General Information about Welding

What is welding?

Welding refers to the uniting or fusing of pieces by using heat and/or compression so that the pieces form a continuum. The source of heat in welding is usually an arc flame produced by the electricity of the welding power supply. Arc-based welding is called arc welding.

The fusing of the pieces can occur solely based on the heat produced by the arc so that the welding pieces melt together. This method can be used in TIG welding, for example.

Usually a filler metal is, however, melted into the welding seam, or weld, either using a wire feeder through the welding gun (MIG/MAG welding) or by using a manual-feed welding rod. In this scenario, the filler metal must have approximately the same melting point as the material welded.

Before beginning with the welding, the edges of the weld pieces are shaped into a suitable welding groove, for example a V grooves. As the welding progresses, the arc fuses together the edges of the groove and the filler, creating a molten weld pool.

For the weld to be durable, the molten weld pool must be protected from oxygenation and effects of the surrounding air, for example with shielding gases or slag. The shielding gas is fed into the molten weld pool with the welding torch. The welding electrode is also coated with a material that produces shielding gas and slag over the molten weld pool.

The most commonly welded materials are metals, such as aluminium, mild steel and stainless steel. Also plastics can be welded. In plastic welding, the heat source is hot air or an electric resistor.

What generates the arc?

The arc needed in welding is a burst of electricity between the welding electrode and the weld piece. The arc is generated when a sufficiently great voltage pulse is generated between the pieces. In TIG welding this can be accomplished by trigger ignition or when the welded material is struck with the welding electrode (strike ignition).

Thus the voltage is discharged like a bolt of lightning allowing the electricity to flow through the air gap, which creates an arc with a temperature of several thousand degrees centigrade, at maximum as much as 10,000 degrees (18,000 degrees Fahrenheit). A continuous current from the welding power supply to the work piece is established through the welding electrode, and therefore the work piece must be grounded with a grounding cable in the welding machine before welding is started.

In MIG/MAG welding the arc is established when the filler material touches the surface of the workpiece and short-circuit is generated. Then efficient short-circuit current melts the end of the filler wire and welding arc is established. For a smooth and durable weld, the welding arc should be stable. Therefore it is important in MIG/MAG welding that a welding voltage and wire feed rate suitable to the weld materials and their thicknesses are used.

Additionally, the working technique of the welder affects the smoothness of the arc and, subsequently, the quality of the weld. The distance of the welding electrode from the groove and a steady speed of the welding torch are important for successful welding. Assessing the correct voltage and wire feed speed are an important part of the welder's competence.

Modern welding machines, however, have several features that make the welder's work easier, such as saving previously used welding settings or using preset synergy curves, which make it easier to set the welding parameters for the task at hand?

The purpose of shielding gas

The shielding gas often plays an important role in the productivity and quality of welding. As its name suggests, the shielding gas shields the solidifying molten weld from oxygenation as well as impurities and moisture in the air, which may weaken the corrosion-tolerance of the weld, generate porous results and weaken the durability of the weld by changing the geometrical features of the joint. The shielding gas also cools down the welding gun. The most common shielding gas components are argon, helium, carbon dioxide and oxygen.

The shielding gas can be inert or active. An inert gas does not react with the molten weld at all while an active gas participates in the welding process by stabilising the arc and securing the smooth transfer of material to the weld. Inert gas is used in MIG welding (**m**etal-arc **i**nert **g**as welding) while active gas is used in MAG welding (**m**etal-arc **a**ctive **g**as welding).

An example of an inert gas is argon, which does not react with the molten weld. It is the most commonly used shielding gas in TIG welding. Carbon dioxide and oxygen, however, do react with the molten weld as does a mixture of carbon dioxide and argon.

Argon (Ar) is an inert shielding gas, which does not react with the work piece. It does not cause oxygenation or affect the chemical composition of the weld. This is the most commonly used shielding gas in TIG welding.

Helium (He) is also an inert shielding gas. Helium and helium-argon mixtures are used in TIG and MIG welding. Helium provides better side penetration and greater welding speed compared to argon.

