SINET: *Ethiop. J. Sci.*, 26(2):173–176, 2003
 ISSN: 0379–2897

Feature article

APPLICATIONS OF A SINGLE CARBON ELECTRODE

David A. Skelskey

ADCS Mekelle Branch, PO BOX 40, Mekelle, Ethiopia. E-mail: skelskey@bc.edu

ABSTRACT: A single carbon electrode used with a common arc welder has been successfully used on steel to weld, to surface harden, to spot weld sheet, to pierce holes and to do simple brazing.

Key words/phrases: **Arc, carbon, dry cell, plasma, welding**

INTRODUCTION

The single carbon electrode and carbon arc welding are not new, but they are not commonly used (Brumbaugh, 1976:14–15). In the industrialized world, more complex and therefore, more expensive technologies have been developed for the general applications of the single carbon electrode. A simply constructed and quite inexpensive single carbon electrode used with a common arc welder has been successfully developed and applied on steel to weld, to surface harden, to spot weld sheet, to pierce holes and to do simple brazing.

CARBON ELECTRODE HOLDER

Fig. 1 displays a special electrode holder made of a metal tube holding carbon electrodes and equipped with a metal strap for insertion into the familiar electrode holder of an arc welder. The metal tube used here is an old shock absorber rod from an automobile drilled at both ends to hold carbon electrodes. The carbon electrodes come from used D dry cells, very common throughout the developing world. As seen in Fig. 2, the carbon electrodes are specially shaped for various applications: welding, spot welding, hole piercing, etc. The metal tube holding the carbon electrodes is banded with a piece of copper tubing that has been flattened into a strap and fitted with a screw for tightening. The perpendicular free end of the copper strap is inserted into the jaws of the electrode holder of an arc welder as seen in Fig. 3.

WELDING

Welding is the joining of materials by the fusion/melting of the materials across their common boundary or interface. Most commonly, heat is needed in simple welding. Single carbon arc welding depends on the heat formed by an electrical arc between the work to be welded and the carbon electrode. In the arc a plasma is formed whose temperature may easily exceed 5000 °C. At this temperature even the carbon of the electrode becomes part of the plasma. The arc formed is quite stable and flat welding is rather simple; vertical welding is difficult, but possible.

The carbon electrodes are shaped according to need. For regular welding we found it helpful to begin with a taper about 25mm in length terminating in a point approximately the diameter of the filler rod one is using. This taper can readily be made with a file, grinding wheel, or lathe. To keep the welding process more homogeneous and continuous we use a double-ended electrode holder, which easily allows the operator to quickly change from a used electrode to a new and sharper one (see Fig. 3). Since the fit is a friction fit one simply inserts a new or removes a spent carbon electrode by pushing into or pulling out of the 8mm diameter hole of the special electrode holder.

An AC or a DC arc-welding machine can be used for the electrical power needed in carbon arc welding. However, when using a DC machine, one should use straight polarity (work, positive and electrode, negative). Using only simple uncoated soft iron wire bought in a hardware shop one may execute such welds as the butt weld of 30mm x 30mm x 3mm angle iron as seen in Fig. 4. To reduce the carburization of the weld (due to the abundance of carbon atoms in the plasma of the arc) one should direct the arc back toward the base metal and the deposited metal as in backhand welding. One must use an adequately dark lens (minimum shade #10) in order to properly add the filler rod to the brilliant molten pool formed by the arc. Fast welding is recommended as is slow cooling since there is no protective blanket of slag to cover the weld as in the case of shielded metal-arc welding using commercial flux coated welding electrodes.

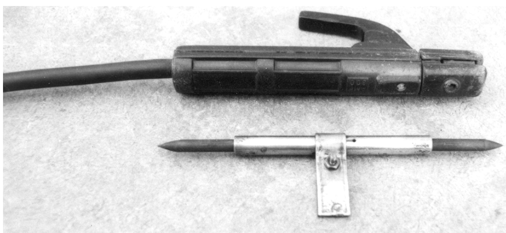

Fig. 1. Foreground: special carbon electrode holder (12.5mm in diameter) with a carbon electrode inserted in each end. Background: familiar electrode holder of an electric arc welder.

Fig. 2. Carbon electrodes (8mm in diameter and 55mm in length) taken from used D sized dry cells. The carbon electrodes are given various shapes depending on the application.

