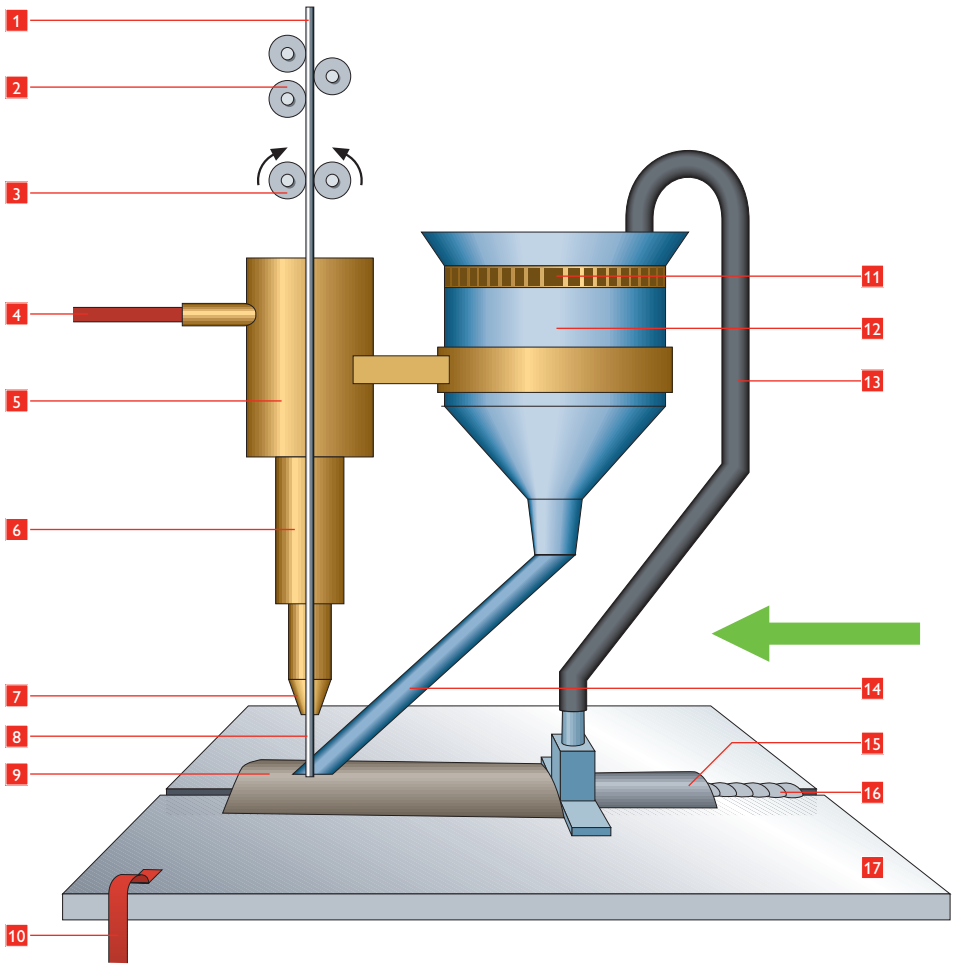
Submerged Arc Welding (SAW)

How it Works

SAW uses the arc struck between a continuously fed electrode and the work piece to melt the metal in the joint area and provide additional filler metal under a blanket of granular flux. This arc is completely submerged under the molten flux, which protects the molten metal from the atmosphere. There is no visible arc, spatter or fume during the welding operation.

The continuous electrode may be a solid or cored wire. The solid wires are normally copper coated. The cored wires may contain either metallic materials or a mixture of metallic and flux materials. Flux cored wires affect the welding characteristics and metallurgical quality of the deposited weld metal. On surfacing applications, a strip electrode can be used instead of a wire.



Schematic of SAW process

1	Submerged arc wire
2	Straightening rollers
3	Feed rollers
4	Power lead
5	Contact tube
6	Extension tube
7	Electrode guide
8	Electrode
9	Flux bed
10	Lead to earth
11	Slag sieve
12	Flux hopper
13	Excess flux recovery system
14	Flux delivery tube
15	Slag
16	Weld bead
17	Work piece

A wide range of flux compositions is used with submerged arc welding. Generally speaking, fluxes with the best welding characteristics give inferior weld metal mechanical properties. These fluxes are known as acid fluxes. Neutral fluxes generally give a good all round performance. While basic fluxes give the best metallurgical results, they possess inferior welding characteristics. The normal approach is to select the flux with the best running characteristics that will meet the metallurgical requirements comfortably.

SAW may be carried out using either DC or AC power sources. The best all round welding conditions are normally obtained with DC electrode positive. DC electrode negative will give higher deposition rates, but fusion characteristics are reduced so that this mode of transfer is mainly used on weld surfacing applications. AC welding may also be used, but arc control is not as good as on DC electrode positive. This means that many fluxes are developed primarily for DC operation and will not operate satisfactorily on AC.

Operating Parameters

SAW is capable of operating at high welding currents. Welding current is the parameter that controls weld deposition rate. It also controls the depth of weld penetration and the amount of base metal melted.

Arc voltage controls the arc length and this has a major influence on the shape of the weld and its exterior appearance. Raising the arc voltage increases the arc length and this, in turn, increases the weld width. Lowering the arc voltage has the opposite effect.

The travel speed controls the heat input into the joint area. Increasing travel speed reduces the heat input and supplies less filler metal per unit length of weld, resulting in less weld reinforcement. Increasing travel speed reduces weld penetration but can cause undercut. Reducing travel speed provides time for the gases to escape from the molten metal and thus porosity may be reduced.

Electrode "stick out", the distance between the contact tube and the arc, has a major affect on weld penetration and deposition rate. Increasing the "stick out" increases deposition rate and reduces weld penetration. However, to maintain optimum process control, the electrode "stick out" is normally maintained between 25–35 mm unless special nozzle adapters are fitted.

Application

SAW is widely used for welding carbon, carbon manganese, alloy and stainless steels. It is also used for joining some nickel based alloys.

The ability to produce high quality, defect free welds at high deposition rates and with deep weld penetration makes the SAW process highly suitable for all mechanized and automatic welding and surfacing applications.

Typical Welding Applications

With welding longitudinal and spiral welded pipes, the longitudinal welds are carried out using a two-pass welding procedure. A welding station located inside the pipe deposits the inside weld and the joint is completed by another station with a single weld on the outside of the pipe. Spiral welded pipes are produced from a continuous coil of strip that is folded into a spiral. One welding head deposits a single weld on the inside and another completes the joint from the outside.

In ship building, the process is used to produce butt welds with a two pass welding procedure depositing a single run on each side of the joint. Stiffeners are produced using single and twin fillet welding procedures. Major ship yards carry out this operation using panel lines where large sections are produced prior to transfer to the construction berth.

Submerged arc welding is widely used on general structural steel welding applications, including mass production of repetitive short welds. Single side welding procedures using a copper backing system are often used on applications such as propane cylinder production.

Typical Surfacing Applications

Roll resurfacing is carried out as a continuous operation. Circumferential bead welds are deposited on the roll surface. When a weld is completed around the roll, the welding head is automatically adjusted to produce the next bead adjacent to the previous one. This process is continued until the complete roll has received one layer of surfacing deposit. The head is then repositioned to produce a second and further layers of weld metal as required.

Submerged arc welding is widely used for cladding carbon and alloy steels with stainless steel and nickel alloy deposits. This process is usually carried out using strip electrodes and alloy bearing fluxes which compensate for alloy losses in the arc.