A report about:

Submerged arc welding

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Content

Introduction

Submerged arc welding can be employed for an extremely wide range of workpieces. The method is suitable for butt welding and fillet welding of such applications as struc tural members in ships, manufacture of pressure vessels, bridge beams, massive water pipes, thin sheet shells and so on. In addition, the process is particularly effec tive for cladding applications, e.g. when surfacing mild carbon steel with stainless steel materials, or when depositing hard materials on a softer substrate. Submerged arc welding is generally performed indoors in fabrication shops. Working outdoors always carries the risk of undesirable levels of moisture finding their way into the joint or flux and resulting in porosity of the weld. If submerged arc welding must be carried out outdoors, special precautions should be taken, such as the construction of a roof over the work area. Submerged arc welding is most efficient if the joint can be filled with as few passes as possible. If, when working in mild steel, the workpiece can be turned over, and if the material is not too thick, a bead is often applied from each side of the joint. If the basic material is alloyed steel, a multi-pass procedure is normally necessary. Admittedly, this results in an increase in process costs, but for many workpieces the economics of the process are still sufficiently attractive for submerged arc welding to be more cost effective than, say, manual welding using coated electrodes. In addition, there will be fewer weld defects with automatic welding.

Principles of submerged arc welding

The diagram below indicates, in schematic form, the main principles of submerged arc welding. The filler material is an uncoated, continuous wire electrode, applied to the joint together with a flow of fine-grained flux, which is supplied from a flux hopper via a tube. The electrical resistance of the electrode should be as low as possible to facili�tate welding at a high current, and so the welding current is supplied to the electrode through contacts very close to the arc and immediately above it. The arc burns in a cavity which, apart from the arc itself, is filled with gas and metal vapour. The size of the cavity in front of the arc is delineated by unmelted basic material, and behind it by the molten weld. The top of the cavity is formed by molten flux. The diagram also shows the solidified weld and the solidified flux, which covers the weld in a thin layer 1 SUBMERGED ARC WELDING 4 and which must subsequently be removed. Not all of the flux supplied is used up: the excess flux can be sucked up and used again.

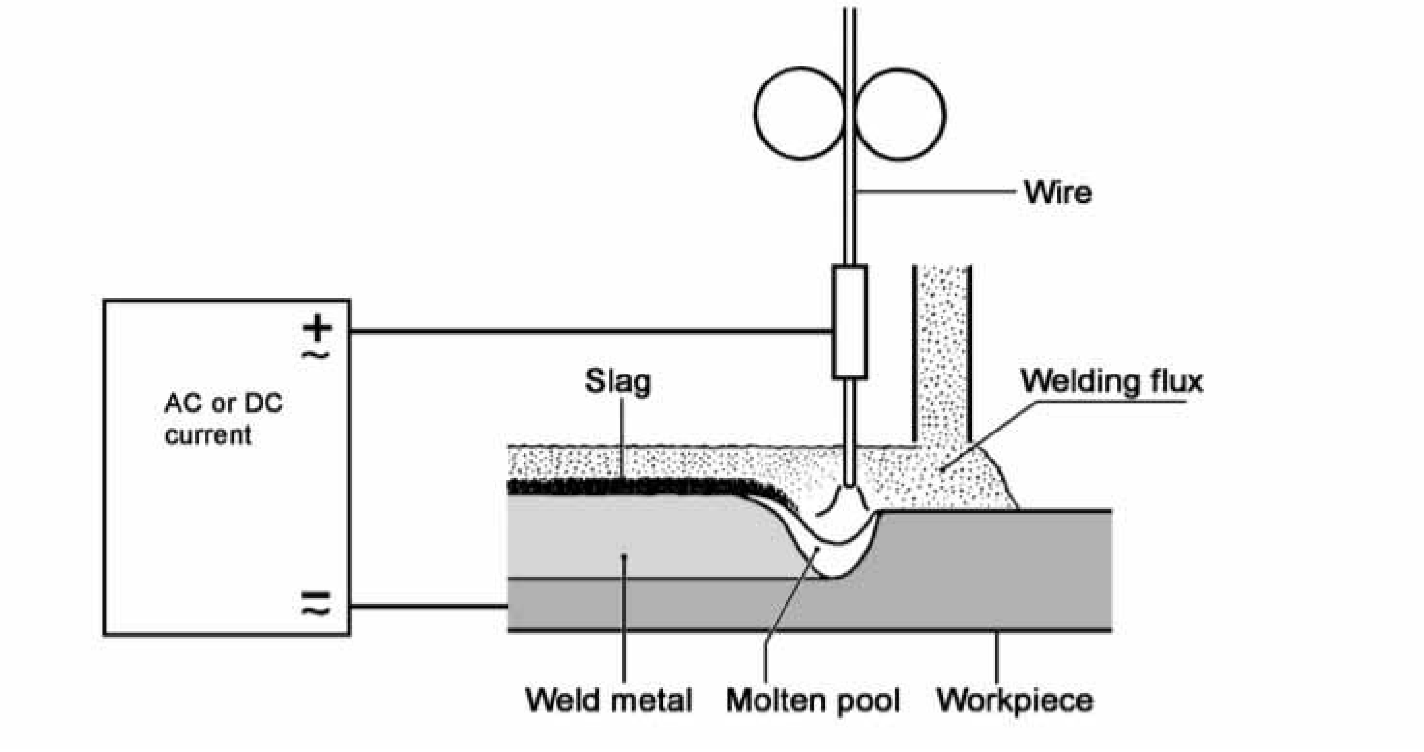


Figure 1. The principle of submerged arc welding

The flux also has a thermal insulating effect, and thus reduces heat losses from the arc. As a result, more of the input energy is available for the actual welding process itself than is the case with processes involving an exposed arc. The thermal efficiency is greater and the rate of welding is faster. It has been found that submerged arc weld￾ing has a thermal efficiency of about 90 %, as against an approximate value of about 75 % for MMA welding. Submerged arc welding can be performed using either DC or AC