Carbon dioxide (CO_2) and **oxygen (O_2)** are active gases used as the so-called oxygenating component to stabilise the arc and to ensure smooth transmission of material in MAG welding. The proportion of these gas components in the shielding gas is determined by the steel type.

Welding norms and standards

Several international standards and norms apply to welding processes and the structure and features of welding machines and supplies. They contain definitions, instructions and restrictions for procedures and machine structures to increase the safety of processes and machines and to ensure the quality of products.

For example, the general standard for arc welding machines is IEC 60974-1 while the technical terms of delivery and product forms, dimensions, tolerances and labels are contained in the standard SFS-EN 759.

Safety issues in welding work

There are several risk factors connected to welding. The arc emits extremely bright light and ultraviolet radiation, which may damage the eyes. Molten metal splashes and sparks can burn the skin and cause risk of fire, and the fumes generated in welding can be dangerous when inhaled.

These hazards can be avoided, however, by preparing for them and by using the appropriate protective gear.

Protection against fire hazard can be accomplished by checking the environment of the welding site in advance and by removing flammable materials from the proximity of the site. In addition, fire-extinguishing supplies must be readily available. Outsiders are not to be allowed to enter the danger zone.

Eyes, ears and the skin must be protected with the appropriate protective gear. A welding mask with a dimmed screen protects the eyes, hair and ears. Leather welding gloves and a sturdy, non-flammable welding outfit protect the arms and body from sparks and heat.

Welding fumes can be avoided with sufficient ventilation at the worksite.

Why do we need different welding methods?

Welding methods can be classified by the method used in producing the welding heat and the way the filler material is fed into the weld. The welding method used is selected based on the materials to be welded and the material thickness, the required production efficiency and the desired visual quality of the weld.

The most commonly used welding methods are MIG/MAG welding, TIG welding and manual metal arc welding. The oldest, most known and still fairly common process is manual metal arc welding, which is commonly used in installation workplaces and outdoor sites that demand good reachability.

The slower TIG welding method allows for producing extremely fine welding results, and therefore it is used in welds that will be seen or that require particular accuracy.

MIG/MAG welding is a versatile welding method, in which the filler material need not be separately fed into the molten weld. Instead, the wire runs through the welding gun surrounded by the shielding gas straight into the molten weld.

There are also other welding methods suitable for special needs, such as laser, plasma, spot, submerged arc, ultrasound and friction welding.

MIG/MAG welding

General

In MIG/MAG welding, an arc is created with the power supply through the welding gun between the welding wire being fed and the work piece. The arc fuses the material being welded and the welding wire, thus creating the weld. The wire feeder continuously feeds welding wire through the welding gun throughout the welding process. The welding gun also provides shielding gas to the weld.

The MIG and MAG welding methods differ from each other in that MIG (metal inert gas) welding uses an inert shielding gas, which does not participate in the welding process, while MAG (metal active gas) welding employs an active shielding gas that participates in the welding process.

Usually the shielding gas contains active carbon dioxide or oxygen, and therefore MAG welding is by far more common than MIG welding. In fact, the term MIG welding is often accidentally used in connection with MAG welding.

Applications

Today, MIG/MAG welding is used nearly everywhere in the welding industry. The largest users are heavy and medium-heavy industry, such as shipbuilding, manufacturers of steel structures, pipelines and pressurised containers, as well as repair and maintenance businesses.

MIG/MAG welding is also commonly used in sheet metal industry, particularly in the car industry, body shops and small industry. Hobbyists and home users also most commonly have a MIG/MAG welding machine.

Equipment

MIG and MAG welding equipment is typically comprised of a power source, wire feeder, grounding cable, welding gun, optional liquid cooling unit and a shielding gas bottle or gas network connection.

The purpose of the wire feeder is to feed the welding wire needed in welding from the wire reel to the welding gun.

The wire feeder also allows for starting and stopping the power source and, when using an electronic power source, control the voltage provided by the power source. Therefore the power source and the wire feeder are connected with a control cable. Additionally, the wire feeder controls the flow of the shielding gas. The shielding gas needed in welding is obtained either from a gas bottle or from a gas network.

