Huntingdon Fusion Techniques, Cambridgeshire, England

Prior electrode preparation prevents poor weld performance

The importance of electrode preparation in ensuring repeatable and high quality TIG welding is often overlooked. This article outlines some of the problems encountered by manual grinding and explains the advantages of mechanising the tungsten electrode grinding process

Ron Sewell established Huntingdon Fusion Techniques Limited in 1975 after a tertiary education in physics and 15 years in the welding and joining industry. Having found a number of areas for product development, he used his knowledge of gas physics and engineering to conceive simple to use, money saving products for the welding industry, some of which have become world standards. Ron is now semi-retired, spending more time involved with his passions of scuba diving, underwater digital photography and writing.

A major factor, arguably the most important one, in fusion welding is consistency of deposition. Whilst the weld bead geometry and metallurgy are influenced by many factors, by far the majority of these are now controlled remote from and independent of the welder. They can include joint design and preparation of component parts, selection of filler metal, welding current and welding power source.

The operator may have control over weld speed but even this is delegated to mechanical drives when using an automatic manufacturing system. In short, modern control systems have reached such a level of sophistication that any variables – of which operator performance is the most significant – have been largely eliminated from the picture.

With the development of formal welding procedures and a ready availability of programmable mechanised welding systems it may be thought that the contemporary welder has little to do other than keep an eye open for system malfunctions.

But one area where the operator has a key role is in electrode selection and preparation. Whilst considerable time and effort may have been dedicated to developing welding procedures in an attempt to remove variables from the welding process, rarely is there any reference to electrode preparation or even to electrode selection.

Electrode materials

A wide range of electrode compositions is now available and selection will be in accordance with previous experience and published information.

Various additions have been made to pure tungsten to improve welding performance, these include oxides based on the rare earth metals cerium, lanthanum, yttrium and thorium.

Thoria containing electrodes introduce a potential health hazard associated with ingesting the dust generated during grinding.

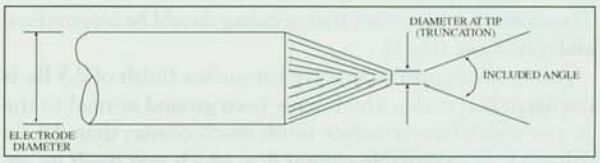


Figure 1: Electrode geometry

Electrode tip geometry

The essential features of the geometry are taper and with truncated electrodes tip diameter (Fig 1).

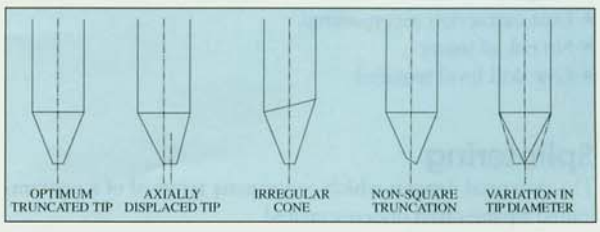
In general, larger angles and tip diameters offer longer life, better penetration, a narrower arc and the capability to sustain more current without erosion.

Smaller angles and smaller tip diameters result in less tendency for arc wander, provide a wider and more stable arc and can be used at lower currents.

Repeatability of both features is a must if you are to realise a consistent weld deposition.

A tungsten tip grinding machine can provide the user with crucial advantages in this regard. This is because the alternative – manual preparation by the welder – introduces the risk of inconsistent geometry from electrode to electrode and significant deviations from the optimum (Fig 2).

Figure 2: Some common potential deviations from optimum



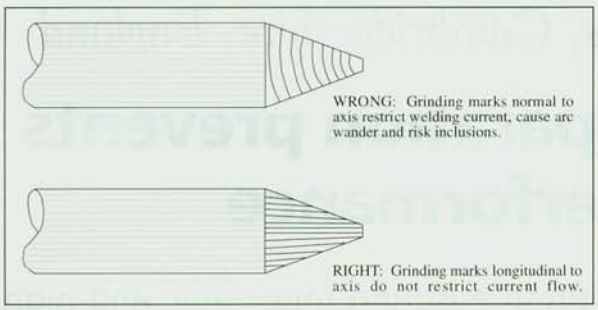


Figure 3: Grinding direction

Examples include:
a) optimum truncated tip
b) axially displaced tip
c) irregular cone
d) non-square truncation
e) variation in tip diameter

Any of these deviations can give rise to consequential changes in weld quality.

Electrode tip finish

Current transfer takes place predominantly by the flow of electrons along the electrode surface and is influenced by surface finish. Free flow of electrons is inhibited by scratches or grinding marks which do not run parallel to the axis. Therefore, it is important that grinding should be longitudinal and concentric (Fig 3).

For optimum operation a typical surface finish of 0.5 Ra is essential. Electrodes which have been ground normal to the axis or which have a surface finish much coarser than 0.5 Ra will produce an unstable current flow which may result in: arc initiation away from the tip, arc wander, thermal shock at the tip and reduced life.

Consistent weld quality can only be realised using electrodes prepared by specialised tip grinding machines. The common practice of sharpening by hand using general purpose grinding wheels should be avoided.

In summation, the advantages of machine grinding are:

Manual grinding
- Surface finish poor and inconsistent
- Electrodes can fracture during grinding
- Short lengths cannot be handled
- Health hazard with dust
- Operator hand injuries likely
- High level of skill required

Machine grinding
- Surface finish consistent and of high quality
- Collet loading ensures security
- Lengths down to 12 mm can be handled
- Dust extraction incorporated
- No risk of injury
- Low skill level required

Splintering

The potential dangers which accompany removal of a contaminated tip are often underestimated.

Re-grinding of the contaminated tip appears to offer an easy solution. However, the only sure way to remove contaminants from the tip and preclude the chance of transferring them to the grinding wheel is to cut off the entire tip.

Untrained operators routinely remove tips using pliers, a hammer or vice or a combination of these. Since tungsten is a brittle material these practices are dangerous – metal splinters can cause injury.

The safest solution is to grind radially through the electrode below the point and thus remove the entire tip.

Figure 4: A typical Tungsten Electrode Grinder with longitudinal grinding direction

Dust hazard

The dust released during grinding of tungsten electrodes can constitute a health hazard. Of particular concern is the release of dust from some doped tungsten electrodes – such as thoriated types which contain radioactive material.

As a consequence, it is recommended that extraction equipment is used in conjunction with machinery employed during the grinding operation. Most dedicated tip grinding equipment now incorporates a dust extraction and storage facility.

Grinding machines

A wide range of mechanised grinding equipment is now available which offers the following features:

Electrode diameter range	1.0 to 6.0 mm
Electrode length	10 to 175 mm
Electrode angle	15 to 95 degrees
Power supply	110/120, 50 or 60Hz or 220 V
Wheel options	diamond and silicon carbide.

The TEG -3 dedicated electrode grinder (Fig 4) is representative of the sophisticated machinery currently available.

Huntingdon Fusion Techniques Limited,
Stukeley Meadows, Huntingdon,
Cambridgeshire, PE29 6EJ England
(Fax: +44 1480 412 841)