatter on the weld because the arc is always under the blanket of flux.

As with any technique there are a few limitations with the SAW method that include:

- You are limited to only a few positions that you can use this within.

- You can only use steel, stainless steel or a few nickel based metals.
- The flux handling systems can be more complex and difficult to use.
- Slag is a problem in a couple of ways: you can get residue from it that may cause some issues with your health or with safety and it will require a complicated slag removal system.

Brazing Overview

When you join two pieces of metal to a third piece of metal that is a filler metal that is molten, you have a technique called brazing. This type of welding is said to be versatile and the joints that are brazed have a very strong tensile strength. One reason to use this method is because it can make the two metals stronger when they are bonded then when they are separate metals.

One of the good points for brazing is that when you have brazed the joints they will repel gas and other liquids so that the metals can resist vibration and they do are not affected with changes in temperature. They can also resist shock.

Also, since the two metals are joined they don't warp or distort but they are able to keep all their metallurgical properties. You will also notice that because the joints themselves are not melted, they come out very clean and you have a nice finish.

Brazing is usually used for the manufacture of plumbing fixtures, for making tools, used in high quality products for consumers and in heavy construction. You can use this process when you want to join two metals that are different. This is also a quick and very cost effective method.

When you are considering what welding process to use it is a good idea to think about the total project and what you want it to do. When you want a strong and permanent fixture then brazing is a better

technique. One of the reasons this is a better technique is because it is more flexible than other forms of welding and you can make mistakes that can be easily corrected and changed as you go.

Brazing can also be used with thin metals because you won't have a lot of warping or distortion. You can also braze linear joints a lot easier than with welding because the filler metal that you use will automatically flow to the joint you are trying to bring together.

There are three ways for you to have the heat that you need for brazing. These three ways are: using a hand held torch, using a furnace or you can use an induction heating system. You can use torch brazing for small areas, but you will have to practice this a bit before you do it on something important. The reason is because you have to have a steady hand and be able to control the movement of the torch.

There are basically three types of brazed joints:

Butt joint -- this is when you have two metals that you want to join end to end. This is a strong brazing when you have enough bond surfaces to work with.

Lap joint -- this type of joint is used when the welder wants a strong bond. The two metals will be overlapped which makes a larger surface to bond, and a stronger bond.

Butt-lap joint -- when these two types of joints are brought together, they create one single thickness and a strength that is stronger then the two individually.

Robotic Welding Overview

Robotic welding is used when an industry wants to animate their welding process. You may know about this type of welding because it is often used on assembly line work, especially in the automotive industry.

Robots are used to handle the parts that need to be welded and to perform the weld. Robots are generally used when you want to do resistance spot welding or arc welding where there is a need for high production.

Although robotic welding is fairly new, they were started in about the 1980s when the automotive industry found that they could use robots to do spot welding. As of 2005, there were over 60,000 robots being used in many industries in North America for welding.

Robotic welding can be relatively expensive to do so it can be difficult for some industries to bring in more equipment. Many robots are being "employed" to also do arch welding and they have two parts: the manipulator that is how the robot is able to move, and the controller which is the "brain" of the operation and actually performs the weld.

They can also optimize welds because of a process known as signature image processing in which data can be collected from the robots in real time, analyzed and then used to create better welding systems.

Types of Robots: There are basically two types of industrial robots:

Rectilinear robots move in a boxed shape along three axes. They are the ones that may be most common in looks because they have a "wrist" at the end of their movement arm so they can move the arm in a rotation.

The ***articulating robot*** is the second type of robot and it moves in irregular shapes. They have both arms and joints that rotate. In this process the arm moves similarly to the way a human arm works and they also have the "wrist" that rotates at the end of the arm.

When setting up a robotic aspect of welding it is important to realize that this is not the same as doing welding manual. Many things have to be taken into consideration around reliability, the number of axes you need and the space where the robots will be installed.

On the human side of this you will have to make sure that there is someone there to check the welds, someone to do maintenance and seam tracking programs should be in place.

Robotics has advantages and disadvantages. As an example, many manufacturers use robots to do the monotonous tasks that are difficult for humans to continue to perform overtime. However, robots will need recalibration, reprogramming and regular maintenance. People need to be in place to take care of these needs.