Applications

Submerged arc welding can be employed for an extremely wide range of workpieces. The method is suitable for butt welding and fillet welding of such applications as struc￾tural members in ships, manufacture of pressure vessels, bridge beams, massive water pipes, thin sheet shells and so on. In addition, the process is particularly effec￾tive for cladding applications, e.g. when coating mild carbon steel with stainless steel materials, or when depositing hard materials on softer substrates. Submerged arc welding is generally performed indoors in fabrication shops. Working outdoors always carries the risk of undesirable levels of moisture finding their way into the joint or flux and resulting in porosity in the weld. If submerged arc welding cannot be avoided outdoors, special measures should be taken, such as the construction of a roof over the work area.

Submerged arc welding is most efficient if the joint can be filled with as few passes as possible. If, when working in mild steel, the workpiece can be turned over and if the material is not too thick, a bead is often applied from each side of the joint. If the basic material is an alloy steel, a multi-pass procedure is normally necessary. Admittedly, this results in an increase in process costs, but for many workpieces the economics of the process are still sufficiently attractive for submerged arc welding to be more cost‐effective than, say, manual welding using coated electrodes. In addition, there will be fewer weld defects with automatic welding.

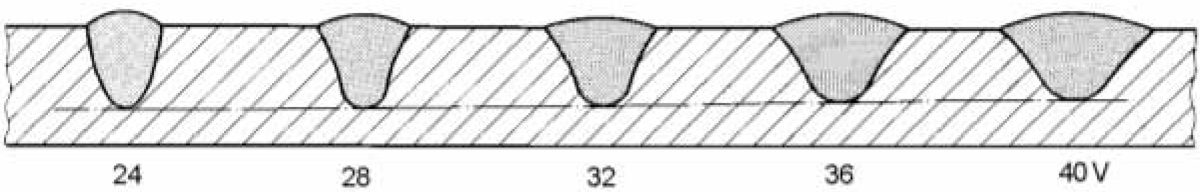
PARAMETERS

Selection of welding data

Welding data depends on the size of the workpiece, and must be selected to ensure satisfactory penetration and correct shape of the weld. Starting from this basic require‐ment, we select the appropriate values of filler wire size, arc voltage, welding current and welding speed. The tables of welding data at the end of this binder give a number of guidelines for selection of correct welding data. It is recommended that the selec‐tions made should be first tested by trial welds, thus avoiding the risk of an unsuc‐cessful weld when working with the workpiece itself.

Arc voltage

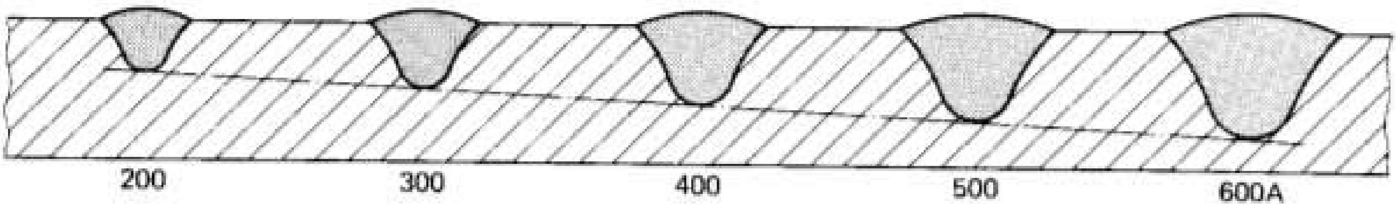
The arc voltage is decisive in determining the shape and width of the arc and, to some degree, also in determining its penetration. Too high an arc voltage in an I-joint in flat sheet will produce a wider weld, while in a V-joint, X-joint and fillet radii it will result in a concave weld, with a risk of undercutting and slag that is difficult to remove. On the other hand, too low an arc voltage will result in a high, round weld in I-joints and V-joints, while in X-joints and fillet radii it will result in a convex weld, and which is also hard to de-slag.



How a change in arc voltage affects the shape of weld. Welding current is constant.

Welding current

Welding current is the parameter that is of greatest importance for penetration. The current setting depends on the thickness of the metal and the type of joint. The current has no effect on the width of the bead, but too high a current can result in burn-through, while too low a current can result in insufficient penetration with resulting root defects. This means that the welding current, which is proportional to the wire feed speed, affects the deposition rate (the quantity of electrode material melted into the weld per unit of time), so that as the welding current increases, the rate of melting of the filler wire also increases. For a given welding current, the deposition rate will be higher if the filler wire is negative with respect to the workpiece than if the wire is positive, but the penetration will be reduced.



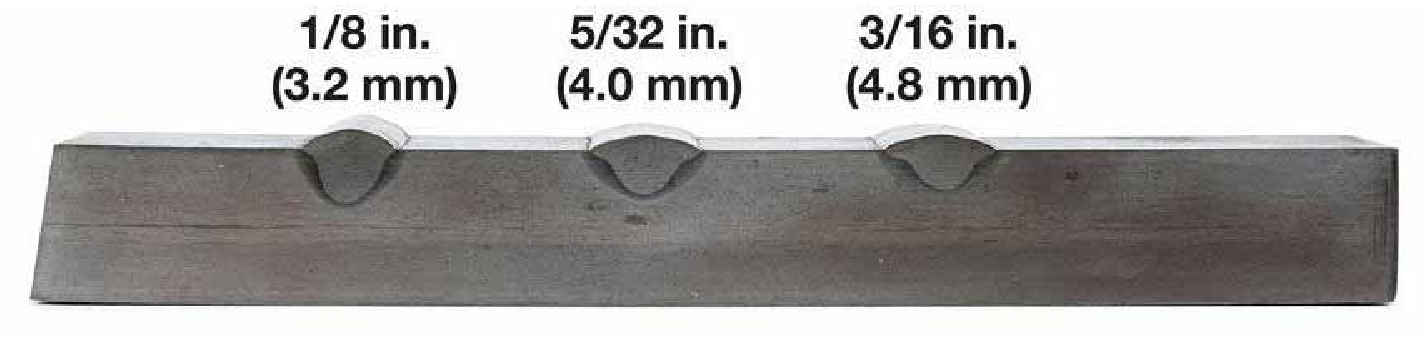
Increasing welding current results in deeper penetration.

