Wire Welding onboard

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Wire Welding is a common name for a group of welding processes that normally is used in connection with production welding. In this article we look at the different type of wire welding processes and to what extent it can be justified implemented onboard a vessel.

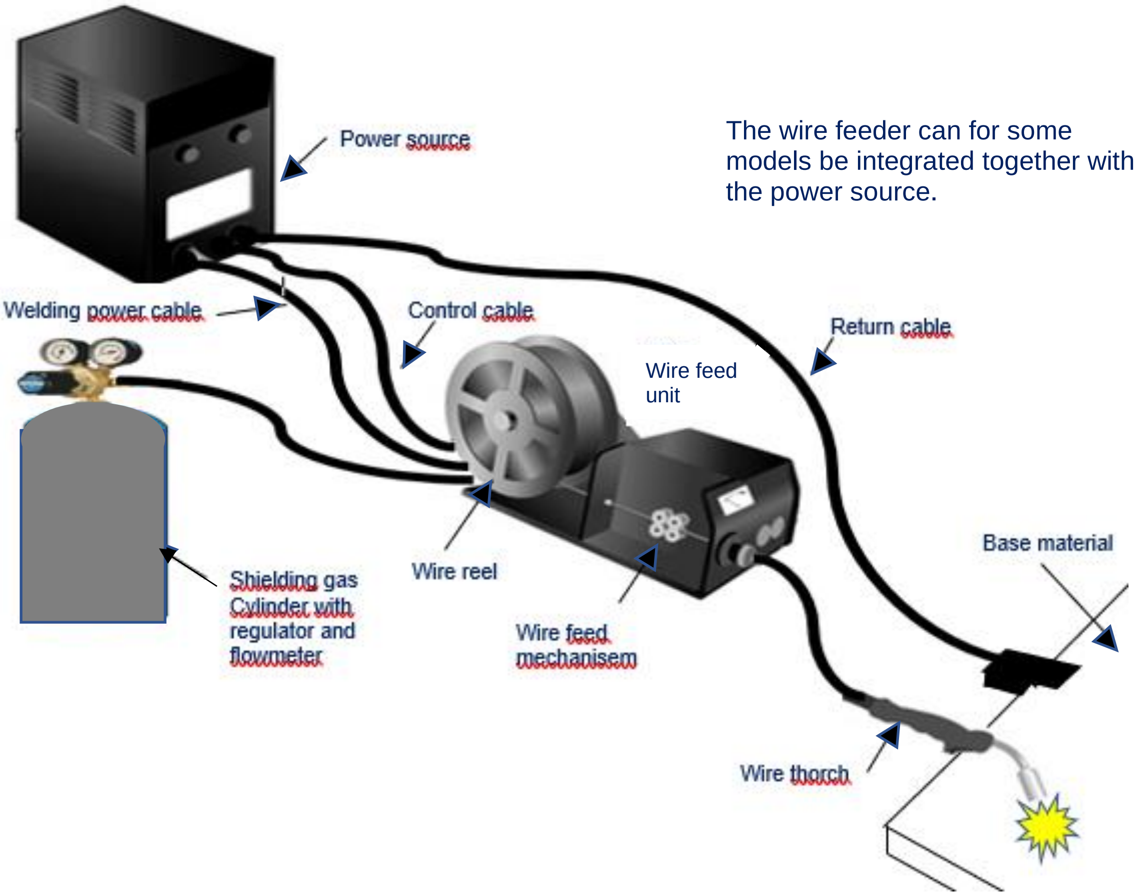
Background

The most popular type of welding processes for use onboard a vessel is Manual Metal Arc Welding (MMAW), American term is Shielded Metal Arc Welding (SMAW). Popular names are “stick welding” or “stick electrode welding”.
The equipment is relatively simple, inexpensive and portable. The shielding gas provided by the burning the electrode coating is less sensitive to wind and drafts when compared to a process with an external shielding gas. The equipment takes little time to set up for different type of repair jobs. In maintenance welding onboard there will be a large number of different jobs involving different base materials. In that case the welder simply changes from one type of electrode to another. Most MMAW welding machines can do TIG (Tungsten Inert Gas) welding, a feature that gives the possibility for welding thin walled pipes and plates with same equipment. Bigger size MMAW welding machines can also be used for Air Carbon Arc (ACA) gouging. This makes MMAW machines the number one choice for most maintenance work onboard.

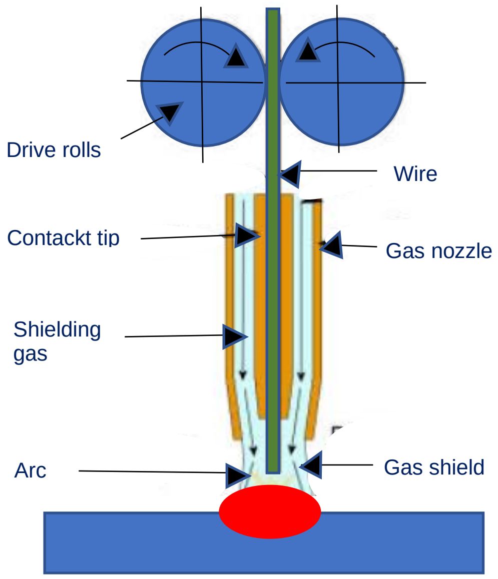
Under what circumstances can Wire Welding be justified onboard? Let’s first look at what different wire welding processes there are, and their pros and cons.

Wire Welding Processes

Wire Welding is a process where a wire from a reel is fed through a welding torch passing a contact tip supplying the welding current. The arc is established between the wire and base material, the wire melts and is transferred to the weld pool. A shielding gas is in most cases necessary to prevent air oxidising the pool.



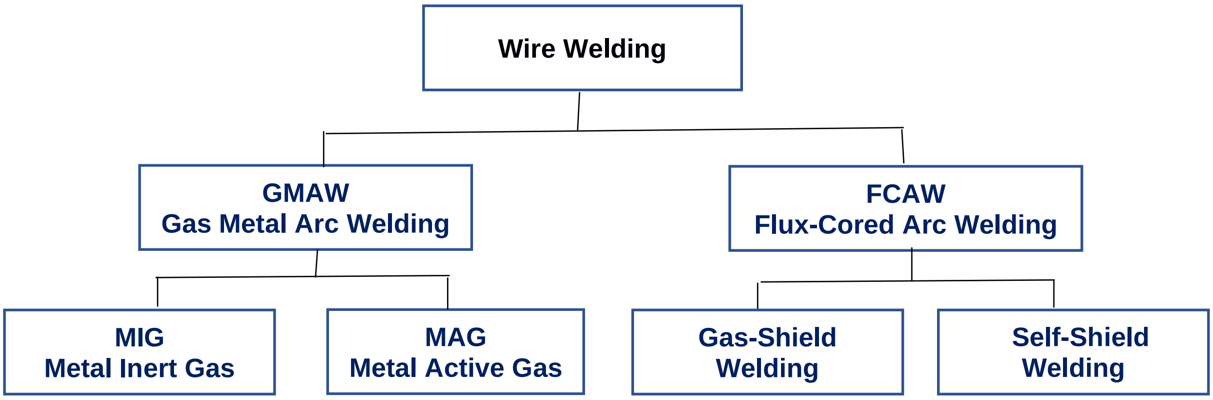
The wire feeder can for some models be integrated together with the power source.