You will also have to make sure that the robots you choose have the right amount of motions to do the job well. You may also have to consider having a backup system of robots in case something goes wrong.

Although robotics seems to be an interesting and exciting way to do welding it is something that needs to be well researched and organized before going to the expense.

Laser Welding Overview

Laser Welding is also called Laser Beam Welding and it is a commercial process and is used when you want to fuse together several pieces of metal. The way it works is that a laser beam is pointed to a joint and then the beam is moved along that joint. The process will melt the metals into a liquid, fuse them together, and then make them solid again.

This is generally a process that is used when you want a linear continuous seam or at times when you want spot welds in a certain area. There are basically two types of laser welding. ***Laser conduction*** welding focuses the beam on a specific area and relies on the conductivity of the metal it is melting to conduct the heat into the joint. As this happens, the material being welded changes from solid to liquid, and then they turn back into solid and they are welded.

In laser penetration welding, the laser beam is pointed into a certain area and at a stack of material that needs to be melted all together. This single location creates a space for the beam to concentrate on the specific needs of the metals to be melted. Some of this material will then vaporize and create a hole that is as thick as the material that was heated.

After the heating and cooling down of the metal it is welded; this is similar to a spot lap joint. The two types of lasers that are used for this process are the ***Gas Laser*** that uses a mixture of several gases that can include helium, nitrogen or carbon dioxide for its media, or a ***Solid***

State Laser that uses a solid media like a synthetic ruby aluminum oxide or gas. Both type so lasers can be used as continuous streams or pulsed modes of operation.

The Laser Welding process is very versatile and it can be used on many different steels including carbon, HSLA, stainless, aluminum or titanium. In some instances like the carbon steels, you will need to guard against cracking because of the cooling rates. This type of welding does gain a high quality weld and it can be a very fast process, depending on the thickness of the piece you are working on.

The automotive industry uses Laser welding for much of what it does and the gas lasers are usually the most readily suitable for this type of high volume.

There are several advantages of laser welding. You can send the laser beam through the air rather than having to place it in a vacuum and robots can easily do this type of work. You can get a higher quality in your welds.

There is also another hybrid type of laser welding that is called laser hybrid welding and it combines both laser beam and arc welding so you get more flexible positions and welding speeds are higher, and undercutting is reduced.

A few of the advantages to laser welding are that you can do deeper or more narrow welds than can be done with other processes, you don't have to worry about distortions because they aren't created with the laser.

Resistance or Friction Welding Overview

Resistance or Friction welding are two welding processes that fit into a category of processes that works with a workpiece that is moving and another piece that remains stationary. In the process heat is generated through friction as the two pieces come together and an "upset" (a lateral force) displaces and fuses these materials.

Friction welding is generally used with thermoplastics and other metals and is used a lot in the aviation and automotive industries. In friction welding there is no melting and the heat is directed to the weld interface. This creates a small heat zone. Also, as the friction is happening it cleans the surface of the materials to be welded so the welder does not have to prepare the surfaces before welding.

This method of welding also has several advantages. The metal that is used has small pieces of "plastic" metal that is forced out of the area where the friction is happening. This metal called "flash" comes out in ripples and seems to carry away the dirt or the debris that would normally occur when doing welding.

Two different types of metals can also be joined using this method. An example of this is in the aerospace industry where they use friction welding to bring together aluminum and high-strength steel. This can only be done in friction welding because they are two different types of metal. The nuclear industry also uses this method to do cooper and steel joints that are used in the reactor's cooling systems.

When you have metals that are under a lot of pressure and heat you will be working with thermoplastics. You can join metal and plastic together. A good example of this is when they use friction welding to join the pins of eyeglass frames to the rest of the frame.

There are several welding techniques that use friction welding. ***Spin or inertia welding*** has two "chucks" that hold the metal with one stationary and the other that rotates. The piece that the welder wants to weld is put on the rotating chuck and a flywheel is added so that it will have a specific weight. They then spin the piece they want to weld at a high speed, then remove the motor and the pieces are put under pressure and forced together. The pieces "set" once the spinning has stopped and the pieces have cooled down from the friction.