Welding speed

The welding speed (the linear speed along the line of the weld) also affects the pene�tration. If the speed is increased relative to the original value, penetration will be decreased and the weld will be narrower. Reducing the speed increases penetration and results in a wider weld (cf. manual welding). However, reducing the welding speed to about 20–25 cm/min (depending on the actual value of the current) can have the opposite effect, i.e. a reduction in penetration, as the arc is prevented from trans�ferring thermal energy to the parent metal by the excessive size of the weld pool. If the welding speed is to be changed while penetration is kept constant, it is necessary to compensate by adjustment of the welding current, i.e. to increa

Wire diameter

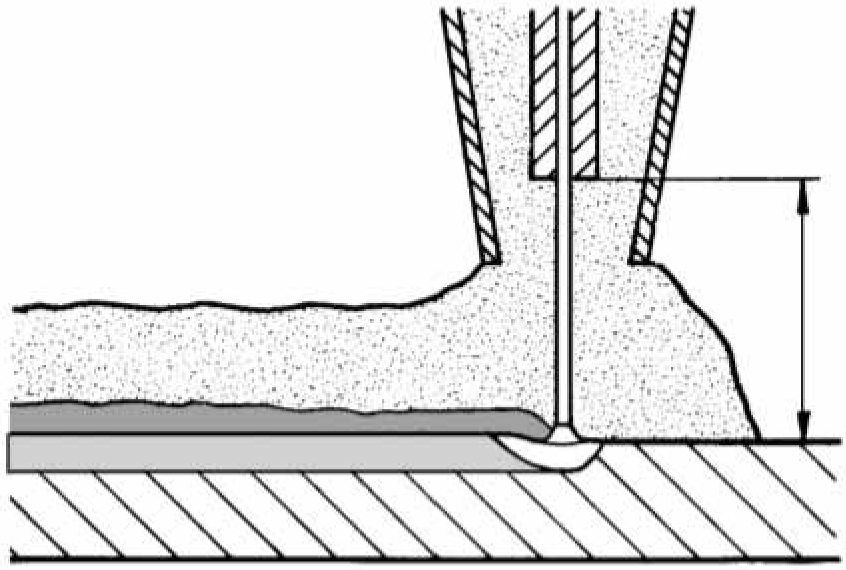
For a given current, a change in wire size will result in a change in current density. Greater wire diameter results in a reduction in penetration and, to some extent, also the risk of burning through at the bottom of the weld. In addition, the arc will become more difficult to strike and arc stability will be adversely affected. There is a risk of root defects if too large an electrode is used in V-joints.se or decrease it.