Adding the current to the wire in the contact tip and thereby close to where it is melted makes it possible to work with high amperage despite a small wire diameter.

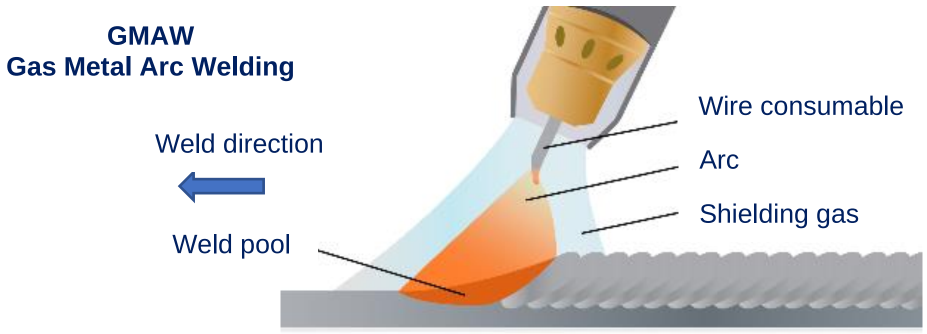
The different Wire Welding methods

The Wire Welding process can roughly be divided into two distinctive methods:
Gas Metal Arc Welding GMAW (solid wire) and Flux Cored Arc Welding FCAW (cored wire)



Gas metal arc welding (**GMAW**), sometimes referred to by its subtypes **metal inert gas** (**MIG**) **welding** (for example using Argon for shielding) or **metal active gas** (**MAG**) **welding** (using CO2 for shielding), is a welding process in which an electric arc forms between a consumable wire and the workpiece. This heats the workpiece, causing wire and workpiece to melt and join. Along with the wire, a shielding gas feeds through the welding gun, which shields the process from atmospheric contamination.

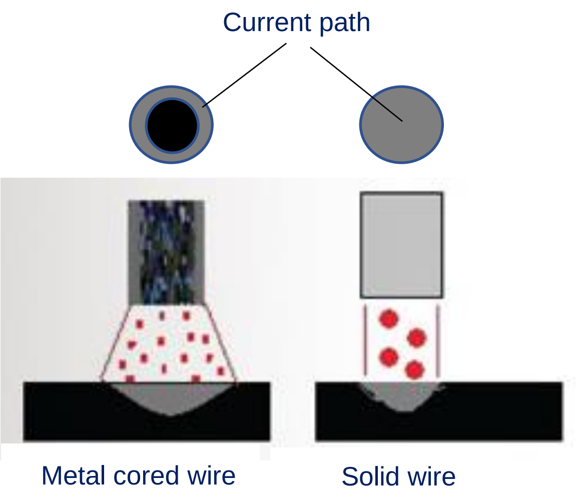
The process can be semi-automatic or automatic. A constant voltage, direct current power source is most commonly used with GMAW, but constant current systems, as well as alternating current, can be used.



Unlike welding processes that do not employ a shielding gas, such as MMAW (Manual Metal Arc Welding), GMAW is rarely used outdoors or in other areas exposed to wind or strong draft. Therefore, not a suitable process for use on the open deck.

GMAW can be performed using Solid Wire or Metal-Cored Wire (MCW).

The advantage of using Solid wire is that it covers a large application area. There are solid wires for Mild steel, Low alloy steel, Stainless steel, Nickel alloys, Copper alloys, Aluminium alloys and Hard surfacing alloys. Welding will have to be done with DC+ polarity (Wire torch connected to + terminal on power source. The welding wire is available in 0,8mm (0,031") -1,0mm (0,039") - 1,2mm (0,047") - 1,4mm (0,055") -1,6mm (0,063") - and 2,4mm (0,094") size.



Metal-Cored Wire (MCW): Unlike solid wires in which the current travels through the entire wire, in metal-cored wires the current travels only through the metal sheath. The metal powders inside are less conductive because of their granular nature. This increases the current density, producing higher deposition rates speeding up the job. More importantly, it gives better penetration and better side-wall fusion than solid wires, so consistently better welds with less defects and need for re-work. Although the initial cost of metal-cored wires is greater, the benefits offset the difference in price and lead to both improved efficiency and cost-savings. It is not the right choice for every job but does have big advantages when it fits.

The internal components of a metal cored wire are composed chiefly of the alloys, manganese, silicon, and in some cases, nickel, chromium and molybdenum as well as very small amounts of arc stabilizers such as sodium and potassium, with the balance being iron powder. Metal cored wires have little to no slag forming ingredients in the internal fill of the wire. Just like solid wire, welds made with a metal cored wire will only have small silicon islands from the deoxidized products that appear on the surface of the weld. This allows for multiple pass welding without de-slagging.

The metal core wire can be used in many of the same applications as solid wire, but applications that benefit most are single-pass welds 75mm (3") or longer in flat or horizontal position using the spray transfer mode. Metal core wire can be welded in Short arc or Spray arc mode. Using the spray transfer mode maximizes the benefits of metal-cored wire because this mode allows the welding operator to move faster. The spray transfer mode also generates little to no spatter, further enhancing the cleanliness of the metal-cored wire and minimizing the amount of post-weld clean up.

Welding will have to be done with DC+ polarity (Wire torch connected to + terminal on power source). The welding wire is available in 1,0mm (0,039") - 1,2mm (0,047") - 1,4mm (0,055") -1,6mm (0,063") - 2,0mm (0,079") and 2,4mm (0,094") size.

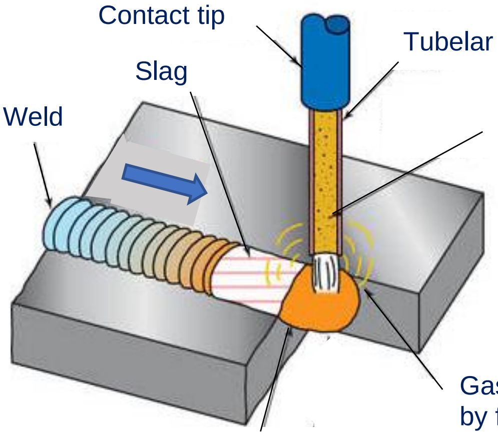
Metal core wire is not, however, recommended for welding sheet metal. This is where solid wire will be a better alternative.

Metal cored wires are classified under the American Welding Society specification with solid GMAW wires (AWS A5.18-93 for mild steel, AWS A5.28-98 for low alloy, and AWS A5.9-93 for stainless steel). Metal core wire are denoted GMAW-C. The "C" informs composite wire (metal core wire).