Linear friction welding is like spin welding but instead of spinning it oscillates in a lateral motion. The speed that the welder uses is lower and the pieces are kept under pressure throughout the entire process. In order to do this type of welding the industry needs a more complex machine which is a bit more expensive, but it also allows any two shapes to be joined.

Thermoplastics have other methods that they use for friction welding. In Orbital friction welding an orbital motion is made by the moving part (similar to the spinning friction process) and it rotates in line with a smaller circle than the joint.

Ultrasonic Welding Overview

Ultrasonic Welding is a process where the high frequency vibrations of an ultrasound are applied to a piece that is to be welded. The pieces are put under pressure and held together until they create what is know as a solid state weld. Usually there needs to be a frequency between 20 and 40kHz in order for this to work. This type of welding is used for plastics and for joining two different materials.

By using an ultrasonic vibration there is no need for bolts, nails, soldering or adhesives to keep the materials together. By using these vibrations on thermoplastics melting occurs on the plastic as it pulls in the energy of the vibration, which is pulled across the joint that needs to be welded. On metals, ultrasonic welding happens when the material is taken through friction welding.

The vibrations from the ultrasonic welding machine are produced by a welding sonotrode (horn) and they soften the thermoplastic material along the line of the joint. The equipment that is used will determine how strong the weld is and this will depend on how the equipment is designed, the materials to be welded and their properties and how the joint is designed.

The time it takes ultrasonic welding to happen is very short and for mass production this type of welding works very effectively. This type of welding will be used in the automotive industry for light clusters of things that need done and in producing electronic products like the casings in mobile phones.

Ultrasonic welding is used to weld both hard plastics and soft plastics and some metals. Today the machines are able to even do semi crystalline types of plastics. There is research and testing going on to see how this process works because not everyone has understood the power of this process. They are studying areas like how the process parameters of something to be welded with relate to the quality of the weld.

The process has needed to be studied because there has been more of a demand for different types of plastics and for electronic pieces which are best made by this process. In many respects it is still a developing field.

Ultrasonic welding is made up of several components. Some of these components are:

- It needs a press that can hold two different parts that will be put under pressure.
- An anvil to put the parts in place to take on the elevated frequency vibration that is needed to hit the pieces.
- Something called an ultrasonic stack that has a converter that holds the horn that needs to be tuned to the specific frequency.
- An electronic ultrasonic generator that can deliver a higher power AC signal that can match the frequency that matches the resonance of the stack.
- A controller that can control the movement that the press will make and how it delivers the ultrasonic energy.

Ultrasonic welding can be found in many different areas beyond electronics and the automotive industry. This process is also used in the electrical area, with computers, with aerospace and with the packing and medical industries.

Stud Welding Overview

When a bolt or a nut needs to be welded onto a different metal part, stud welding is used; this is another form of the process known as spot welding. Spot welders are usually automatically fed the bolds. These types of weld nuts have a flange and the flange has a smaller nub that is able to melt and create the weld. On studs there is also a part that is un-threaded and necked down which also helps in the melting of the stud.

Stud welding is another form of arc welding and it brings a piece of metal and a stud to join together. In most cases there is a flat plate that the stud is joined to and the stud works as an electrode. There are different polarities for this process that are determined by the type of metal that you are going to use. The different steels tat you use will require a different type of current.

The way that this is done is through a weld gun where you place the stud against the metal and then an arc is created and it melts the stud and part of the area where the metal is located. The stud is pushed into the pool of molten metal and it stays in place until the two materials are solid again. This happens within milliseconds and makes a very strong connection weld.

This can be a portable process with the help of a portable stud welding machine. This is a very flexible type of welding and can be used in automobiles to work on the bodies, it can be used to weld electrical panels and in construction of ships or buildings.

There is one type of stud welding that is different than the regular type because it doesn't need flux to make it work. This type is called *capacitor discharge stud welding*. Because this type doesn't need to have the heat concentrated it lets the weld happen quickly and there it has eliminated most of the oxidation.

The capacitor discharge stud welding is most often used when you have small diameters that need to be fastened to a thinner base metal. The arch stud welding is usually used for the larger diameters that need to be fastened to metals that have a thicker base or that are rougher in texture.