The effect of different wire diameters at constant welding current

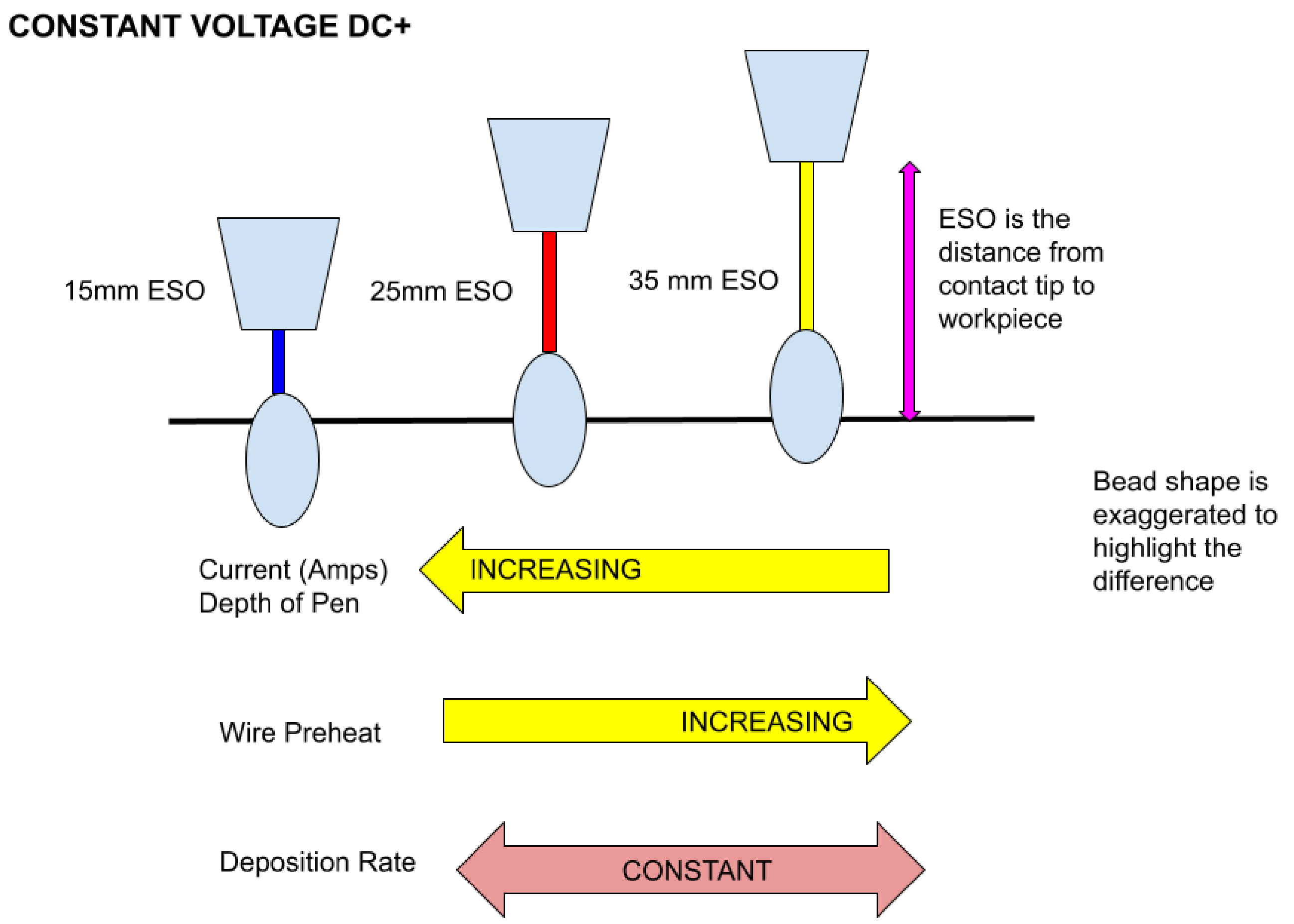
Stick-out

The electrical stick-out of the wire is the distance from the contact tip to the surface of the workpiece.



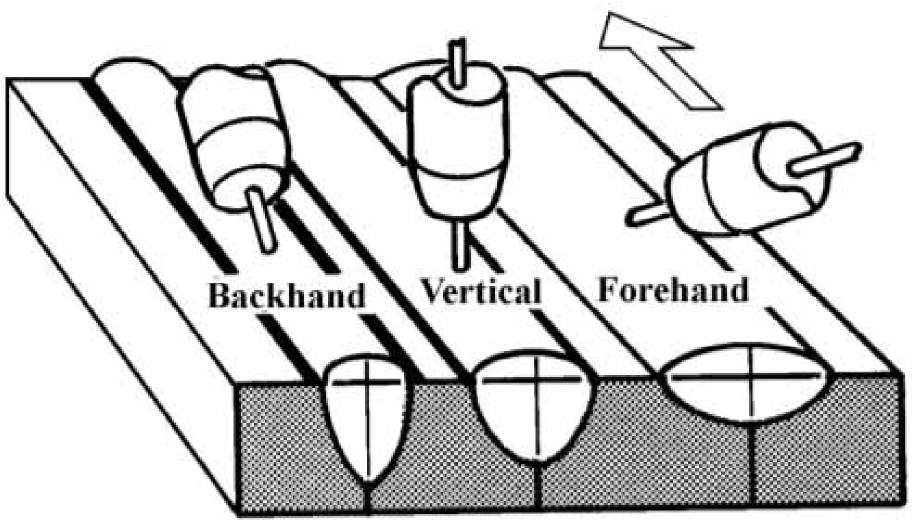
Stick-out distance.

This distance is an important parameter, affecting the resistive heating of the tip of the wire. If the stick-out is short, little heat will be developed in the wire and penetration will be greater. As the stick-out length is increased, so the temperature of the wire increases and penetration is reduced, while the rate of deposition is increased. Extra long electrical stick-out is employed particularly for deposition and cladding (application of a stainless steel or wear-resistant layer). It is possible to increase the rate of deposition by up to 50% with a long stick-out. When welding in normal struc?tural steels, a normal value of stick-out is 25–30 mm, with a somewhat shorter stick?out of about 20–25 mm being used for stainless steels, as stainless steel filler wires have higher resistance. It is desirable to be able to adjust the flux depth, depending on the amount of molten metal in the bead. Figure 6. Penetration is reduced as electrical stick-out increase



Wire angle

The angle between the filler wire and the workpiece determines the position of the weld, its appearance and its penetration



Effect of wire angle on weld penetration and width.

Electrode angle	Backhand	Vertical	Forehand
Penetration	High	Normal	Low
Weld convexity	Narrow (high)	Normal	Wide (low)
Tendency to undercut-ting	High	Normal	Slight

Vertical filler wire angle is most commonly used, but when tandem and multi-wire sys�tems are used both forehand and backhand wire angles are used in order to achieve the welding performance.

Formula

Heat input

Q=(U*I*60/V)* η

where Q = Input energy, kJ/mm

U = Voltage,

V I = Current,

A V = Linear welding speed, mm/min

η = Efficiency (for submerged arc = 0.9 or 1.0

Carbon equivalent

Ec= Cev= (C+Mn/6)+(Cr+Mo+V/5)+(Ni+Cu/15)

The parent metal should/must be preheated if Ec > 0.40 %

Form factor

F=B/D

where F = Width/height ratio

B = Width of weld

D = Height/depth of weld

F should not be less than 1–1.5, as there will otherwise be a risk of cracking

Deposit rate An approximation of the deposit rate is given by the formulas

Dep. rate (kg/h) = Amp / (50 x Diam0.3) Single wire DC+

Dep. rate (kg/h) = Amp / (40 x Diam0.3) Single wire AC

Somewhat more accurate value on wire feed speed (m/min) for DC+:

WFS={(AMP+22)/44.7DIAM^1.79}^1.41

SUBMERGED ARC WELDING METHODS

١-Single-wire welding

Filler wires with diameters from 1.2 mm to 6 mm can be used with welding currents of 120–1500 A. Submerged arc welding processes have developed from single-wire welding to higher productivity processes.