Flux-cored arc welding (**FCAW** or **FCA**)

Flux-cored arc welding is a semi-automatic or automatic arc welding process. FCAW requires a continuously-fed consumable wire containing a flux and a constant-voltage or, less commonly, a constant-current welding power supply. An externally supplied shielding gas is sometimes used, but for some wires the flux itself generate the necessary protection from the atmosphere, producing both gaseous protection and slag protecting. The process is widely used in construction because of its high welding speed and portability.

FCAW-S
Self-Shield Welding



One type of FCAW requires no shielding gas. This is referred to as **Flux Cored Arc Welding Self Shielded (FCAW-S)**. A trade name used by one manufacturer is “Innershield Welding”. This feature is made possible by the flux core in the tubular consumable wire. This core contains more than just flux. It also contains various ingredients that when exposed to the high temperatures of welding generate a shielding gas for protecting the arc.

This type of FCAW-S (Self-Shield) is attractive because it is portable and generally has good penetration into the base metal. Also, windy conditions need not be considered. FCAW Self shielded welding is a good alternative to MMAW (Manual Metal Arc Welding, Electrode/ stick welding) out on the open deck. One disadvantage is that this process can produce excessive, noxious smoke.

As with all welding processes, the proper wire must be chosen to obtain the required mechanical properties. There are wires available for Mild steel and Low alloyed steel. Some of the wires can weld in all positions including vertical down. With some exceptions welding will have to be done with DC-polarity (Wire torch connected to – terminal on power source).

Self-Shielded Welding wire is available in 0,9mm (0,035”) - 1,1mm (0,043”) - 1,6mm (0,063”) -1,7mm (0,067”) -1,8mm (0,071”) -2,0mm (0,079”) -2,4mm (0,094”) and 3,0mm (0,118”) size.

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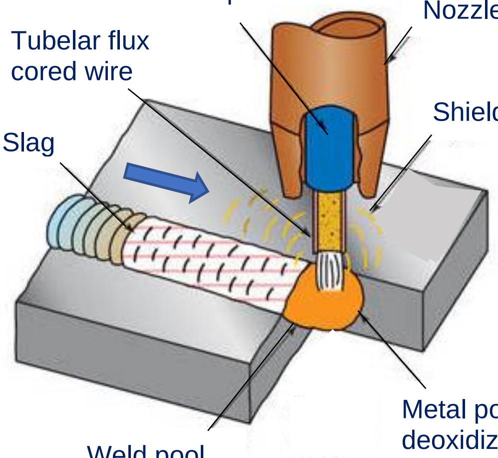
Another type of FCAW uses a shielding gas that must be supplied by an external supply. This type of **FCAW-G** (Gas-shield) was developed primarily for welding structural steels. In fact, since it uses both a flux-cored wire and an external shielding gas, one might say that it is a combination of gas metal (GMAW) and flux-cored arc welding (FCAW). The most often used shielding gases are either straight CO2 or argon CO2 mix. The most common mixture used is 75% Argon 25% CO2.

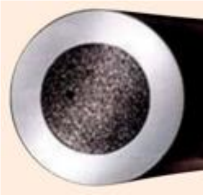
FCAW-G
Gas-Shield Welding



This particular style of FCAW is preferable for welding thicker and out-of-position metals. There are wires available for Mild steel, Low alloyed steel, High strength steel, Low temperature steel, Weathering steel (Corten steel), Creep resistant steel and Stainless steel.

Some of the wires can weld in all positions. Welding will have to be done with DC+ polarity (Wire torch connected to + terminal on power source). The welding wire is available in 1,2mm (0,047”) - 1,6mm (0,063”) and 2,4mm (0,094”) size. The slag created by the flux, can be of rutile or basic type and is easy to remove.

The main advantages of this process is that in a closed shop environment, it generally produces welds of better and more consistent mechanical properties, with fewer weld defects than either the MMAW or GMAW processes. In practice it also allows a higher production rate, since the operator does not need to stop periodically to fetch a new electrode, as is the case in MMAW. However, like GMAW, it cannot be used in a windy environment as the loss of the shielding gas from air flow will produce porosity in the weld. Therefore, a process that should not be considered out on the open deck onboard.

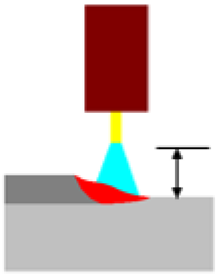


Tubelar wires can be manufactured as seamless wire or folded wire. The advantage of seamless wire is that there is less risk for moisture pick up.

Self-Shield Welding and **Gas-Shield Welding uses the same equipment**. The welding machine will be a constant voltage DC arc welding power source.

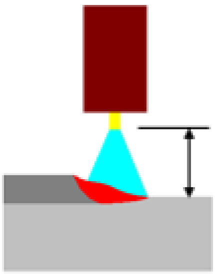
THE POWER SOURCE

Although there are many styles and designs of power sources produced by manufacturers, they serve the same basic function. The power source is classified as a constant voltage power source. This means the voltage remains relatively constant as set on the machine, while the amperage increases or decreases according to the arc length, in other words the distance of the nozzle and wire from the work. The Amperage in GMAW/FCAW welding is controlled by the wire speed setting on the wire feed unit. The welding machine is usually set to provide DC + (reverse polarity).

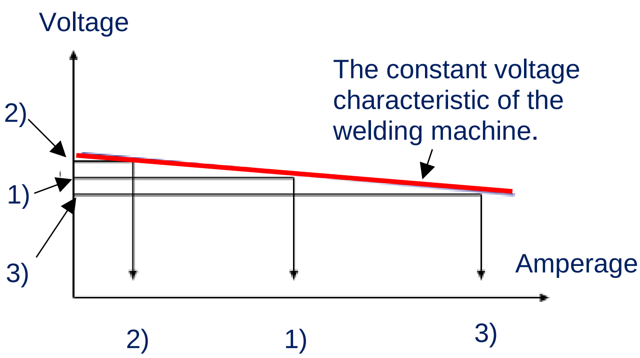


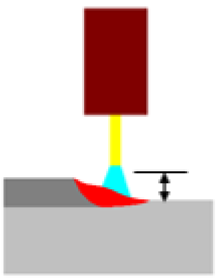
A constant voltage machine will fluctuate its output current (Amperage) to maintain a set voltage. It will automatically maintain the arc length by adjusting the amperage according to need, once the arc voltage and thereby the arc length has been selected.

1) The welder will set the machine to a certain voltage and wire speed. During welding he will try to keep a constant arc length.



2) If the welder increases the arc length, the welding machine will lower the amperage decreasing the burn rate of the wire to keep the arc length constant.

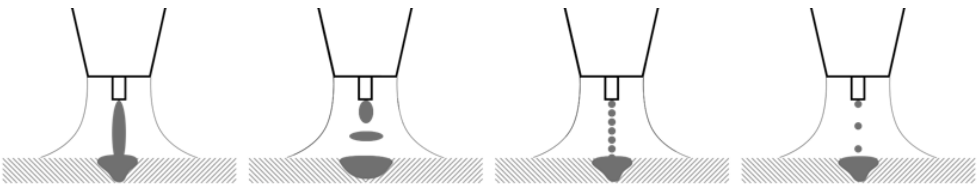




3) If the welder shortens the arc length, the welding machine will increase the amperage thereby increasing the burn rate of wire to keep the arc length constant.