There are many advantages to using stud welding and some of it is for appearance. With stud welding you can produce a uniformed look because the energy that is used to create the weld is monitored and controlled meticulously so that the amount of the energy used is consistent. This makes the weld strong and consistent.

You can also use stud welding with a variety of steels including aluminum, stainless steel, copper, brass and even zinc. Some of the more exotic steels can also be used in this process. This process also eliminates the need to do anything extra to the holes like drilling or tapping and the surface metal will not have to be touched up by polishing; this method does it all. This makes a very strong connection.

Underwater Welding Overview

Underwater welding is done under water in the ocean and is used when there is a need to repair a ship, oil platforms that are offshore and pipelines. Usually these all need to be repaired using steel only. There are two basic types of underwater welding and these will depend on whether the situation needs a dry welding or a wet welding. These are called *hyperbaric welding*.

Both of these occur underwater but the dry aspect is done through a special pressure chamber that creates the dry environment. This dry mode can be better controlled underwater. This is used when there is a need for very deep water welds and where a high degree of strength is required. Research is being conducted to see whether dry welding can be done at depths of 1000 meters.

When dry welding is used, the chamber is filled with a gas mixture has to be used to seal the structure that is being welded. Usually a gas tungsten arc welding is used to make sure that this is a strong weld. For those structures that receive wet underwater welding it is difficult to know whether the weld has worked because the risk that may be involved are difficult to see in the water.

One of the challenges with doing welds underwater is that integrity of these welds are difficult to determine because there can be defects that are underneath the surface that is being weld and these can be hard to find.

There are several processes that can be used underwater and these include flex core arc welding, friction welding and shielded metal arc welding. All of these are good to use underwater with a waterproof electrode. Since hydrogen will cause cracks in metal, low carbon steel is usually used in performing the underwater welding.

The greatest challenge for underwater welding is that is may not be a very safe situation because the welder is in water. This means that there is a higher risk for electric shock and some equipment being used may not be adaptable to a marine setting. Any type of welding equipment that is going to be used underwater has to be adapted to this environment and it needs to be insulated and have a controlled welding current.

Another area where welders who work underwater will need to be careful about is that they are susceptible to decompression sickness if they have been underwater for a long period of time. They will be breathing an increased pressure of gases during this the time they are welding and this can create problems for them when they come out of the water.

Both hydrogen and oxygen will also build pockets underwater because of their ability to explode. Some divers have found that they experience a metallic taste in their mouth, especially when they fillings that are made of amalgam. There may also be problems with cognitive processing or musculoskeletal issues when a diver has been exposed to underwater welding over time.
Although this is an important process, welders who dive must make sure to take safety precautions.

Plastic Welding

Plastic welding is the ability to take two pieces of plastic and weld them together. This is a type of weld that will be done on children's toys, lawn furniture, automobile parts and other types of plastic equipment that you may use everyday or commercially.

This type of welding is used to join thermoplastics when they are heated and under pressure. Generally the pieces are fused together with filler material, but some instances do not require filler material.

Plastic often has a shorter lifespan than most types of products because there are so many things that can go into how it is maintained. Elements from nature like cold weather, UV rays from the son or chemical contamination can create damage with plastic. Plastic can also receive damage if it is hit hard like in a car bumper or other hard surface, but the purchase of the new parts can be cost prohibitive; this is when it may be a good idea to repair it instead.

There are different types of plastic so it is important to know which one you are working with in order to make sure that the proper welding material is used. It is a good idea to understand the difference between thermoplastics and thermosets because thermosets cannot be welded.

The type of plastic that needs repair will require different welding rods and if you use the wrong rod for the plastic you need to repair, there

will be no bond. Materials like Polyolefines have a lower surface energy so this means they cannot usually be repaired with an adhesive or other types of glue. There are a special group of polyolefine adhesives that can do this job.

When you are making repairs on plastic there are usually two types that you will come up against -- you will either have to repair a crack or a broken part. If you find a crack, it means that there is some type of stress affecting the inside of the material you are using. This means that you will have to repair the crack and make sure it doesn't continue through the piece.