NITRO-manufactured MIG welding machines are often modular in structure, and the cooling device, power source and wire feeder can be freely selected according to the requirements. The wire feeder can be detached from the power source, thus making it unnecessary to move the entire welding machine from one worksite to another.

The devices may also have a replaceable control panel and separately activated additional features.

The welding gun heats up during welding, and therefore it must be cooled with gas or liquid. In gas-cooled welding guns, the shielding gas running to the gun through the welding cable simultaneously acts as the gun cooler. In liquid-cooled guns, a separate liquid cooling unit is required to recycle the cooling liquid within the welding cable to the gun.

The structure of a MIG/MAG welding machine is restricted by the welding wire reel inside the machine. The reel is often a heavy and space-consuming component. Even so, the most modern MIG/MAG welding machines are stylish, compact machine packages.

Welding technique

In MIG/MAG welding, the welder's tool is a welding gun. It is used to introduce the filler material wire, shielding gas and the required welding current to the work piece. The most important issues related to MIG/MAG welding are the welding position, welding gun angle, wire stick out length, welding speed and the shape of the molten weld pool.

The arc is ignited with a trigger in the gun, and the gun is then moved at a steady welding speed along the weld groove. The formation of the molten weld must be observed. The position and distance of the welding gun relative to the work piece must be maintained constant.

It is particularly important that the welder concentrate on managing the molten weld at all times. A moment of wandering thoughts increases the risk of welding errors. In such cases, it is advisable to interrupt the welding for a moment and then resume.

MIG/MAG processes

Synergic MIG/MAG welding

Synergic adjustment, or 1-knob adjustment, means that the wire feed speed is connected to the voltage and possibly other parameters. This makes it easier to find the welding values, as only one knob is needed for power adjustment.

The ease of adjustment is based on preset synergy curves, which are stored in the control panel of the welding machine. A guideline material thickness can also be connected to the synergy curves, which makes it even easier to adjust the welding parameters.

Pulse welding

In pulse welding, the power source pulses the welding current so as to move the filler to the groove one drop at a time. The peak current of the pulse is great enough to spurt the material into the groove, while the lower basic current keeps the molten weld and the end of the welding wire molten. The pulse feature requires that several inter-dependent welding parameters be used.

Pulse welding is primarily used in welding aluminium and stainless steels. Additionally, nickel and copper alloys are often welded with the pulse feature.

The greatest benefit of pulse welding is the lack of spatters in the weld and its good appearance. With aluminium and stainless steels, pulse welding reduces the porousness. With nickel alloys and other difficult-to-weld materials, the pulse method makes welding easier.

Double-pulse welding

In double-pulse welding you can pulse also the wire feed speed in addition to the regular pulsing features. It means that the wire feed speed varies during the welding, and the user can adjust the amplitude and frequency of the variation. It allows for adjusting the desired penetration and creating clean welds. It also helps control the weld pool in various welding positions.

The frequency of a double pulse refers to the number of times a double pulse is repeated in one second, and the amplitude refers to the magnitude of the change. This affects the appearance and heat input of the weld.

Efficient MIG/MAG welding

Welding devices equipped with remote control speed up welding, particularly in an installation environment. Using a remote control improves work quality and productivity as the welder does not have to move to the machine every time when changing the welding parameters.

TIG welding

General

In TIG welding (Tungsten inert gas), the welding arc is formed between a non-consumable tungsten electrode and the work piece. The shielding gas is an inert gas that does not affect the welding process per se. Usually the shielding gas is argon and it protects not only the molten weld but also the electrode in the torch from oxygenation.

A filler material may not be necessary in TIG welding. The pieces can be fused also by melting the groove together. If a filler is used, it is fed into the molten weld manually and not through the weld torch as in MIG/MAG welding. Therefore, the TIG welding torch has a completely different structure than a MIG/MAG torch.

Various TIG welding methods include, for example, the DC TIG welding method that uses direct current, AC TIG welding that utilises alternating current, and pulse TIG.

Applications

The most important applications for TIG welding are pipeline and pipe welding. It is, however, used in many industries, such as aviation and aerospace and sheet metal industries when welding particularly thin materials and special materials such as titanium.

TIG welding is suitable for both manual and mechanised welding as well as for using welding robots.