Methods of metal transfer in GMAW solid wire

There are no settings on a welding machine to choose a transfer method. Each method is achieved through voltage/amperage (wire feed speed) setting adjustments and the type of shielding gas mixture used. The Pulse transfer is the exception, where one need a special power source for this method, as well as the proper wire feeder along with a high argon content shielding gas mixture.



Short Circuit Transfer | Globular Transfer | Spray Transfer | Puls Transfer

Short-circuiting transfer

Short circuit transfer is the coldest form of wire welding and uses low voltage. In the Short Circuit transfer method, the consumable wire arcs and touches the base material and shorts. This creates a small, quickly solidifying, weld metal puddle that drips into the weld joint fusing the materials together sometimes referred to as “fast freezing.” This process is repeated about 100 times per second, making the arc appear constant to the human eye.

This type of metal transfer provides better weld quality and less spatter than the globular variation, and allows for welding in all positions. Setting the weld process parameters (volts, wire feed rate/ amps) within a relatively narrow band is critical to maintaining a stable arc generally between 100 to 200 amps at 17 to 22 volts for most applications. Using short-arc transfer can result in lack of fusion and insufficient penetration when welding thicker materials, due to the lower arc energy and rapidly freezing weld pool. Short circuit transfer can only be used on ferrous metals.

Globular transfer

Globular transfer takes place between short circuiting and spray transfer modes at medium current and voltage levels. The molten droplets are larger than the wire diameter and some intermediate short circuiting can take place, leading to the arc being unstable and producing high spatter levels. GMAW with globular metal transfer is often considered the most undesirable of the four major GMAW variations, because of its tendency to produce high heat and a poor weld surface. The method was originally developed as a cost-efficient way to weld steel using GMAW, because this variation uses carbon dioxide, a less expensive shielding gas than argon. Adding to its economic advantage was its high deposition rate, allowing welding speeds of up to 110 mm/s (250”/min). The high amount of heat generated is also a downside, because it forces the welder to use a larger wire, increases the size of the weld pool, and causes greater residual stresses and distortion in the weld area.

Spray transfer

Spray transfer GMAW is well-suited to welding steel, aluminium and stainless steel while employing an inert shielding gas. This is a pure CV (constant-voltage) process producing a stable arc from the wire to the workpiece, essentially eliminating spatter and resulting in a high-quality weld finish. As the current and voltage increases beyond the range of short circuit transfer the wire metal transfer from larger globules through small droplets to a vaporized stream at the highest energies. Since this vaporized spray transfer variation of the GMAW weld process requires higher voltage and current than short circuit transfer, and as a result of the higher heat input and larger weld pool area (for a given weld electrode diameter), it is generally used only on workpieces of thicknesses above about 6 mm (1/4”). Also, because of the large weld pool, it is often limited to flat and horizontal welding positions and sometimes also used for vertical-down welds. It is generally not practical for root pass welds. When a smaller wire is used in conjunction with lower heat input, its versatility increases.

Pulsed-spray arc

This is a more recently developed method. The pulse-spray metal transfer mode is based on the principles of spray transfer but uses a pulsing current to melt the filler wire and allow one small molten droplet to fall with each pulse. The pulses allow the average current to be lower, decreasing the overall heat input and thereby decreasing the size of the weld pool and heat-affected zone while making it possible to weld thin workpieces. The pulse provides a stable arc and no spatter, since no short-circuiting takes place. This also makes the process suitable for nearly all metals, and thicker wire can be used as well. The smaller weld pool gives the variation greater versatility, making it possible to weld in all positions. In comparison with short arc GMAW, this method has a somewhat slower maximum speed (85 mm/s or 200”/min) and the process also requires that the shielding gas be primarily argon with a low carbon dioxide concentration. Additionally, it requires a special power source capable of providing current pulses with a frequency between 30 and 400 pulses per second.

Methods of metal transfer in GMAW metal-cored wire

Short circuit transfer can be active when relatively low current and arc voltage settings is used. Higher values will cause Spray transfer mode. Metal Cored wires show the greatest advantage when the pulse mode of transfer is used.

Methods of metal transfer in FCAW (Gas shielded and Self Shielded wire)

The metal transfer for FCAW it is more complicated. The mode of transfer is to a large extent determined by the flux system used (rutile or basic). If a mixed gas with a high percentage of argon is used, it will tend toward a spray like transfer. Straight CO_2 or Self shielded FCAW tend toward giving globular type transfer.

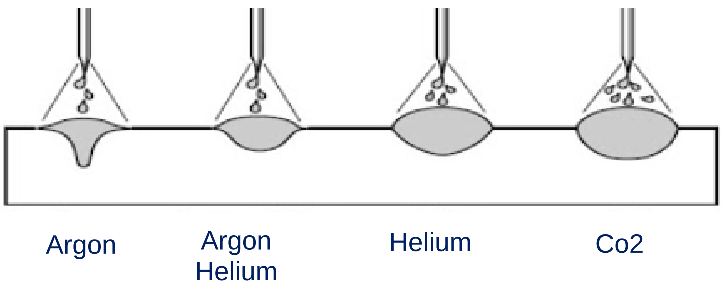
Shielding gas

The primary purpose of shielding gas is to prevent exposure of the molten weld pool to oxygen, nitrogen and hydrogen contained in the air atmosphere. The reaction of these elements with the weld pool can create a variety of problems, including porosity (holes within the weld bead) and excessive spatter.

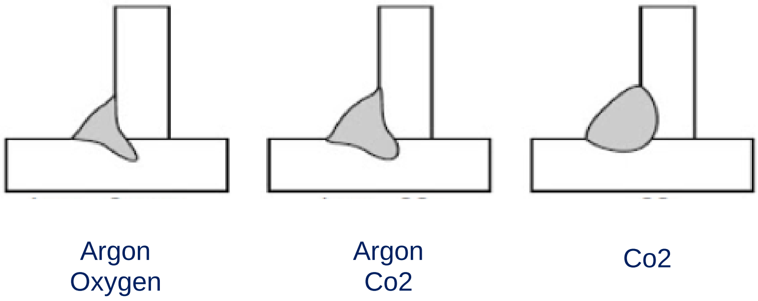
The choice of a shielding gas depends on several factors, most importantly the type of material being welded and the process variation being used. Pure inert gases such as argon (Ar) and helium (He) are only used for nonferrous welding (Aluminium, copper and nickel alloys). With steel they do not provide adequate weld penetration (argon) or cause an erratic arc and encourage spatter (with helium).
Argon 4.8 Purity >= 99.998%

Pure carbon dioxide (Co2), on the other hand, allows for deep penetration welds but encourages oxide formation, which adversely affect the mechanical properties of the weld. Its low cost makes it an attractive choice, but spatter is unavoidable and welding thin materials is difficult.