There are several types of plastic welding. A few of them are:

- Hot gas welding uses a welding gun that has electric heating elements within in it that produce a heat of hot gas.
- Hot plate welding uses a hot plate between the two surfaces that are being joined. Ultrasonic welding uses a high frequency acoustic vibration to weld the pieces together. These are placed under high pressure and then exposed to the vibrations until the weld is completed.
- Spin welding where friction is used to weld two cylindrical parts as these parts are rotated. At a certain time the rotation stops and the weld is completed.
- Vibration welding takes to pieces of plastic and exposes them to a frequency called an amplitude. The two pieces are under pressure which causes a friction that generates heat.

All of these types of welding work on plastic and they are geared towards working with a variety of polymers.

Thermite Welding

Thermite welding is a process that results from a chemical reaction that is created through heating metal to a super high temperature between two reducing agents, one of which will be a metal oxide and the other aluminum or sometimes other types of reducing agents are used. This can be done with pressure or without pressure. At this point the liquid metals will produce a filler metal.

The chemical reaction that is produced will give off a temperature of 4500 degrees Fahrenheit or 2482 degrees Celsius. This metal that was created with high heat is found in a crucible that is part of the weld joint. It is actually above this joint.

This chemical reaction or exothermic reaction as it is also called, will be slow compared to other processes; it takes about 20 or 30 seconds and it doesn't matter how many chemicals are part of the process -- it still takes about the same amount of time.

When the welder wants to weld two things together, the two parts are lined up equally but a gap is made between the two pieces of metal. Before the two pieces of metal are put together there is a mold that is put between them so that the hot steel can go into the mold. Because this new metal is hotter than the base metal, the base metal will melt along the edge of the pieces to be welded.

From the crucible, the hot metal now allows heat to be lost and this causes the metal that has been melted to become solid again and a

process called *coalescence* happens and this completes the weld. In the event that you have larger parts that need to be welded, you may need to preheat them and this is done inside the cavity within the mold. This is done to bring these larger pieces to the correct temperature for welding and the process also help to make sure that the mold is dry.

When you have smaller parts, this preheating is usually not necessary. The mode that is used for thermite welding is the automatic one which means that once the chemical reaction starts, the process continues until it is finished.

The process of thermite welding uses gravity to bring the metal down to the cavity between the two parts through the gap. This practice of welding is like pouring castings in foundry type businesses. The basic difference between these two processes is that in Thermite welding the temperature of melted metal is higher.

After the metal filler cools you may find extra filler on it and this can easily be removed by using a machine, grinding it or by using oxygen cutting. However, when the weld is finished you the finished weld surface is usually very smooth and you don't have to worry about doing any finishing.

Thermite Welding is used a lot at the Railroads to weld the rails together. A couple of advantages of this type of welding is that it that it doesn't need a power source that is outside of the process because the heat is produced through the chemical reaction and you can join parts if they are larger and have heavy sections.

Finding a Good Welding School to Learn Welding

When you are looking for a good welding school to learn welding it will be important for you to think about several issues before you go. A good question to ask yourself is "What do I want to do?" and "Who has what I need?" These two questions will be determined through looking at a variety of schools that may meet your needs.

Finding a good welding school to learn welding will be determined by the type of welding you want to do in the end. Do you want to work on specific projects that are small ones or large ones? Are you interested in doing underwater welding? Are you interested in just learning the basics?

Do you want to do welding as a career where you can start out with someone else or do you want to start on your own? Many of these questions will be important for you to know before you start doing research on schools.

Another thing to consider is whether you want to go for formal training at a trade school or at a college. The difference between the two will be important. At a trade or *vocational school* you will learn the *trade* of welding and everything you do will be geared towards learning the trade.

At a college or university you will learn the trade, but as part of a larger group of studies. There are also online schools that are both formal and informal so you will need to know the best way for you to learn.

There are several ways you could decide to go to school in one of the areas. You could go to a college or university as suggested, or you can find one of the many welding schools; the third option is that you can go directly to the trade union for welders and apply for an apprenticeship. All three options should give you plenty of hands on work, but each will provide you with a different experience.

You can also visit one of the schools near you to see what they do -- in fact, you can take a class to see whether it is something you want to do and whether the course work will give you what you need.