Equipment

TIG welding equipment comprises a power source, grounding cable, welding torch and shielding gas bottle or gas network connection. The machine may also contain a liquid cooling unit. A wire feeder is not required as the filler material is manually fed.

Welding technique

TIG welding is used in sites where the appearance, quality and cleanness of the weld are important. This presents special requirements for the accuracy of the welding job. Additionally, TIG welding is more demanding because there are more issues to control in this welding technique than in the other techniques. In TIG welding, the torch is moved with one arm while the other feeds the filler material to the molten weld. A TIG welder must, therefore, accurately control both arms and one cannot be used for supporting the torch as in MIG/MAG welding.

These special requirements make TIG welding more difficult particularly in the beginning. However, the arms will soon adjust to the paths of motion required in welding and TIG welding becomes routine. Yet, demanding TIG welding is usually done by a welder who specialises in TIG welding.

TIG welding is done with a pushing torch motion. The filler can be fed into the weld either drop by drop or continuously, keeping the filler wire constantly in the molten weld.

TIG processes

AC/DC

TIG welding methods are classified according to the welding current to DC TIG and AC TIG for direct current and alternating current, respectively. TIG welding power sources are suitable for both current types (AC/DC) or for only DC welding.

DC welding is typically used in welding a variety of metals. Alternating current must, however, be used in aluminium welding.

If current mixed of both direct and alternating current is used in TIG welding, the method is called **MIX TIG** welding. It is a particularly useful method when welding aluminium materials of different thicknesses together.

Pulsed TIG

In Pulse TIG welding, the power source pulses the welding current, which reduces the heat effect affecting the material being welded. This is useful particularly when welding thin materials in which the TIG heat input is great. Pulse welding also improves the manageability of the molten weld pool and the penetration.

Efficient TIG welding

TIG welding is usually used when the welding quality requirements are high or the material thickness is particularly low. In this case, the production of the weld material is often low and the welding speed does not grow to a large figure. TIG welding can, however, be enhanced in a variety of ways.

The melting power can be increased by integrating the wire feeder into the torch or by moving from cold wire technique to hot wire technique. The production of the weld material may increase by up to 200% when moving to hot wire welding. In the cold wire technique, the melting of the filler material commits part of the effect of the arc and reduces the production of the weld material. In the hot wire process, however, the filler material wire is heated with a separate power source and the production of the weld material increases.

Using activating paste improves welding speed and increases the penetration. When activating PATIG paste is spread on the weld spot, the area of the arc becomes smaller and the density of the current in the anode point increases by 150% to 200%. The paste is comprised of a powder and binding acetone that can be spread with a brush or as a spray. The applications include sheet wheels, pressurised containers and material thicknesses 3–12 mm (I groove with one burn).

The selection of the shielding gas can affect the fusing and penetration of the basic material. The most commonly used shielding gas in TIG welding is Argon. Its benefits are its low price and good shielding effect combined with the ignitability of the arc. Its weakness is its poor thermal conductivity and the subsequent potential problems in the smooth fusing of the weld. The fusing can be improved by adding 5–25% hydrogen to the shielding gas. This will also reduce the area of the arc and increase the penetration.

Using helium as the shielding gas allows for good merging of the filler with the basic material and produces good penetration. However, its weakness is in the poor ignitability of the arc. This can be improved by using a mixture of helium and argon.

MMA welding

General

MMA welding refers to a welding method where a filler electrode in the electrode holder serves as the welding electrode. The arc burns between the electrode and the work piece.

The difference to other welding methods is that the welding electrode in MMA welding shortens continuously as the welding progresses. In TIG and MIG/MAG welding the distance of the torch from the work piece must remain constant at all times. In MMA welding, however, the electrode holder must continuously be brought toward the work piece to keep the distance between the electrode and the molten weld constant. This presents special challenges for MMA welding.

Applications

MMA welding can be used under almost any conditions, and therefore it is a rather universal method in the welding industry. It is commonly used in installation worksites were good reach ability is required of welding machines and where work is often done in outdoor environments.

MMA welding is a common welding method for example in welding power plant pipelines and in other pipe welding sites. It is also a welding method favoured by hobbyists and small repair shops. It can also be applied in underwater welding, where electrodes designed particularly for underwater environments are used.