٢-Twin-arc welding

Submerged arc welding with two parallel wires differs more from twin-wire welding with separate welding heads than it does from conventional submerged arc welding having one wire and one welding head. An automatic twin-arc welding machine can be easily produced by fitting a single-wire machine with feed rollers and contact tips for two wires, together with an extra carrier for a second wire bobbin. Double wires have become increasingly common in the interests of higher productivity. Without very much higher capital costs, it is possible to increase the deposition rate by 30–40% in comparison with that of a single-wire machine, as a result of the higher current density that can be carried by two filler wires in parallel. As the equipment uses only a single wire feed unit, the welding current will be shared equally between the two wires.

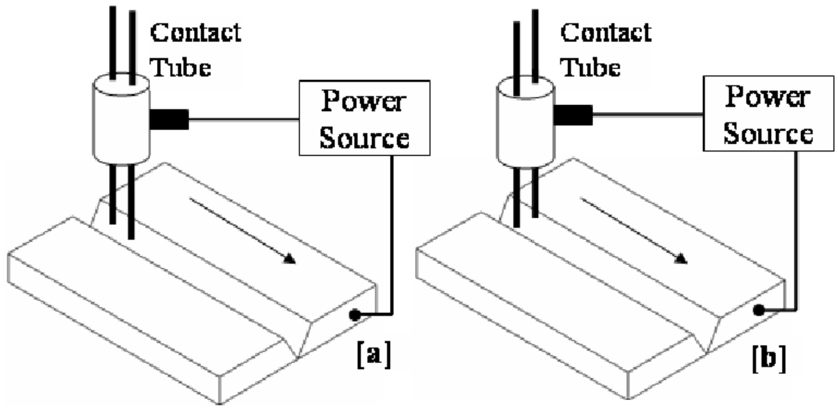
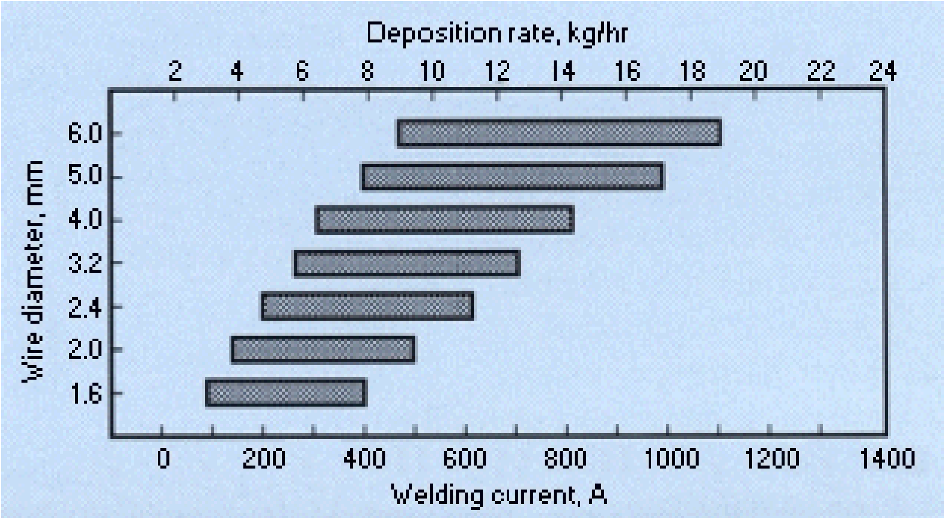


Illustration of twin-wire welding (a) wires in tandem (one after another), (b) transverse wires (beside each other)

Wire sizes and types of current

Wire sizes normally used for butt welding are 2.0, 2.5 and 3.0 mm, with wire separations of about 8 mm. DC welding, with the wire positive relative to the workpiece, is preferable, as this results in the best arc stability and least risk of porosity. When hardfacing using tubular wires, it is generally preferable for the wire to be negative, resulting in minimum penetration and highest deposition rate. Commonly used tubular wire diameters are 2.4, 3.0 and 4.0 mm.



Wire angles and positions: advantages and drawbacks

• By varying the angle of the contact tip, the wire angle relative to the joint can be varied.

• With the wires in line with the joint, penetration will be highest and risk of undercutting will be least. This position ensures the least risk of porosity, as the molten weld metal has longer to cool, allowing more time for gas to escape from the weld.

• With the wires perpendicular to the joint, penetration is minimum. This arrangement is pre�ferred in welds in which ordinary root faces for submerged arc welding cannot be used, e.g. corner/fillet welds, and also where wide joint widths need to be covered with one pass or where the edges of the joint are uneven. There is some risk of undercutting at high welding speeds. As, with the wires in this position, very little of the parent metal is melted relative to the amount normally melted in the submerged arc process, resulting in an improved form factor of the weld. This arrangement is also used for welding materials in which there is a risk of thermal cracking.

• A pair of wires arranged diagonally to the weld can be used as a compromise position to obtain the benefits of the two basic positions described above.

Comparison between single-wire and twin-wire welding

The performance parameters shown in the table below are based on the performance of the A6 wire feed motor, and not on basic welding characteristics.

TYPE OF WIRE	DIAMETER mm	AREA mm^2	WELDING CURRENT A max	DEPOSITION RATE kg/h
SINGLE WIRE	3.0	7.06	650	8.0
SINGLE WIRE	4.0	12.56	850	11.5
SINGLE WIRE	5.0	19.62	1100	14.5
TWIN WIRE	2.0	6.28	1000	14.0
TWIN WIRE	2.5	9.81	1200	17.0
TWIN WIRE	3.0	14.13	1500	21.0

Tandem welding

When the wires are connected to separate power units, and the welding heads work on the same joint, the process is referred to as tandem welding. Tandem welding uses thicker wires (3–4 mm). The method is used when welding thick plate, where substan�tial cross-sectional areas have to be filled with weld metal.