Another option you might try is to go to one of the larger and reputable welding schools like Lincoln or Hobart where they have one and two week courses in TIG welding. You can do this for the short term and decide as you go whether this is an opportunity that you will like, and whether the information you receive is what you need.

With all of these options you will have an opportunity to work in the field, with hands on instruction and some of the opportunities may get you a job before you finish the schooling.

Another good idea is to talk to your friends about welders they know or you can talk to welders you know if you know anyone to see if they

can make recommendations. Always visit the school though before you decide on finding a good school to learn welding.

Weld Symbols

When you first start welding it may be difficult to understand what you are seeing when you look at the weld symbols. However, if you think of this as a system of codes or a way of shorthand that tells you different information about the weld that needs to be done, these weld symbols will be easier to read.

The information you can gain from these symbols is important; they tell you the type of weld to do, the size of the weld you should do and other information about how you will process it or finish the job. These are all weld symbols that are set up by the American Welding Society and the American National Standards Institute.

The first part of the weld symbols that you will find is a horizontal line because this is the one that tells you much of the information. This is also referred to as the *reference line* because it is the part that all the other symbols will be attached to. In other words, you will look at this line first to see what is needed a then the other lines act as the *attachments* for the rest of the work (attachments similar to email attachments).

There are also going to be arrows on different parts of a diagram after this initial reference point to show you where you need to do the weld. You might have one side of the joint that needs welding or more than one place. The diagram and the reference line will tell you what to do.

You will know which side you need to weld by the way that the symbols are laid out. As an example, the weld symbol will show one side with an arrow and white space that will put the reference line in the middle of the space to be welded.

You will have the side with the arrow called the *arrow side* and whatever information you have below and above the reference line will be what you will do on that side. The second side of the joint of course called the *other side* will have directions of what to do listed under the reference line. This helps to keep things form getting to confusing, and will be the same no matter how the arrow is directed.

When you see a small circle around the angle part of the arrow and the reference line, this indicates a *flag* which means that the weld you are making should be made in the field when you are creating the structure. If you do not see the flag then this means you are to do your weld inside the shop. Also, the circle may also tell you that the weld needs to go the full circle of the joint. In some of the drawings of older structures you might see a filled in black circle which will indicate that this weld should be done in the field.

You will find that every weld type will be shown with a different symbol and usually it will be placed close to the center of where the reference line is located.

Welding Job Types

When you are interested in welding it is a good idea to know the types of welding job types there are and how they are used commercially. This will help you the types of skills you will need to do the work.

The challenge for most people is that there are so many welding job types that it is difficult to pick what you want to do. This is where a little research and a lot of information interviews will come in handy.

Currently any type of welder is needed in many industries. According to the Carolina Energy Solutions, welders are in high demand because of the changes that have been made in several industries. As an example, there is more demand for welders in the building of nuclear power plants and other energy sources as well as in construction and in repair work.

According to the Wall Street journal, in an article in 2006, all types of welders whether they specialize in welding, brazing or soldering are in demand because of all the construction that continues to grow at least until 2014; in fact the need for new skilled welders is said to increase but the supply hasn't met the demand.

Some of the skills needed to be a good welder and get a good job include:

- Blueprint reading - -you have to be able to read a blue print very quickly and know exactly what you need to do in the job.

- Safety -- you have to know the safety rules and how it affects you, other people and the equipment you use. You have to be sure to help people stay safe.
- Lots of concentration -- you have to be able to focus on the job for long periods of time and not get distracted.
- Be able to serve customers -- although you may not think this is something that would be included in welding, it means that you need to be able to get along with customers and other staff.
- You need good eyesight and are detail oriented.

If you have the skills many people are ready to put people to work since the demand for skilled welders outweighs the demand. All though this can be a dirty job and you may have to work 60 or more hours a week, most welders say a skilled welder can make around $30 an hour which translates into about $60,000 a year; this can happen when you first start the job if you are skilled.

In order to get a high paying job right away, as you are going through your training it is important to get as much experience as possible. This allows you to practice certain techniques and acquire more skill towards a job. You also should be certain of your skills and how to put them onto a resume -- a career guidance counselor can help in this area.

Many welding jobs expect that you will be able to pass a certified test so it is important to find out what you will need to understand in order to be tested. All of these little details can help you find the job that you want.