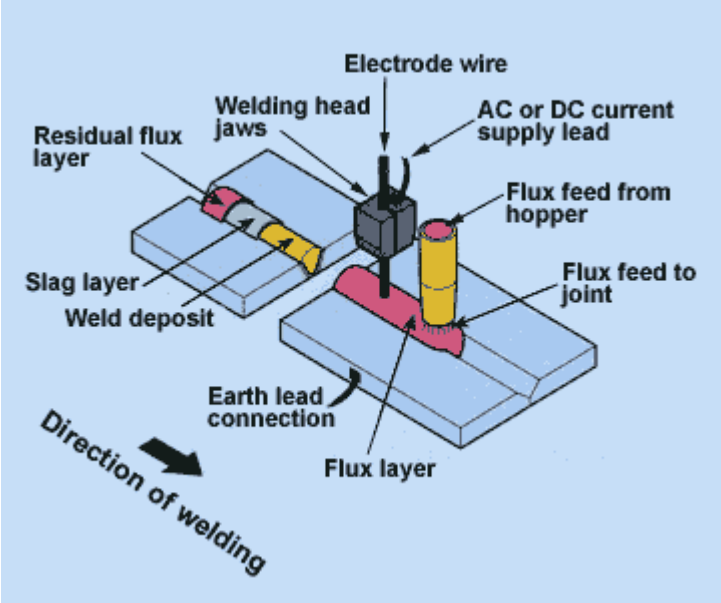
Welding Job Knowledge

Submerged-arc Welding

Job Knowledge

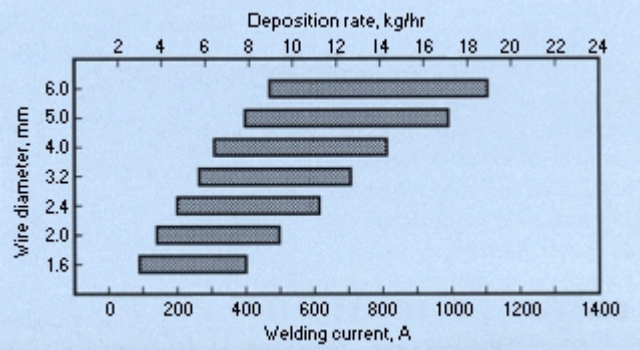


The first patent on the submerged-arc welding (SAW) process was taken out in 1935 and covered an electric arc beneath a bed of granulated flux. Developed by the E O Paton Electric Welding Institute, Russia, during the Second World War, SAW's most famous application was on the T34 tank.

Process features

Similar to MIG welding, SAW involves formation of an arc between a continuously-fed bare wire electrode and the workpiece. The process uses a flux to generate protective gases and slag, and to add alloying elements to the weld pool. A shielding gas is not required. Prior to welding, a thin layer of flux powder is placed on the workpiece surface. The arc moves along the joint line and as it does so, excess flux is recycled via a hopper. Remaining fused slag layers can be easily removed after welding. As the arc is completely covered by the flux layer, heat loss is extremely low. This produces a thermal efficiency as high as 60% (compared with 25% for manual metal arc). There is no visible arc light, welding is spatter-free and there is no need for fume extraction.

Operating characteristics



SAW is usually operated as a fully-mechanised or automatic process, but it can be semi-automatic. Welding parameters: current, arc voltage and travel speed all affect bead shape, depth of penetration and chemical composition of the deposited weld metal. Because the operator cannot see the weld pool, greater reliance must be placed on parameter settings.

Process variants

According to material thickness, joint type and size of component, varying the following can increase deposition rate and improve bead shape.

Wire

SAW is normally operated with a single wire on either AC or DC current. Common variants are:

- twin wire
- multiple wire (tandem or triple)
- single wire with hot or cold wire addition
- metal powder addition
- tubular wire

All contribute to improved productivity through a marked increase in weld metal deposition rates and/or travel speeds.

A narrow gap process variant is also established, which utilises a two or three bead per layer deposition technique.

See What is narrow gap welding?

Flux

Fluxes used in SAW are granular fusible minerals containing oxides of manganese, silicon, titanium, aluminium, calcium, zirconium, magnesium and other compounds such as calcium fluoride. The flux is specially formulated to be compatible with a given electrode wire type so that the combination of flux and wire yields desired mechanical properties. All fluxes react with the weld pool to produce the weld metal chemical composition and mechanical

properties. It is common practice to refer to fluxes as 'active' if they add manganese and silicon to the weld, the amount of manganese and silicon added is influenced by the arc voltage and the welding current level. The the main types of flux for SAW are:

- **Bonded fluxes** - produced by drying the ingredients, then bonding them with a low melting point compound such as a sodium silicate. Most bonded fluxes contain metallic deoxidisers which help to prevent weldporosity. These fluxes are effective over rust and mill scale.
- **Fused fluxes** - produced by mixing the ingredients, then melting them in an electric furnace to form a chemically homogeneous product, cooled and ground to the required particle size. Smooth stable arcs, with welding currents up to 2000A and consistent weld metal properties, are the main attraction of these fluxes.

Applications

SAW is ideally suited for longitudinal and circumferential butt and fillet welds. However, because of high fluidity of the weld pool, molten slag and loose flux layer, welding is generally carried out on butt joints in the flat position and fillet joints in both the flat and horizontal-vertical positions. For circumferential joints, the workpiece is rotated under a fixed welding head with welding taking place in the flat position. Depending on material thickness, either single-pass, two-pass or multipass weld procedures can be carried out. There is virtually no restriction on the material thickness, provided a suitable joint preparation is adopted. Most commonly welded materials are carbon-manganese steels, low alloy steels and stainless steels, although the process is capable of welding some non-ferrous materials with judicious choice of electrode filler wire and flux combinations.