Bead contour and penetration for various shielding gases.



The effect of Oxygen versus Co2 additions to argon.



As a result, argon and carbon dioxide are frequently mixed in a 75%/25% to 90%/10% mixture. Generally, in short circuit GMAW, higher carbon dioxide content increases the weld heat and energy when all other weld parameters (volts, current, vire type and diameter) are held the same. As the carbon dioxide content increases over 20%, spray transfer GMAW becomes increasingly problematic, especially with smaller wire diameters. Therefore oxygen (O2) is used in small amounts (typically as 2–5%) as an addition to argon for spray transfer welding of mild carbon steels, low alloy and stainless steels. It enhances arc stability and reduces the surface tension of the molten metal, increasing wetting of the solid metal.

Shield gas combinations for Wire Welding

Base Material	FCAW Gas Shield Welding	Transfer mode	GMAW Solid wire	GMAW Metal core wire **(1)**
Mild steel	100% Co2 or 75% Ar/25%Co2	Short Circuit	100% Co2 or 75% Ar/25%Co2	100% Co2 or 75% Ar/25%Co2
		Spray/ Puls	90%Ar/10%Co2**(3)**	90%Ar/10%Co2**(3)**
Low alloy steel	100% Co2 or 75% Ar/25%Co2	Short Circuit	75% Ar/25%Co2**(4)**	75% Ar/25%Co2**(4)**
		Spray/ Puls	98% Ar/2%O2**(5)**	98% Ar/2%O2**(5)**
Stainless steel	100% Co2 or 75% Ar/25%Co2	Short Circuit	90%He/7,5%Ar/2,5%Co2	N/A
		Spray/ Puls	98%Ar/2%O2**(6)**	98%Ar/2%O2**(6)**
Aluminium	N/A	Spray/ Puls	100% Ar**(2)**	N/A
Nickel alloys	N/A	Short Circuit	100% Ar	N/A
		Spray/ Puls	100% Ar or 75%Ar/25%He	
Copper alloys	N/A	Spray/ Puls	100% Ar or 75%Ar/25%He	N/A

1) It is possible to operate metal cored wire in a short circuit transfer but arc performance is poor. They operate at their best in spray arc or pulse spray arc transfer mode.
2) On thicker plates, 100% He or an Ar/He mix may be used for more radiated heat into the base material.
3) Other Ar/Co2 mixes may be used with a minimum of 82% Ar (sometimes 80%Ar/20%Co2 mixes are used)
4) 100%Co2 shielding gas may also be used.
5) Other gas mixes that may be used include 95%Ar/5%Co2 and 90%Ar/10%Co2
6) Other gas mixes may be 98%Ar/2%Co2

Gas flow

The desirable rate of gas flow depends primarily on weld geometry, speed, current, the type of gas, and the metal transfer mode being utilized. Welding flat surfaces requires higher flow than welding grooved materials, since the gas is dispersed more quickly. Faster welding speeds, in general, mean that more gas needs to be supplied to provide adequate coverage. Additionally, higher current requires greater flow, and generally, more helium is required to provide adequate coverage than argon. Perhaps most importantly, the four primary variations of GMAW have differing shielding gas flow requirements:

Short circuiting and Pulsed spray modes, about 10 L/min (20 ft^3/h)
Globular transfer, around 15 L/min (30 ft^3/h)
Spray transfer, around 20–25 L/min (40–50 ft^3/h)

Actual gas flow at the wire torch may deviate from what is set on the cylinder regulators flow meter, especially if long gas hoses are used. The flow control meter measures actual flow at the torch nozzle and is a useful tool for the operator.

Wire feeder and the wire feed system

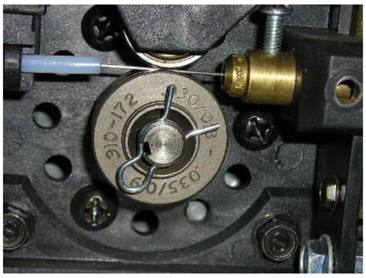
Some GMAW/FCAW power source are designed with an enclosed wire feed unit, while others have a separate wire feed unit attached.

Enclosed wire feeder inside power source

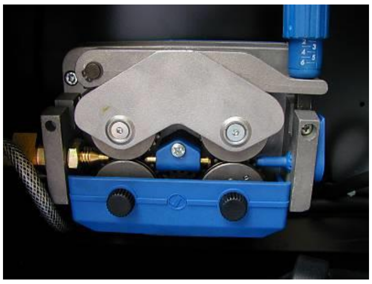
Separate wire feed unit

A wire feeder enclosed in the power source can be a good solution in a workshop.
Having a wire feeder that is separate from the power source give a number of advantages onboard where welding may be required at several locations outside the workshop. Instead of transporting a bulky machine consisting of power source and wire feeder to the work site the power source is left and only the wire feeder brought to work location. The two will be connected by an extension cable.

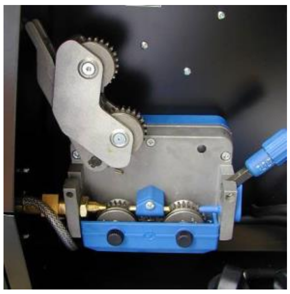
Wire feeders will be fitted with Two drive roll or Four drive roll drive system



Two drive roll system



Four drive roll system in closed position



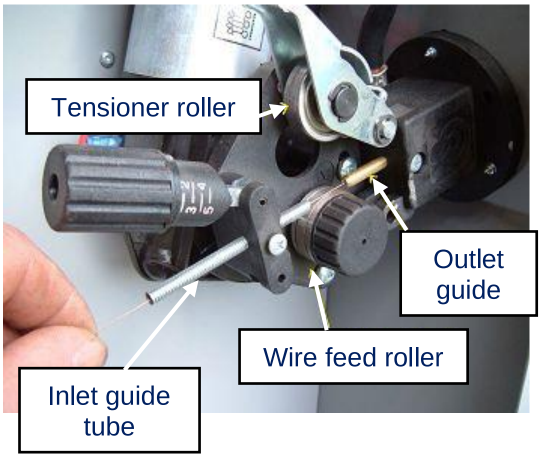
Four drive roll system in open position

Two drive rolls or four drive rolls wire feeder?