Tandem welding partly offsets the metallurgical structure drawbacks that can result from a large, slowly solidifying, weld pool

Strip welding

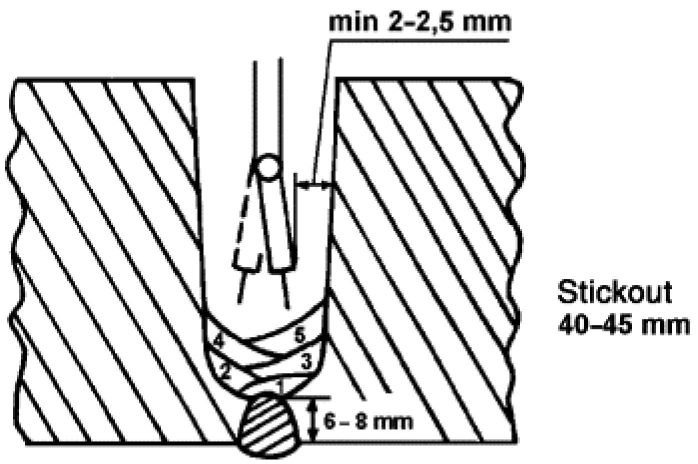
The same equipment can be used for strip welding as for single-wire welding, but the wire is now in the form of a strip of metal, either 0.5 x 60 mm or 0.5 x 100 mm. The welding head and flux feed arrangements are modified to suit. As a result of the rec�tangular cross-section, penetration is exceptionally low, producing a smooth and wide weld. The process is used for such applications as cladding carbon steel with stain�less steel, where the dilution from the parent metal must be low in order not to affect the corrosion resistance of the surface layer. The method is also used for repair of worn parts.

Narrow gap welding

ESAB's NGSA method has been developed for the welding of thick-wall pressure ves�sels in very narrow gaps. The joint sides are almost parallel, inclined at an angle of only 3. Conventional welded joints use either double V-joints or U-joints, so it can be easily appreciated that both welding time and the amount of filler material can be reduced when using narrow-gap welding methods. Instead of applying a substantial pass in the middle of the joint, the method is based on applying passes to the left and right sides alternately. In order to ensure good release of the slag, the width of the slag must not be wider than the joint. Narrow-gap welding can be used in metal thickness up to 350 mm, which can be welded from the root to the final pass without interruption.

Benefits of narrow-gap welding

- Short arc times
- Minimum of filler materials
- Low welding stresses
- Narrow heat-affected zone
- Low input power
- High quality.



A narrow-gap U-joint, suitable for submerged arc welding.

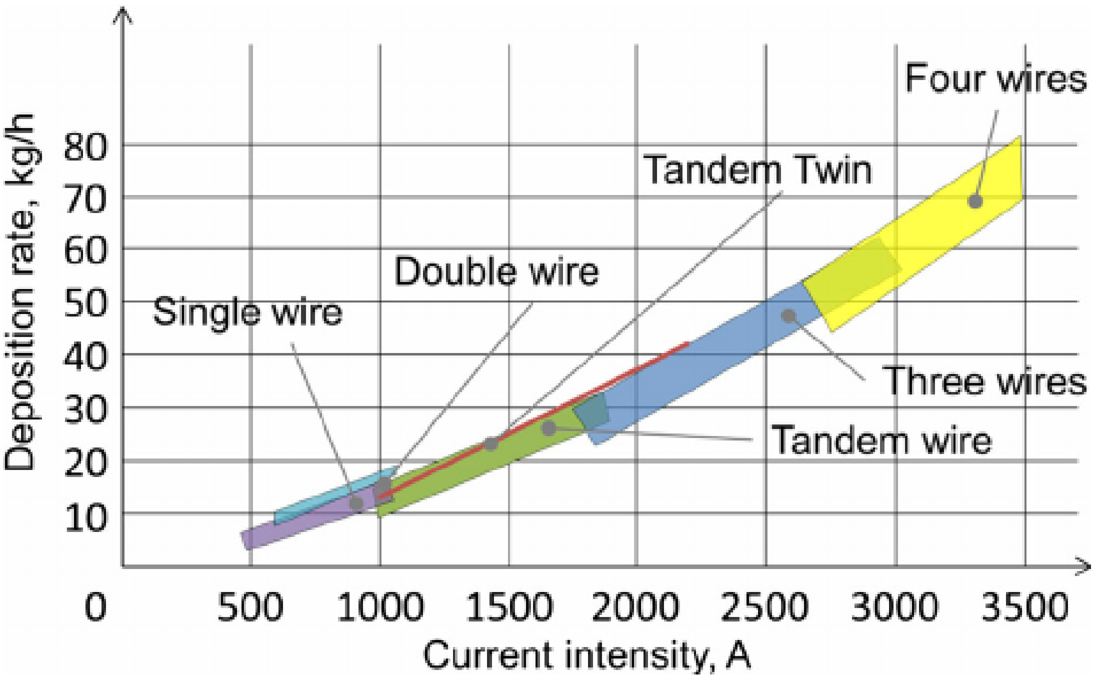
Cold wire addition

ESAB has introduced a simple equipment for cold wire addition, a process called Syn?ergic Cold Wire (A6 SCW). It offers the opportunity to increase the deposition rate by up to 100% compared with single-wire welding. The cold wire is fed in synergy (e.g. with the same wire-feed speed) with the normal arc wire into weld pool where it melts. Because the wire feed speeds are the same, the arc and cold wire ratio always remains constant. The proportion can be changed by the choice of the individual wire diameters.

Iron powder

Productivity can be increased by adding cold materials, such as iron powder, to the weld beads. The shipbuilding industry in particular now makes widespread use of.

welding with iron powder. In comparison with conventional submerged arc welding, productivity can be increased by almost 50%.



