Reduction of Costs in Manual arc Welding†

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In a situation of continuing wage escalation, management becomes more and more aware of the importance of investment in machines and in methods which will lead to more effective use of time and manpower. This applies in the welding industry as much as in any other. The purpose of this paper is to combat any complacency that may exist in the industry by emphasising the need for *positive thinking* as a way of increasing *productivity* and improving, or, at worst, maintaining *profit* margins.

By thinking positively on all welding procedures and techniques of application, production could be stimulated and profit margins maintained or even increased. Efficiency in welding and economy of production are all important to the profitability of companies in the welding and fabricating field, be it in mild steel, stainless steel or aluminium. Complacency over methods and equipment is something they cannot afford, for if profits are not forthcoming no company can survive. Ultimately, management and employee alike must see that their approach to all welding problems and associated work is of a *positive* nature.

Supervision on all welding projects can be fully justified and production will be increased, with considerable cost savings, if positive steps are taken to eliminate overwelding in both fillet and butt welds.

1. By using correctly the largest size electrode with the highest deposition efficiency.

2. By ensuring that plate-edge preparations are such that the minimum weight of weld metal has to be deposited for the joint design.

3. Making sure of the correct fit up at all times ; and

4. Keeping electrode wastage to a minimum.

It is also most essential that, at all times, supervisors clearly define all the necessary details of work required, and make sure that they are completely understood by those who have to carry out all operations of the project on hand.

In the very early years, the cost of arc welding was primarily dependent on the cost of electrodes ; power, wages and overhead were small by comparison. With the aid of science and technology, improved methods of manufacturing have reduced both electrode and power costs but the wage component has escalated by some 400% to 500%.

The cost of any welding process can be represented as a function deposition rate for a given duty cycle.

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Methods of cost calculations in welding are numerous, some lacking in clarity and precision, but all must rely on the basis of how many pounds of weld metal can be deposited per hour. Regardless of which method is adopted, the total costs are made up of consumables, power, labour and overhead, which could represent as much as 50% to 80% of the total cost of many welding projects.

We must therefore turn to this aspect of our welding costs to effect economy and increase productivity and to do this we must think positively so as to utilise man hours more efficiently. The principal methods whereby we can achieve this efficiency are the basic established ones of utilising the maximum proportion of available man hours as arc time, and at the same time using correct procedures to achieve the maximum deposition rate of deposited weld metal. By attacking such problems in a *positive* manner, productivity can be increased and welding costs reduced.

Factors Affecting Arc Welding Cost

1. Use the largest size of electrode with the highest deposition efficiency. Use the highest possible amperage within the manufacturer's recommendation.

2. Weld in the down hand position wherever possible.

3. Welding machine size must match the work on hand. Too small a machine means a small profit through inability to use the larger, modern high-efficiency electrodes.

4. Control overwelding.

5. Control electrode wastage.

6. Control joint design, fit up and edge preparations.

7. Care of electrodes.

8. Supervision.

9. Increase *duty cycle* by the use of correct cable size, electrode holders, positive earth clamps, effective handling facilities ensure that the welder is comfortable, with good ventilation. Make use of positioners, rotators and jigs.

10. Adopt a welding procedure that will control distortion.

11. For out of position welds, work vertically down wherever possible in both butt and fillet welds.

12. Be fully conversant with code requirements where necessary

Considerations in Electrode Selection

A. Base metal identification and weldability.

B. Thickness and shape of base metal.

C. Joint design and fit up.

D. Environmental job conditions.

E. Preheating and postheating if required.

F. Production efficiency.

G. Code requirements ; radiography.

For the purpose of discussion we will first take the full iron powder rutile type of electrode with classification BS 1719—E227K, AWS E7024 for flat and horizontal welding with efficiencies up to 160%. This high-efficiency highspeed contact type of electrode is excellent for production and code quality welding. These electrodes were developed for downhand welding of standing fillets and have a deposition advantage over the general purpose BS217 E6012 and BS317 E6013 type in excess of 50% in most gauges. When used correctly at the optimum currents, correct angle and travel speeds, they result in perfect mitred fillets, with increased production and reduced welding costs. When travel speed and currents are low, irregular and convex fillet welds will be the result. This means overwelding and added weld costs.

These electrodes are available from 12 gauge to 4 gauge and can be used over a wide range of welding applications.

When used for fillet welding, the greatest economics for a given size of fillet will come from the use of the right size of electrode at the highest possible current and travel speed.

$\frac{1}{8}''$	fillet	...	12	gauge	electrode
5/32″	,,	...	10	,,	,,
3/16″	,,	...	8	,,	,,
$\frac{1}{4}''$	,,	...	6	,,	,,
5/16″	,,	...	4	,,	,,

Deposition at maximum currents :

10 gauge	...	5 lb per hour
8	...	6.8 lb ,, ,,
6 ,,	...	11.1 lb ,, ,,
4 ,,	...	13.5 lb ,, ,,

Greater cost savings can still be made on work that can be turned into the down hand gravity position by use of the very modern E634HK AWS E7028 type of low hydrogen zircon basic coating iron powder electrode. This electrode has a deposition efficiency of 195% with the following deposition rates :

8 gauge	.....	8.85 lb per hour
6 ,,	.....	14 lb ,, ,,
4 ,,	.....	19.6 lb ,, ,,

All deposition rates are quoted from maximum current values, based on figures derived from Philips Electrical Industries of N.Z. Limited technical information sheet.

The deposition rate for 4 gauge at 19.6 lbs per hour is nearly equivalent to 700 amps on 5/32" wire when used with the submerged arc process.

Once again it is essential that we think positively when it comes to deciding whether to turn a welding job or do it in a conventional manner. With deposition rates as quoted with either of these electrodes, the decision in most cases should favour turning.