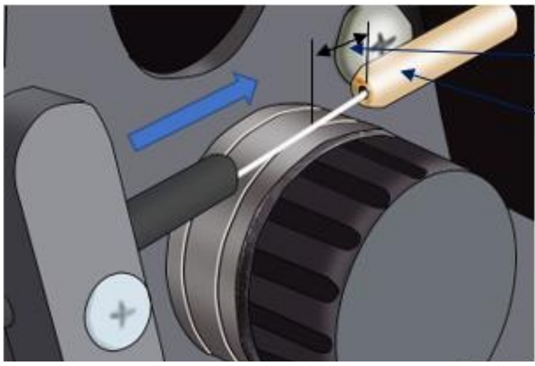
Small diameter, solid hard wires like 0,9mm (0.035”) or 1,2mm (0.047”) steel feed fine with a two-drive roll system in most cases. Consider a wire feeder with four drive rolls when using hard and flux cored wires 2,4mm (0,094”) and larger, when using a gun with a long welding torch cable say 7,6m (25 ft.). In a four-roll feeder, the first set of drive rolls almost acts as a wire straightener, helping to remove the longitudinal twist and spiral in the wire, while the second set of drive rolls helps smooth the wire feeding performance. When using very soft wires, such as aluminium and certain flux cored wires with a low cylindrical strength, a two-drive roll system is best. “Over pressuring soft wire can deform and flatten it, resulting in poor feeding and possible tangling of the welding wire. Properly adjusting the drive roll pressure is critical when running soft wires.

Setting up the system

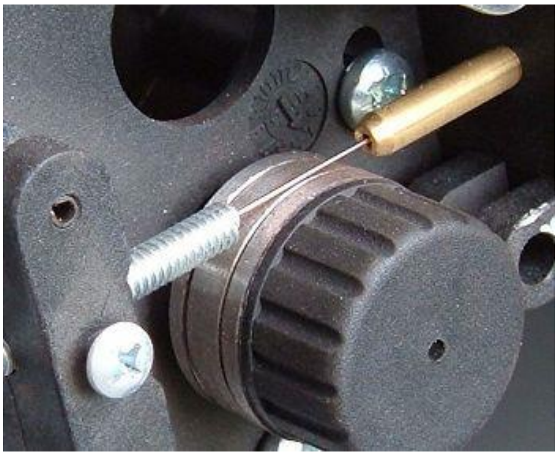
Preparing the wire:
The first 75mm (3”) of wire should be as straight as possible to reduce the chance of damage to the liner or snagging as the wire is fed through. Sharp wire cutters can be used for trimming.
Letting go of the end of the wire would cause it to unravel and tangle. To avoid damaging the liner or getting the wire stuck when feeding it through the liner, it may be an advantage to round off the wire end with a file.



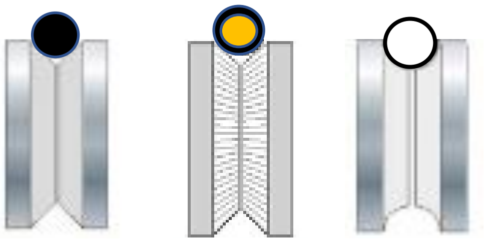
Feeding the wire to the torch:
The wire is inserted through the inlet guide tube and over the roller. On the torch side of the welder the small hole of the outlet guide should be visible. The end of the wire must be aligned with that hole. The wire can then be pushed into the liner manually for a few inches, and should feed easily and without any force. If force is required it is likely that the wire has missed the liner.



It is also very important that the outlet guide is placed as close to the drive roll as possible to catch the wire as it comes off the drive roll.



The wire feed roller itself will normally have two grooves, and is secured either by a grub screw in the side of the roller, or a knurled plastic cap as in the photo. The groves are normally matched to 0.6mm (0,024) and 0.8mm (0,031) wire and the roller can be reversed to line up the appropriate groove for the wire size being used.
Rust or grease on the wire can reduce the effectiveness of the rollers, and they need to be cleaned with a dry cloth before inserting the wire.
With the wire pushed a couple of inches into the liner replace the tension roller, switch on the welder and use the wire feed mechanism to push the wire through the liner. The torch should be a straight as possible especially near the torch to reduce the chance of the end of the wire wire catching inside the liner.



V- shaped groove drive roll | V-shaped knurled (serrated) drive roll | U-shaped groove drive roll

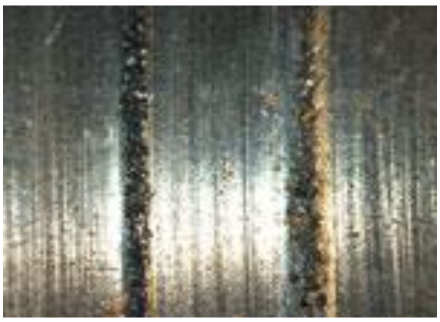
The drive rolls in the wire feed system must be selected according to wire size and type. The grove in the drive rollers varies between wire types:

V- shaped groove drive rolls should be used for standard solid wire.

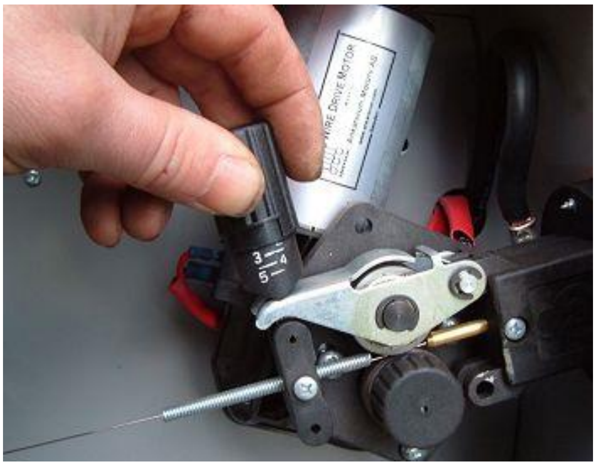
V-shaped knurled (serrated) drive rolls should be used for metal cored and flux cored wires. This are tubular wires and can easily be deformed if there is used V-shaped rolls and to much tension. The small "teeth" in the knurled drive rolls grip and guide the wire with less tension

U-shaped groove drive rolls should be used for aluminium wire.
Setting the drive roll tension too tight can deform the aluminium wire that is soft, which can result in arc instability or burn back.

The difference is obvious between a clean drive roll surface and a drive roll with debris build-up from the wire, environment, or feed apparatus. Particles can be carried into the gun with the welding wire and cause uneven feed, resulting in burn back.



Always remove the contact tip from the end of the torch before feeding the wire through. The gas nozzle is secured by a spring and can be removed by pulling and twisting in a clockwise direction, and the tip has a standard screw thread that unscrews in an anti-clockwise direction (viewed as in the photo). Never unscrew the tip when it is still hot or it may break or strip the thread inside the torch.
If the wire snags in the torch it may be possible to withdraw a little wire onto the reel, and use a rotating motion with the torch to get the wire past the snagging point.