Equipment

MMA welding requires a power supply, a ground cable and a welding cable equipped with the electrode holder. There is no shielding gas, as the welding electrode is coated with a material that produces shielding gas and slag over the molten weld pool. Many TIG welding machines are also suitable for MMA welding.

Today's small inverter power sources further increase mobility and reach ability. The power supply can, for example, be connected to a generator with long input cables, taking the welding machine next to the work piece. The smallest power sources currently weigh only 5 kg (10 lbs).

MMA welding is rather popular in hobbyist use as the only required parts are the power source and the welding electrodes. No shielding gas is required, and the devices usually operate with the current obtained from a regular residential power outlet.

Welding technique

The welding is started by sharply striking the bottom of the groove with the welding electrode. After this, move the welding electrode back to the beginning without stretching the arc, and move the electrode easily while monitoring the width of the molten weld pool. Move the welding electrode at a pulling angle. The boundary of the slag formed is visible after the molten weld. It must be behind the molten weld. The distance of the slag boundary from the molten weld can be adjusted with the welding current and the angle of the electrode.

Throughout the welding, concentrate on the length of the arc and keep it as short as possible. The length of the arc increases easily as the electrode decreases in length during the welding. The movement may be somewhat difficult to control at first but it is easy to get accustomed.

When the welding electrode runs out, one needs to remove the slag from the previous weld and clean it with a steel brush. Ignite the next electrode slightly ahead of the previous weld and then move the welding electrode back to the previous weld and continue with the welding.

End welding by moving the welding electrode slightly back to the completed weld and then lifting the electrode straight away from the work piece.

MMA welding electrodes

A welding electrode is a fixed-length, straight welding wire coated with a filler material. The welding electrode has a fixing head with which it is attached to the electrode holder. The other end of the electrode has the ignition head with which the work piece is stuck to ignite the arc. The quality or trade name of the electrode is indicated near the fixing head in the coating. Usually also the AWS class ID is included.

The diameter of a welding electrode refers to the diameter of the metal rod inside the electrode. The purpose of the coating on the surface of the metal rod is to protect the welding event from the effects of the surrounding air, to produce slag to support the weld and to make the creation of the arc easier.

Efficient MMA welding

One can improve the efficiency of MMA welding by selecting equipment, cables and accessories that suit the worksite and by keeping the worksite clean and orderly.

Wear an **automatic mask** to speed up welding, cutting and polishing. The mask has a self-dimming screen with an adjustable dimming scale, and therefore one does not have to lift it up or replace it when one moves from one work phase to another.

Productivity aspects can also be considered when **selecting the welding machine**. Do not select an excessively large machine, as moving the extra weight from one location to another in installation environments slows down the work. Select the device size according to the maximum electrode size needed at the site.

Furthermore, the type of the selected welding machine is important for productivity. Inverter machines increase productivity thanks to their smaller size and lightweight design but also because of their welding dynamics adjustment, which produces cleaner seam, which reduces the amount of required post-welding work. The efficiency of a power source implemented with the inverter technology is high, which means low electricity consumption.

Welding devices equipped with **remote control** speed up welding, particularly in an installation environment. Using a remote control improves work quality and productivity as the welder does not have to move to the machine every time when changing the welding parameters.

Cable lengths affect the efficiency of welding work. If a welding cable is too long, the total weight of the equipment increases, which makes it more difficult to move the equipment. In such cases, a trolley is recommended for moving the machine even if the power source itself is not too heavy or large to be moved.

The electrode holder should be selected according to the maximum current used in the worksite. An excessively large electrode holder hinders reach ability and slows down the welding. On the other hand, an excessively small electrode holder creates a hazard.

When selecting **welding electrodes**, consider high-capacity electrodes whenever possible. They increase the productivity of the work, as the electrodes are coated with the filler and powder-form iron, which melts into the weld, increasing the yield of each electrode. For more information on high-capacity electrodes, refer to the electrode manufacturers' filler material lists.

The work order of each welding job should be well planned in advance to make the work as efficient and productive as possible. Furthermore, the general cleanliness and order of the work environment contribute to the speed and productivity of the work.