Deposition rate of different SAW processes arrangements at a range of currents

JOINT PREPARATION

General

In order to be able to obtain full benefit of the productivity of automatic welding, it is essential that joints are prepared with the greatest accuracy. The edges of sheets must be carefully machined to ensure optimum penetration. The root face on a V-joint or Y-joint must be sufficiently high to ensure production of the required root pass and to prevent burn-through. The edges of the sheet must be absolutely clean, i.e. with no traces of water, oil, paint, mill scale or rust, which would otherwise result in pores or crack formation. If the sheet has been plasma-cut, the edges must be ground. Dimensional inaccuracies in joint preparation result in defective welds. They will also, in any case, make automatic welding more difficult. The results of poor matching of joints will be burn-through or incomplete penetration, i.e. root defects. Submerged arc welding requires more expensive joint preparation than manual weld�ing. However, the cost difference is so small that there is no justification for attempting to skimp the joint preparation work. A clean, properly prepared joint allows higher welding speeds, which more than offsets the expensive preparation.

Joint backing

The advantage of good joint backing is that it allows the use of welding currents sufficiently high to ensure adequate penetration, a high deposition rate and acceptable appearance of the root side of the weld.

Backing

This is defined as a root face, a manually welded bottom pass, a copper bar (common with stationary working positions) or some form of fireproof material that can be fitted to the workpiece.

Backing strips

Consists of a bar or section, generally of the same grade of material as the parent metal, tack-welded beneath the joint and intended to form part of the joint when finished.

Ceramic backing

Easily applicable root support in the form of ceramic tiles, intended to be used with workpieces that cannot be turned, e.g. the decks of vessels, fixed structures etc., and thereby avoiding arc-air gouging and post-welding

FILLER MATERIALS

Two main items are generally used as filler materials for submerged arc welding: electrodes (filler wire) and flux. Recently, a third component has become increasingly commonly used: iron powder

Filler wire

The filler wire is generally copper-plated in order to ensure good current transfer to it from the contact jaws, and to reduce wear of the jaws. The copper, in other words, is not intended as corrosion protection in the usual meaning, and coils of filler wire must be protected against moisture in the same way as must other filler materials.

The wire may be of various types, solid or tubular and, in the case of solid wire, be round or rectangular in cross-section. Solid filler wires of round section are used for fabrication welding and cladding, while rectangular section wires – known as strip electrodes – are generally used only for cladding. Tubular wire electrodes are also very suitable for cladding, as the alloying elements necessary can be contained in the hollow centre of the wire. Both strip electrodes and tubular wire electrodes are an important part of the field of welding technology devoted to cladding.

Flux

As yet, there is no universal flux suitable for all purposes. A flux that has been developed, for example, for good mechanical properties in high-grade steel, generally has poorer characteristics in some other respect that is of importance for welding. It is therefore only natural that companies with a mixed range of manufactured products have to use two or more grades of flux. Flux compositions are optimised for use in combination with filler wires of varying metallurgical characteristics. This combination can be provided in three ways: with all the necessary alloying elements in the filler wire, in the flux or in the filler wire and flux together

Flux can be classified as a fused, sintered or agglomerating type.

A fused flux is homogeneous, i.e. the substances in the flux have been melted together to form a glass-like substance, which has then been crushed and ground before finally being classified to a suitable grain size.

The particles in an **agglomerated flux**, on the other hand, have been formed by 'rolling' the various constituents on a rotating dish, drum or cone, with waterglass as an additive. The resulting product has then been dried in a rotary kiln at a temperature of 800–900 °C. After drying, the flux is classified to give approximately the same grain size as that of a fused flux.

Sintered fluxes are produced by sintering the various components to produce blocks, which are then crushed and classified.

Fused fluxes are non-hygroscopic, and are therefore particularly suitable for outdoor welding and in high-humidity environments. Agglomerated fluxes, which may be hygroscopic, should be handled with the same care as recommended for electrodes for manual welding.

ESAB fluxes and characteristic properties from a welding viewpoint

From a chemical viewpoint, fluxes can generally be categorized as follows:

- Acidic and neutral fluxes (with basicity B =< 1.2)
- Basic fluxes (B = 1.2–2.0)
- High-basic fluxes (B => 2.0)
- Special fluxes

The special fluxes are defined not in chemical terms, but in terms of their applications, e.g. for welding stainless steel or for hardfacing.

A. Acidic and neutral fluxes

This group is characterised by:

- Excellent welding properties
- Moderate mechanical properties (Grade II approval, i.e. with impact strength requirements at 0 °C)
- The fluxes are alloyed, i.e. intended for use with unalloyed filler wire (OK Autrod 12.10)
- Suitable for use with both AC and DC welding current Within this group, ESAB markets two fluxes: the acid OK Flux 10.81 and the neutral OK Flux

10.80. OK Flux 10.81 has a basicity index of about 0.5 in accordance with the Boniczewski index, and can be classified chemically as being of the alumina type. It demonstrates excellent slag release, good weld formation, high welding speed, low risk of porosity and gas flats, together with good current tolerance. These characteristics have earned the flux wide application, particularly for welding of vertical and horizontal fillet joints with both single-wire and multi-wire systems.

Additional applications for the flux are the welding of thin sheet, various types of pipes and other structures having requirements up to Grade II approval. OK Flux 10.81 is equivalent to – and, in some cases, better than – competitive fluxes available on the market of this group, i.e. with basicity index up to 1.0.

OK Flux 10.80 has a basicity index of about 1.1, and can chemically be regarded as being of calcium/magnesium silicate type. It belongs to the older generation of fluxes,

But is still widely used for butt welding of thicker materials, e.g. in the shipbuilding industry.