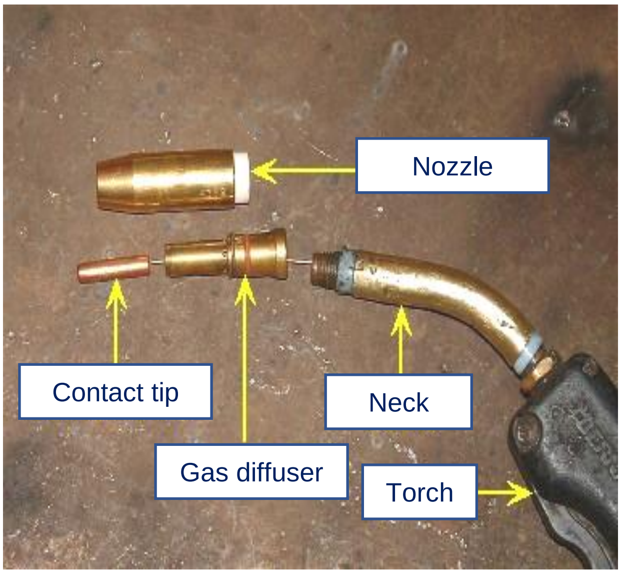
Setting the roller tensioner:
The wire is driven by friction between the wire feed drive roller and the wire. Care in tensioning the wire feed can prolong the life of the tensioner mechanism.
Tightening the tensioner fully can cause the tensioners or tensioner mountings to bend and could also shear the motor gearing if the wire were to stick in the tip during welding. The minimum tension that will ensure good wire feed is recommended.

One way to judge the tension is to grip the wire very lightly between your fingers and pull the trigger. Care is needed with this approach as if the wire were to touch the earth clamp it would arc, resulting in burned fingers and possibly arc eye.
Starting with very little tension on the wire feed mechanism, Increase the tension until the wire feed stops slipping, but do not grip the wire so tightly that the wire feed motor slows.
The wire should ideally start to slip inside the rollers before the motor stalls.

Setting the reel tensioner
Finally check the tension on the wire reel. The tensioner on the reel is there to stop the wire becoming loose and tangled, but the tension should be as light as possible to avoid unnecessary load on the wire mechanism.
Set your wire speed to the maximum that will be needed, and press the trigger on the torch. The wire reel should stop without unravelling when the trigger is realised.

Avoiding wire feed problems:
Wire feed problems are commonly caused by rusty welding wire. The rust acts as a lubricant on the feed rollers causing slip, and as an abrasive on the wire liner which increases resistance.
Wire can quickly go rusty when left unused inside a welder. Ideally the wire should be removed and stored indoors when the welder is not in use. This wire in the photo was reusable after the top couple of layers of wire had been removed. Liners damaged by rusty wire can be replaced fairly cheaply.

Wire liners do wear and are considered to be a wear item. Professional welders might replace the liner after every 100kg (220 pound) of wire.
On most welders the liner can be unscrewed at each end and pulled out of the cord.
Wire liners come in steel, plastic and Teflon. The steel liners are the most robust and are excellent for mild steel wire, offering the lowest resistance to the wire. Teflon liners are intended for use with aluminium wire, though plastic liners can also be used for aluminium welding.



Contact tip Internal Diameter (I.D.) and quality are of great importance as current is transferred to the wire in the contact tip. The wire diameter and contact tip must match. Check that the contact tip and nozzle are free from spatter, and that the contact tip is of correct size for the wire to be used. Worn contact tips or liners should be replaced. Contact tips made specifically for aluminium welding are available, with smooth internal bores and the absence of sharp burrs on the inlet and outlet ends of the tips which can easily shave the softer aluminium alloys. Note that FCAW Self shielded torch and contact tips are of special design.

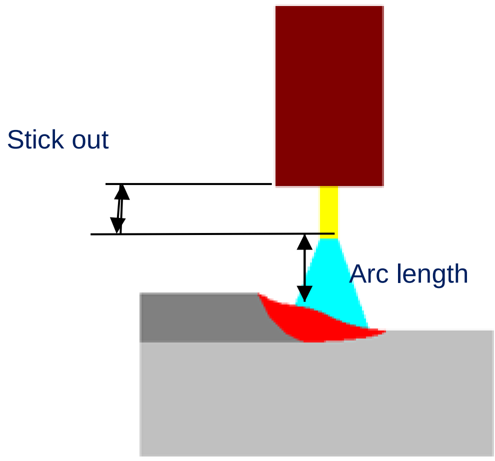
Spool gun alternative.

Aluminium welding wire isn't as strong as steel so pushing it along the length of a GMAW torch cable often results in the wire jamming in the cable or bunching up between the cable entrance and feed mechanism. There are two solutions to this problem:

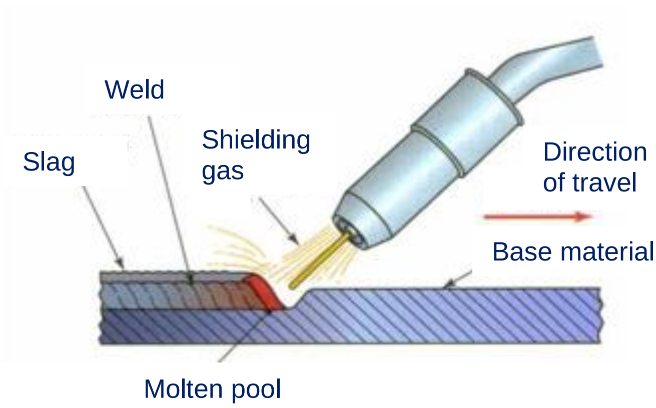
1) Arrange your torch cable so it is as straight as possible.

2) Make use of a spool gun. Spool guns offer portability and provide optimum feeding performance for difficult-to-feed welding wires, such as aluminium and other soft alloys. Spool gun, is a portable lightweight wire feeder/gun combination normally equipped with a 7,6m (25 ft.) cable assembly. Designed for 100mm (4”) diameter spools of welding wire, they are ideal for lower duty applications requiring mobility and access.

Welding technique

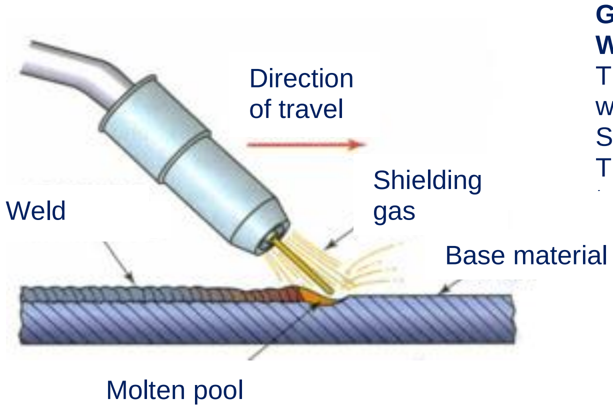


During welding the welder must control the sickout. The stick-out is the distance from the end of the contact tip to the tip of the wire. This distance decides how long the current carrying part of the welding wire is to be. The electric resistance and voltage drop in the wire increases with increasing stick out. This voltage drop is part of what the equipment measures as arc voltage, and the welding current will decrease with increasing stick out and vice versa. Too long stick out may result in too cold arc and insufficient gas shield and must be avoided. Too short stick out may overheat the contact tip and will also allow more spatter to reach the nozzle. This may again cause turbulence in the gas flow, and insufficient shielding. When Flux Cored Arc Welding Self Shielded is to be used, a too short a stick out will give porosity.



Wire Welding may be done with the forehand (push) or backhand (pull) technique, depending on welding position and alloy.