MIG brazing

MIG brazing, or arc brazing, was introduced in the 1990s. It greatly resembles MIG/MAG welding. The greatest difference is in the filler material wires and the melting of basic material, as the basic material does not melt in MIG brazing.

The heat input in MIG brazing is considerably lower than in MIG/MAG welding, and therefore MIG brazing is particularly well suited for joining zinc coated plates used in the automobile industry, for example. Owing to the low heat input, the plate does not bend and the zinc coating will not be damaged. Therefore the automobile industry is showing great interest toward MIG brazing. MIG brazing is also commonly used in car repair shops.

Welding automation

The mechanisation of welding is divided into four levels according to the proportion of work stages done mechanically with a welding machine.

- **In manual welding**, the welder moves the welding head manually as well as monitors and controls the welding process.
- **In semi-automatic welding**, the welding machine carries out one of the work stages. Such a welding method can be, for example, MIG/MAG welding, where the wire feeder feeds the filler wire through the welding gun.
- **In mechanised welding**, the welding system does the physical work but the welder continuously controls and supervises the process.
- **In automatic welding**, the welding system does everything independently according to a preset program.

Welding robotics represents highly advanced welding mechanisation and automation. In welding robotics, the welding apparatus controls both the motion of the welding end and the welding process according to a preset program. The robot can also be re-programmed for use in different sites.

Better productivity and consistent quality

Welding automation usually aims at better welding productivity, higher production capacity, more consistent quality and cost efficiency.

In welding robotics, the cost structure is emphasised at the beginning of the acquisition, in cost f equipment, testing and user training. Therefore transition to robotised welding always requires careful advance planning. The existing welding production must be analysed with all work stages included and their related expenses must be itemised. In addition, the suitability of the products for robotisation must be studied.

Robotised welding is best suited for products that contain several short welds in different directions and the surfaces being welded are curved. Robotisation does not necessarily require that the product in question is continuously manufactured in large quantities. Modern technology allows for welding increasingly small series in a cost-efficient way. Even individual pieces have been successfully manufactured in robotised environments.

Enhancing robotised welding

Robotised welding can be enhanced by decreasing the groove volume. In mechanised and automated welding, the welds are of even quality, and therefore their minimum rated size can be utilised. Automated welding allows using the weld depth, or penetration, as part of the visible effective throat thickness. This is based on the fact that automated welding always takes place in the same way, and therefore a penetration once attained and measured will probably be attained in subsequent welds, as well.

Welding equipment designed for robotised welding should be used in a robot station to keep the welding wire feed good and even. Welding devices dedicated to robotised use allow the robot to control all features. Various signals and feedback signals have been designed according to the high quality and efficiency requirements of robotised applications. This avoids unnecessary downtime and improves the arc time ratio of the welding equipment.

Other welding methods

Laser welding

The principle of laser welding is simple: a laser beam created with carbon dioxide or NdYAG laser is targeted at the work piece to weld the parts together. Shielding gas is used to prevent the oxygenation of the material being welded and to protect the optical parts of the welding machine.

The benefits of laser welding are high welding speed, a narrow welding seam and a small temperature area, and therefore it is at its best when small thermal impact is required.

Laser welding is precise. It allows for narrow welds and causes minimal changes to the welded items. On the other hand, it requires precise fitting of the pieces being welded as well as the use of jigs, and therefore it is not economical for adjoining individual pieces.

Submerged arc welding

Submerged arc welding is an arc welding method where the arc burns underneath the welding powder. The filler material is introduced with a separately fed welding wire or wire feeder. During welding, the welding powder on the welding seam melts on the surface of the weld and generates a protective slag layer. The welding powder can also contain metal powder, which will melt into the weld as filler material during welding.

Submerged arc welding is almost always implemented in at least a partly mechanised form, and therefore high productivity can be attained when doing long welds. Submerged arc welding is commonly used in medium-heavy and heavy machine industry and docks.

Plasma arc welding

Plasma arc welding is a gas arc welding process. Plasma refers to superheated gas at a temperature of 15,000–25,000 degrees centigrade (25,000–45,000 Fahrenheit) in which the arc burns surrounded by the shielding gas between a non-consumable tungsten electrode and the work piece.