Fig. 3. Arc welding operator inserting the special carbon electrode into the electrode holder of an electric arc welder.

HARD FACING/SURFACING

One can make beneficial use of the carburizing effect of the plasma of the single carbon electrode. One may surface harden steels, and by build-up may even make small, hard, high carbon tools.

In Fig. 5 one can see shop fabricated tools: two chisels, a center punch, a drill drift and a mill hammer. Each tool's surfaces exposed to abrasive wear and impact have been hardened with the use of the single carbon electrode. The hardening procedure is to slowly weld on a layer(s) of metal using a thin iron rod playing the carburizing plasma on the surface to be hardened. To take advantage of the carburizing plasma we found it better to weld in the forehand direction. While the surface to be hardened is still hot, it is quenched - usually in water. One may also harden a steel surface by just playing the carburizing plasma in small circular motions over the specific area of concern.

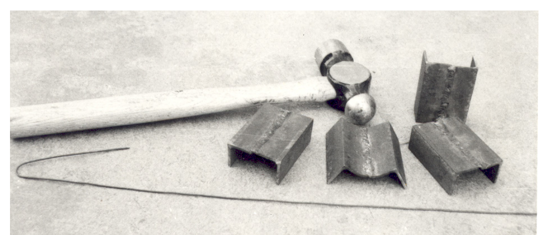

Fig. 4. Butt welds of 30mm x 30mm x 3mm angle iron at 50 amperes current using the single carbon electrode and 2mm bare iron wire as filler rod. Note the fast cooling beads seen here are a bit rougher than the slower cooling slag covered beads one associates with electric arc welding using flux-covered electrodes.

Fig. 5. Metal chisel made from a 14mm diameter reinforcing rod, metal chisel made from a 12.5mm diameter used shock absorber rod, metal punch made from a 16mm diameter used shock absorber rod, drill drift made from 3mm thick mild sheet steel, and a mill hammer made from 6mm x 40mm mild steel bar.

Table 1 lists the average before and after values of hardness tests (Rockwell) of a used shock absorber rod made into a chisel, a reinforcing rod made into a chisel, a piece of mild steel bar made into a mill hammer and a piece of mild sheet steel face hardened for abrasive garden work.

Table 1. Before and after hardness tests (Rockwell Hardness B and C) of some handmade steel tools.

Item	Mean hardness before	Mean hardness after	Methods used in making
Steel Chisel from used shock absorber rod	RHC 21	RHC 60	1) Overlay with weld using hacksaw blades as filler. 2) Forge blade. 3) Grind shape. 4) Heat and quench.
Steel chisel from 14mm diameter reinforcing rod	RHB 91	RHC 50	1) Forge blade. 2) Overlay with weld using hacksaw blades as filler. 3) Grind shape. 4) Heat and quench.
Mill Hammer from 6mmx30mm steel bar	RHB 76.5	RHC 44.5	1) Double pass with carbon electrode only. 2) Quench.
Ridger from 3mm steel sheet	RHB 69	RHC 35	Overlay using 1.5 mm diameter soft iron wire as rod.

Our experience shows that the filler rod also contributes to hardening and the filler rod should contain hardening alloys that can also increase the final hardness and toughness of the face or surface welded. We have used as surface hardening filler rods used/broken high carbon steel (RHC 42) hacksaw blades.

To produce small tools such as a good chisel or center punch, one must be patient in gaining skill in playing the plasma arc and in building layers of carburized steel. However, we found that in simple face hardening of mild steel, say for use in abrasive environments, any slow welding of iron rod with the single carbon electrode produced a Rockwell C Hardness of 25–30 (Brumbaugh, 1976:586–587; Mohler, 1983:33; Nippes, 1985). Usually a second layer welded on the first is harder than the first especially when the base metal is soft.

SPOT WELDING

When specially shaped and with the electric current properly adjusted, one may also use the single carbon electrode for many spot welding jobs. Fig. 6 shows two pieces of steel sheet, one 1.5 mm thick and the other 1.2 mm thick, spot welded together using a carbon electrode with a 3mm in diameter contact tip. It is necessary to both thoroughly clean the surfaces to be spot-welded together and to clamp them closely as no significant pressure can be exerted by the carbon electrode on the sheets to be spot welded.