FCAW Self shielded and Gas-Shielded Wire: Backhand Technique.
Like MMAW (Stick Electrode welding) will FCAW Self shielded welding and Gas shielded welding produce a slag that need to be kept under control. The torch should be tilted in the direction of travel



GMAW Solid Wire and Metal-Cored Wire: Forehand technique.
There is only a slight oxide on top of the weld deposit when performing GMAW Solid Wire and Metal-Cored Wire welding. The torch should point in the direction of

SUMMING UP

The facts:

GMAW Solid Wire/ Metal-Cored Wire and FCAW Gas-Shielded riley on Shielding gas in order to produce a satisfactory result. Strong draft or wind may disturb the shielding gas flow and cause welding faults. The weld location must therefore be shielded and preferably below deck.

FCAW Self shielded have no need for external shielding gas. The flux core in the tubular consumable wire gives the same shielding as MMAW (Stick electrode welding). A suitable welding process out on the open deck. FCAW Self shielded will provide a higher deposition rate than MMAW and also give higher production rate, since the operator does not need to stop periodically to fetch a new electrode, as is the case in MMAW.

Deposition rate (Kg weld deposited/hour):

Flux cored and metal cored wires are more expensive than solid wire. Deposition rates in Kg/hour (pounds/ hour): Flux cored and metal cored wires have some of the highest deposition rates of the welding consumables. Flux cored and metal cored wires can have deposition rates as high as 5,4-6,4Kg/hour (12-14 pounds per hour) for a 1,2mm (0.047") diameter wire. This compares to a solid wire in the same diameter of 3,6-4,5 Kg/hour (8-10 pounds per hour). Rule of thumb: When a deposition rate of 4,1Kg/hour (9 pounds per hour) or greater is achieved with a metal cored or flux cored wire, the economics of the weld will show a cost savings in favour of the flux cored or metal cored wire.

Labour and consumable cost:

In the western world filler metals make up 10% of a weld's cost and shielding gas 3%. Labour accounts for 85% of welding costs. This will to some extent be different in other parts of the world. Never the less it is important to put emphasis on high deposition rate for a welding process in order to have the job done as fast as possible and thereby lower labour cost.

Welding equipment

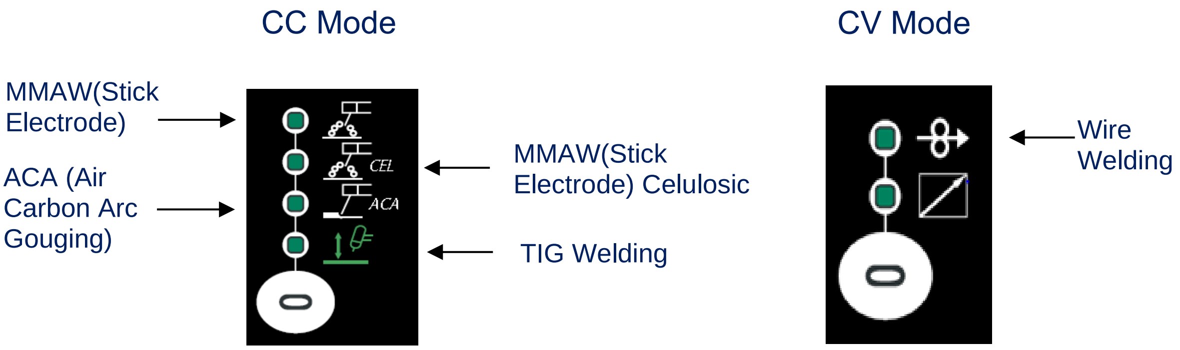
Wire feeders can be connected with three basic categories of DC power sources: Constant Voltage (CV), Constant Current (CC), or one with both capabilities (CV/CC). Wire feeders are not recommended for use with AC output-only machines. Generally speaking, CV-only power sources are dedicated for wire welding, GMAW Solid Wire/ Metal-Cored Wire and FCAW Gas-Shielded/ Self shielded processes. They do not have, nor can they be converted for, MMAW (Stick Electrode) or TIG capabilities. CC-only power sources are often initially purchased for Stick or TIG welding. CC/CV power sources can inherently perform all three processes.

The recommendation is therefore to use a CC/CV type of welding power source that can provide the established maintenance welding processes onboard in CC mode to MMAW, TIG welding, ACA gouging and in CV mode provide Wire Welding. In this way all welding processes in one machine. If the power source should be Pulse transfer type depend if welding aluminium, stainless steel, nickel and copper alloy. In order to provide sufficient energy, the power source should be able to provide approximately 500 Ampere at 50% duty cycle. The Duty Cycle is the percentage of 10 minutes that a welding machine can weld at rated load without overheating. It refers to a 40°C (104°F) environmental temperature.

Based on the above a constant speed wire feeder is then used when the power source is set in CV mode. Voltage and wire feed speed (which controls amperage) is set at the constant speed feeder. The power source and wire feeder can together provide for all wire welding methods.

Having a wire feeder that is separate from the power source give a number of advantages onboard. Instead of transporting a bulky machine consisting of power source and wire feeder to the work site the power source is left at a fixed location and only the wire feeder brought to work location. The two will be connected by an extension cable.

CV mode provide Wire Welding



Wire Welding should only be considered if there is a justifiable amount of welding to be performed onboard. The type of ships where this could be the case is:

Heavy lifters doing sea fastening.

The amount of welding onboard a Heavy lift vessel in connection with sea fastening of steel structures will definitely justify the use of Wire Welding FCAW Self shielded consumable. If the power source also has CC mode it can also perform ACA gouging to fast remove the sea fastening welds.

Jack-up installations vessels. Windmill carrier vessels have sometime the same need for sea fastening as heavy lifters.

Dredgers.

Wear and tear plus hard surfacing. Also, dredgers have a need for Wire Welding in order to improve on time consuming MMAW (electrode/stick welding). On dredgers there will be a large amount of tear (cracks) to steel plating and wear from impact and abrasion. Wire Welding FCAW Self shielded consumables for joining and hard surfacing will be recommended.

Cement carriers. Wear and tear plus hard surfacing. This type of vessels will to a lesser extent have the same need as dredgers.

Cruise vessels. Aluminium and stainless steel. Onboard cruise vessels especially aluminium welding can represent a maintenance welding problem. Best and most efficient welding method will be GMAW Solid Wire. Stainless steel can be welded using GMAW Solid Wire or Metal-Cored Wire.

Chemical carriers. Many chemical carriers have tanks and piping made out of stainless steel. For plate material FCAW Gas Shield Wire, GMAW Solid Wire or Metal-Cored Wire can be used. For Thin walled piping TIG welding using the welding machines CC mode will be a better alternative.

Big steel replacements (bulk head replacements) during voyage onboard for example a bulk carrier can also justify the use of wire welding equipment. Ropes and chains wear and tear on pulleys, windlass drums and winch wheels can, if of sufficient amount and magnitude, also fast and efficient be rebuilt by Wire Welding.