Usually a filler material is used in plasma arc welding, introduced to the molten weld as wire. In powder plasma arc welding, the filler material is introduced to the molten weld with the shielding gas as metal powder.

The high energy density of plasma arc welding also enables an arc that completely penetrates the work pieces. Plasma arc welding is particularly suitable for mechanised welding processes, and is used, for example, in welding stainless steel.

Spot welding

Spot welding is a resistor welding process where spots of the pieces being welded are heated with electricity near their melting point and then compressed against each other, welding the pieces together.

Spot welding is used in sheet metal work. The plates must be compressed against each other without an air gap. The penetration of the weld is adjusted with the spot welding time and welding current. Spot welding uses a specially crafted gas nozzle, which is pressed against the surface of the plate. The gas nozzle usually has small gaps from which the shielding gas can exhaust.

Friction welding

In friction welding, friction is used for producing the heat needed in welding. The joint surfaces are clamped together and rotated against each other. After heating to a soft state, the surfaces are firmly compressed against each other, thus welding them together.

Explosion welding

Explosion welding is a special welding method for connecting two different metal types together with a controlled explosion. The explosion is used to generate great pressure between the metal plates, which fuses the metals at an atomic level. The compound structure thus attained has extremely high quality and consistent metallurgical features.

Explosion welding is used in sites where two different metal types must be connected with a firm joint.

Welding tips

Checking the equipment before starting the welding

Before starting a new welding job, the operating condition of the welding equipment should be inspected. The connections of the power cable, gas tube, grounding cable and welding gun must be checked. It must also be ensured that one is using the right shielding gas type and that the gas output works. The type and diameter of the filler material wire must be checked. Additionally, the appropriate fixing of the wire reel in the wire feeder must be ensured.

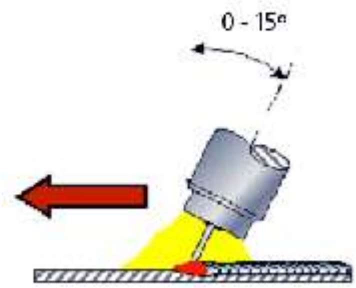
After this one must review the feed rolls of the wire feeder engine and make sure that the wire guides and feed rolls are suitable for the filler material and wire diameter used.

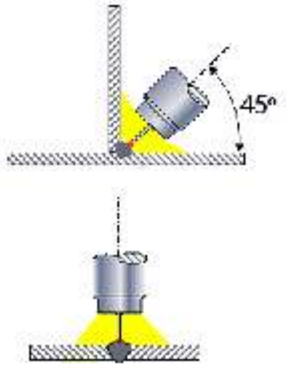
The welding gun must be detached from the wire feeder, making sure that the gun's liner is of correct size and type are correct. The gas nozzle must be detached from the gun and any splashes must be cleaned from it. The condition and size of the contact tip must be checked. Additionally, the gas disperser and contact tip holder must be cleaned.

One can check the shielding gas flow with a rotameter at the end of the welding gun. If the wire is already in the gun, the pressure adjustment screw of the wire feeder engine needs to be detached to prevent the wire from moving, after which one should press the gun trigger and measure the gas flow. The easiest way for checking the flow of the shielding gas is the GAS TEST function, if one is available in the wire feeder. This function only activates the gas flow to the welding gun but does not activate wire feeding.

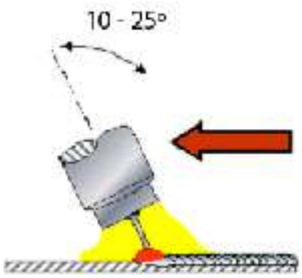
Welding angle and torch movement

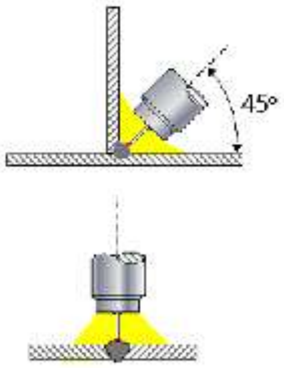
When welding with solid wires or metal-cored wires, the gun is usually moved in pushing angle, with the exception of downward welding and welding of particularly thin sheet metals. In symmetric fillet welding, aim the welding gun has a 45-degree angle to the corner of the fillet and perpendicular to the groove in butt joints.