Remember that the greatest cost savings are made by using the largest size of electrode with the highest deposition rate in the down hand position.

Vertical Welding

In vertical welding, we must again think positively in weighing up the economics of whether we should weld *up* or *down*. In the past, many of us have looked upon vertical down welding with suspicion, but with the development of the special basic coated low hydrogen electrode B.S.E676H AWS E7016 this barrier has been broken. These electrodes are eminently suitable for down welding. The slag is easy to keep above the arc, and the high currents that can be applied provide high deposition rates and travel speeds. The bridging of gaps presents no problems at all to these electrodes, which can be used for both fillets and prepared butt welds. The mechanical properties of the weld metal are excellent, and the deposited metal is not susceptible to cracking.

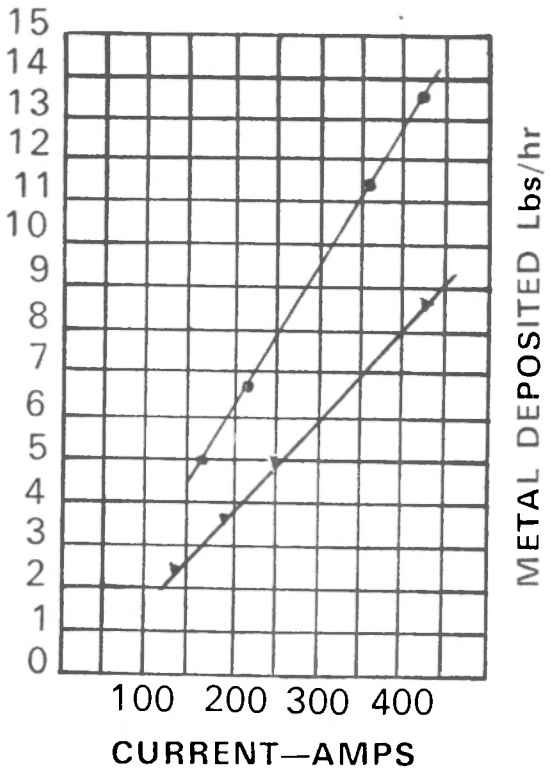

Fig. 1. Graph showing the differential between the deposition rates of a B.S. E.227K and a B.S. E.217 electrode.

As well as the one mentioned above, there is a wide range of electrodes, which can be used successfully for vertical down welding.

These are :

B.S. E100P. AWS 6010
B.S. E106P. AWS 6011
B.S. E100P. AWS 7010
B.S. E307. AWS 6013
B.S. E907J. AWS 7014

All of these show speed advantages in the vertical down position, and with such a variety available, consideration must be given to welding down in preference to vertical up with small diameter electrodes at low current values.

Overwelding can be more easily controlled by welding in the vertical down position. A strong recommendation therefore is :

Think in a *POSITIVE* manner and weld vertical down wherever possible.

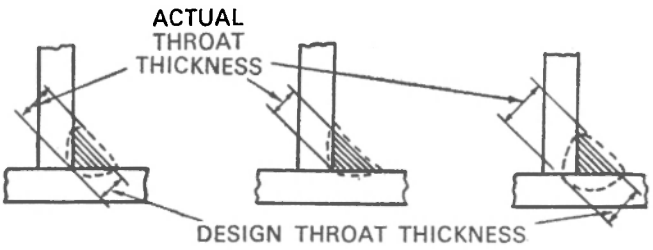

Fig. 2. Examples of actual throat thickness of fillet welds compared with design throat thickness.

Fig. 3. Profile of typical uneconomic fillte welds.

Overhead Welding

When welding economics are a consideration, the overhead welding position should be eliminated wherever possible. Serious consideration should be given to turning the job to the down hand position. When this is not possible use the largest size of electrode possible to suit the joint design.

The Effect of Overwelding

Overwelding has a very serious effect on arc welding costs. The general tendency is for many operators to deposit fillet welds much larger than specified, or in the case of butt welds to deposit far greater amounts of reinforcement than is actually necessary. The cost of welding is directly affected by the amount of weld metal required.

Very few people realise the great increase in weld metal and costs that result from a slight increase in weld size. For example, making a 5/16″ leg size fillet when ¼″ weld is desired increases the leg length by only 25%, but in area of the weld the increase is of the order of 56%.

A slight increase in root gap and angle of edge preparation increases the amount of weld metal for the entire length of weld. The percentage increase in weld metal that results is usually surprising.

Fillet welding, where the size is normally specified by the leg length, calls for the use of correct welding techniques with electrodes which are designed to deposit welds of a true mitre profile. Avoid using electrodes which deposit excessively convex bead shapes., as more electrodes will be required, and the superfluous weld metal can only increase weld costs. See Figs. 2 and 3.

Care of Electrodes

The care and storage of electrodes can play an important part in welding economics. At all times electrodes should be cared for in conditions as set down by the manufacturer. It is especially applicable to the Low Hydrogen types. If the moisture content is excessive when used on code quality work to radiographic standards, the result will be gross porosity. Repairing such welds can be costly.

Electrode Wastage

The waste of electrodes in full or part rods, and long stubs, is a matter of concern to all those who have to purchase these consumables. Often the cost of the wastage is more than the purchasing discount received.

The habit of disposing of lengthy stubs also lowers the operator's duty cycle as more electrode changes are made. Strict attention to the elimination of this practice is yet another way in which welding costs can be reduced.

Summary

Some of the points discussed in this paper may already have made themselves apparent to you. Others would doubtless come to light in any critical, objective survey of the average welding and fabrication shop. I conclude, therefore, as I began by emphasising that positive thinking, followed up by positive action by management and employee alike can bring about significant savings in welding costs.