Its most characteristic feature is its excellent current tolerance, which allows welding with a large weld pool, i.e. at high current and low welding speed. The reason for this is to be found in the slag's relatively high SiO_2 content. However, in comparison with OK Flux 10.81, this high SiO_2 content does mean that its slag release characteristic is poorer, and that the flux is less suitable for welding fillet joints.

The drawback of this flux is its somewhat limited shelf life, due to the fact that absorbed moisture can be taken up as water of crystallisation.

B. Basic fluxes

This group, having a basicity index of 1.2 – 2.0, is generally characterised by:

• Good welding characteristics

• Good mechanical characteristics (Grade III approval, with impact requirements at -20 °C)

• The ability to supply alloyed fluxes, i.e. intended for use with unalloyed filler wire (OK Autrod 12.10), or unalloyed, i.e. intended for use with alloyed filler wire (e.g. OK Autrod 12.24).

Within this group, ESAB sells two fluxes: OK Flux 10.70 and OK Flux 10.71.

OK Flux 10.70 has a basicity index of about 1.7, and can chemically be regarded as being of the aluminate-basic type. It is of the alloying type, and one of its features is that its basicity is such that it is suitable for use with either AC or DC welding.

In addition, it features good slag release, good weld formation, low pore formation and good current tolerance. These characteristics have resulted in it being suitable not only for normal butt welding, but also for use with vertical and horizontal fillet welds with single-wire or multi-wire systems. Partly as a result of its good shelf life, it is intended that it will replace OK Flux 10.80 in the longer term.

OK Flux 10.71 has a basicity index of about 1.6 and can, in the same way as can OK Flux 10.70, be regarded chemically as of the aluminate-basic type. However, it differs from OK Flux 10.70 in being compensating or weakly alloying in respect of alloying elements, and must therefore be used in combination with alloying filler wire.

Its general welding characteristics are identical with those of OK Flux 10.70. The real difference is that, for metallurgical reasons, OK Flux 10.71 is more suitable for multi-pass welding in thicker materials, e.g. when welding steels with fine grain stru cture.

C. High basic fluxes

This group, which has a basicity index of 2.0–3.5, generally has the following charac-teristics:

• Reasonable welding characteristics (can usually be used only for DC + welding).

• Excellent mechanical characteristics. (This type of flux is used for welding LPG materials having impact strength requirements down to -55 °C.)

• The fluxes are unalloyed, i.e. intended for use with alloyed filler wires, e.g. OK Autrod 12.34.

Within this group, ESAB markets OK Flux 10.61 and OK Flux 10.62.

OK Flux 10.61 has a basicity index of about 2.8 and can be regarded as being chemi-cally of the lime basic type. It is compensating, or produces a slight loss of alloying elements. Its welding characteristics are so good for this type of flux that tandem weld-ing, with DC current, is possible.

The slag release, weld formation, risk of pore formation and current tolerance can be regarded as being of the very best for fluxes of this type.

OK Flux 10.62 has a higher basicity index than OK Flux 10.61, together with better welding characteristics for AC and DC.

D. Special fluxes

As stated at the beginning of this section, these fluxes are generally defined only in terms of their applications. ESAB markets the following fluxes in this category.

OK Flux 10.91 and 10.92 are both intended for welding stainless steel, and therefore include Cr for compensation of Cr loss during welding. Both are acid fluxes, having a basicity index of about 0.8. This is because they are intended for cladding applica-tions using stainless steel strip and therefore require excellent welding characteristics.

OK Flux 10.91 is intended for use together with OK Autrod 16.10 and 16.30, while OK Flux 10.92 is intended for use with (stainless steel) strip electrodes.

OK Flux 10.96 is of the alloying type, intended for hardfacing. With an unalloyed filler wire (OK Autrod 12.10) it produces a hardness of about 36 HRC.

OK Flux 10.16 is intended for cladding with Inconel strip, and is also used for joint welding of duplex and wire electrodes. We are not aware of any third-party equivalent of this flux on the market at present.

Iron powder

In order to increase the productivity of welding materials over 20 mm thick, additives in the form of cold materials such as iron powder or cold wire can be used in filling passes.

For the same energy input per unit length of weld, the addition of iron powder results in a smaller heat-affected zone than does conventional submerged arc welding, which is beneficial in respect of the strength of the weld. The energy input per unit length of weld reduces in proportion to the increasing amount of iron powder.

In comparison with submerged arc welding, productivity increases by almost 50%. This means that the labour cost of welding is correspondingly reduced. In addition, the length of time during which the workpiece is in the workshop is also reduced, resulting in financial savings.

Single-wire welding with separate addition of iron powder requires a backing strip or root pass in order to prevent the iron powder from running through the joint. Normally, it is not reasonable to expect that the joint is sufficiently tight to prevent the powder from running through. The powder requires a feed device, which is included in the range of ESAB A6 welding equipment. It consists of a feeder unit and a control unit, incorporating a display for direct readout of the quantity of powder. Iron powder is usually alloyed with manganese (about 1.8%), although nickel-alloyed powder is also available.

OK Grain 21.85 consists of low-alloyed iron powder with a mesh size of 0.5–0.7 mm. When added to the weld, it assists welding in thick plates or where a high throat dimension is required in horizontal fillet joints, by enabling the weld to be filled with fewer passes. Penetration is reduced, which reduces the risk of burn-through at joint gaps and in the event of inadequately sized root faces. In some cases, the reduced penetration into the parent metal is an advantage.

Conclusion

It uses the submerged arc welding process for heavy metal and heavy structural welding. The fastest and strongest arc welding process available with the best deposition rates. The SAW welding is the process of welding chosen according to the need of the project. Whenever you need to weld in heavy welding in fabrication, pipe, boiler, and rail the submerged arc welding machine is your choice

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