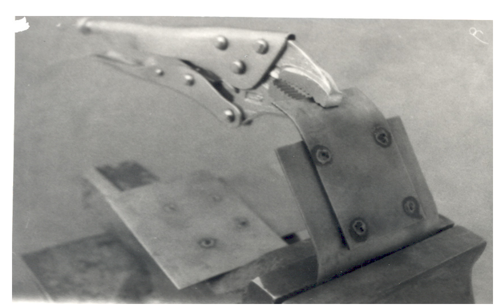

Fig. 6. Examples of 1.5mm steel sheet spot-welded to 1.2mm sheet steel.

The commoner result is that the surface touched by carbon electrode is deformed although the surface opposite the electrode remains unmarred. However, one will find exceptionally strong spot welds may be made with this very simple welding electrode.

HOLE PIERCING

Metal may also be quickly and simply pierced with specially shaped carbon electrodes instead of drilling or punching holes. Fig. 7 shows holes pierced in 3 mm and 4 mm thick angle iron and in 2mm thick box beam. The carbon electrode must be slightly larger, *e.g.,* 0.3 mm, than the final hole diameter desired. The higher the current setting, the thicker the steel to be pierced, *e.g.,* 110 amperes for 2 mm thick steel and 170 amperes for 4mm thick steel. We note that the perimeter of the hole is carburized and harder than the base metal, which is a desirable effect in the case of the insertion in the hole of hooks, springs, *etc.*

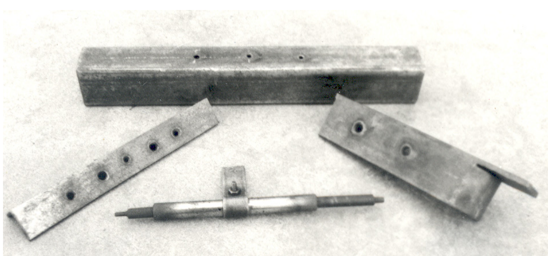

Fig. 7. Examples of hole piercing in 3 mm thick angle iron, 2mm thick box beam, and 4mm thick angle iron using the single carbon electrode.

OTHER APPLICATIONS

The single carbon electrode has been used to weld copper using a bare electrical wire as the filler rod (Brumbaugh, 1976:708–711) (see Fig. 8). Since no flux is used, contamination of electrical conducting elements is reduced; the oxygen contamination (reduced conductivity) typical in the use of an oxy-acetylene torch is less a problem.

One may also do simple brazing with the single carbon electrode. Fig. 8 displays a carbide cutter brazed on its holder using a copper-silver brazing rod (We do not recommend copper-zinc brazing using the single carbon electrode).

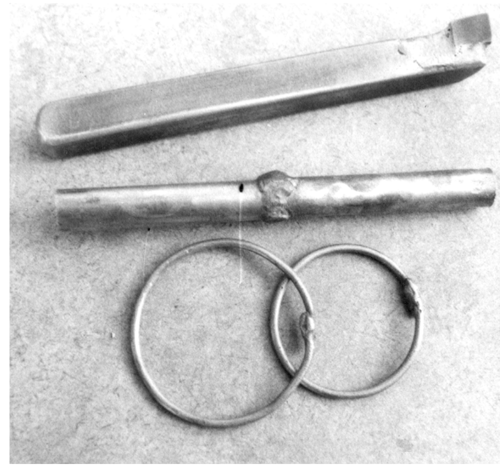

Fig. 8. Simple examples of welding copper electrical wire and 12.5mm diameter copper tubing and an example of brazing a carbide cutter using the single carbon electrode.

CONCLUDING COMMENTS

We offer that without much effort and with minimal costs the simple carbon electrode can be made with local materials, indeed mostly recycled materials. Without expensive and specialized equipment the small-scale metalworker, welder, or machinist can execute with the simple carbon electrode alone various procedures in welding, surface hardening, hole piercing and brazing. The single carbon electrode is rather simple to use, and imagination and patience, may well broaden its presently described list of applications as well as advance local technology, especially where funds are limited.

REFERENCES

1. Brumbaugh, J.E. (1976). Welders Guide and Handbook. Audels, D.B. Taraporevala Sons, Bombay.
2. Mohler, R. (1983). Practical Welding Technology. Industrial Press, New York.
3. Nippes, E.F. (1985). Joining. **In:** ***Metals Handbook***, Desk Edition, pp. 30·60–30·61, (Boyer, H.E. and Gall, T.L., eds). ASM, Metals Park, Ohio.