When welding with flux-cored wires, move the welding gun in pulling angle to prevent the slag generated by the wire from mixing with the molten weld. The arc pressure will keep the slag behind the molten weld. Certain directional welds, such as upward welding, are an exception to this. In this case the welding gun is moved with the handle behind the direction of movement, and earth's gravity ensures that the slag will not rise above the molten weld.





Welding torch speed

The correct speed of the welding torch is an important factor for successful welding. The speed of motion affects the shape, penetration, heat input and effective throat thickness of the weld. The effective throat thickness refers to the shortest distance from the base of the weld to the surface of the weld.

If the speed of motion is too slow, the molten weld may roll in front of the arc and make the molten weld pool difficult to manage. An excessively high speed, on the other hand, may result in too small penetration and effective throat thickness.

The recommended speed may be provided in the welding instructions. It is, however, difficult to estimate the speed during welding. One way to determine the speed is to weld approximately 10 cm and time it with a clock. This allows for determining the speed as centimetres per minute.

Creep start

When using high wire feed speeds, it may be difficult to start the welding. A so-called creep start feature has been designed to make the beginning of welding easier.

The creep start feature starts feeding the wire at a low speed and does not attain the preset value until the wire touches the work piece and the arc ignites. The creep start adjustment is done in the welding machine's control panel, if needed.

Hot start and soft start

When welding materials with good thermal conductivity, such as aluminium, it is easy to generate faults in the weld in the beginning. Using the so-called hot-start feature can decrease these. When using the hot-start feature, the welding power momentarily increases at the beginning of the welding to a level above the preset welding power. The power and duration of a hot start can usually be adjusted in the machine's control panel.

When doing butt welding of sheet metal, the so-called soft-start feature may be useful, as it helps keep the edges of the sheets intact. A soft start is the opposite of hot start. The welding power is momentarily lower than the preset welding power during the start-up of the welding. The power and duration of a soft start can also usually be adjusted.

Adjusting welding parameters

The wire feed speed and the welding current are connected to each other. When increasing or decreasing the wire feed speed, the welding current follows. The arc voltage must be in correct relation to the wire feed speed and the welding current to produce stable welding. Sometimes it may, however, be very difficult to decide which value to change and in which direction to attain a good welding result.

The arc voltage is too low in relation to the wire feed speed, if

- the sound of the arc is loud
- there is a lot of spatters
- the weld is more narrow and the cap is higher

The arc voltage is too high in relation to the wire feed speed, if

- the sound of the arc is soft
- the arc is long
- the weld is wider and lower
- the drop size of the filler material is large
- the risk of undercuts is increased

There are a number of tables and guides that will assist in producing good welding results. There are also welding machines that automatically determine the correct arc voltage for the wire speed and welding current. Even in those machines, one may need to make adjustments to the arc voltage, as there may be differences between the filler material wires of different manufacturers.

With power sources equipped with stepped voltage adjustment it may not be possible to adjust the voltage to the exact correct figure in relation to the wire speed. In such cases, one can do the fine-tuning by increasing or decreasing the speed of the wire feed.

Common tips for enhancing welding work

There are simple ways for enhancing the welding work. With manually done work stages planned in an appropriate way and designed ergonomically, individual production may experience higher productivity increases than mechanisation would attain.

Pay attention to the **working position**. The most efficient position to do welding is downhand. In downhand welding, the work piece is placed on a level so that welding can be done in a natural position. Devices intended for turning the work piece should be utilised so that the work piece position allows for an ergonomic welding position.

Choosing the right welding process also plays an important role in work productivity. Any productivity increase attained by changing the welding process should be carefully investigated, even if changing the process could require additional investments.

Correct choice of welding parameters affects the efficiency of the welding work and also extra labour expenses. For example, the time spent removing spatters decreases the productivity of welding work. One can reduce the generation of splashes with pulse welding, for example.

------ The End ------