# Prediction of wire feed speed from AC submerged ARC welding parameters

R.S. Chandel

***ABSTRACT***

*The effect of welding current, arc voltage, electrode diameter, electrical stickout and flux type on the wire feed speed during AC submerged-arc-welding has been studied. The results show that wire feed speed is influenced by welding current, electrode diameter and electrical stickout. A mathematical model to predict wire feed speed from welding parameters has been developed from the data.*

## 1. INTRODUCTION

The importance of controlling wire feed speed (W.F.S.) is reflected by the incorporation of digital W.F.S. meters in semi-automatic and automatic-welding equipment of recent design. Since hand-held wire feed speedometers are now readily available, it is possible to measure the W.F.S. on all welding equipment whether new or old. Because W.F.S. can be measured easily and accurately and is a good indicator of deposition rate and a means of quality assurance, knowledge of its relationship with other welding parameters is desirable.

Chandel and Malik (1) made the first attempt to correlate wire feed speed with direct current (D.C.) submerged-arc welding parameters and reported the following equations :

W.F.S. (mm/s) (for DCRP) =

$$0.618 \frac{I}{d^2} + 0.00001 \frac{I^2 L}{d_2} - 7.31 \qquad \text{Eq. 1}$$

Direct current reverse polarity

W.F.S. (mm/s) (for DCSP) =

$$0.878 \frac{I}{d^2} + 0.00001 \frac{I^2 L}{d_2} - 9.23 \qquad \text{Eq. 2}$$

Direct current straight polarity

Where, I = welding current (A)

d = electrode diameter (mm)

L = electrical stickout (mm)

Recently AC square-wave power sources have become increasingly popular, particularly for submerged-arc narrow-gap welding applications (2,3). Therefore, the aim of this work is to study the effect of AC submerged-arc-welding parameters on wire feed speed.

## 2. EXPERIMENTAL WORK

The base material used for the experimental work was a 19 mm thick ASTM A 36 steel plate. This plate was cut into 600 x 150 mm pieces and both surfaces were sand blasted. Lincoln L-60 electrodes of 3.2 and 4 mm diameter were used along with Linde 124 and OP121TT fluxes (basicity indices 1 and 3 respectively).

A Miller AC square-wave 1000 power source was used which operates in a constant-voltage mode. The experimental work was designed such that the effects of welding current, arc voltage, electrode diameter, electrical stickout and flux basicity on W.F.S. could be studied. Welding current and arc voltage were recorded on a chart recorder for every weld, while the corresponding W.F.S. was measured by a hand-held digital-wire-feed speedometer. Forty-eight bead-on-plate welds were deposited, and their parameters and corresponding wire-feed speeds are given in Table - 1.

## 3. RESULTS AND DISCUSSION

Figure - 1 shows the effect of welding current, electrode diameter and electrical stickout on wire-feed speed. It can be seen that, for a given electrode diameter and electrical stickout,

**R.S. Chandel is with Canada Centre of Mineral and Energy Technology, Physical Metallurgy Research Laboratories, Ottawa, Canada.**

TABLE - 1

**Welding Parameters and Wire Feed Speed**

| Wire diam. (mm) | Current (A) | Voltage (V) | W.F.S. (mm/s) Linde 124 Flux 25.4 mm ESO | W.F.S. (mm/s) Linde 124 Flux 76.2 mm ESO | W.F.S. (mm/s) OP121TT Flux 25.4 mm ESO | W.F.S. (mm/s) OP121TT Flux 76.2 mm ESO |
|---|---|---|---|---|---|---|
| 3.2 | 400 | 30 | 21.15 | 24.53 | 23.26 | 26.40 |
| 3.2 | 500 | 30 | 26.43 | 35.95 | 29.61 | 36.20 |
| 3.2 | 600 | 30 | 38.00 | 50.76 | 40.18 | 50.76 |
| 3.2 | 700 | 30 | 47.37 | 67.68 | 46.53 | 70.10 |
| 3.2 | 400 | 34 | 21.15 | 25.38 | 23.26 | 26.20 |
| 3.2 | 500 | 34 | 26.64 | 35.95 | 29.61 | 36.40 |
| 3.2 | 600 | 34 | 37.64 | 48.64 | 38.10 | 49.34 |
| 3.2 | 700 | 34 | 47.30 | 67.68 | 46.95 | 70.30 |
| 4.0 | 450 | 32 | 16.10 | 16.92 | | |
| 4.0 | 550 | 32 | 21.15 | 23.26 | | |
| 4.0 | 650 | 32 | 25.38 | 31.72 | | |
| 4.0 | 750 | 32 | 32.14 | 40.20 | | |
| 4.0 | 450 | 36 | 16.00 | 16.92 | | |
| 4.0 | 550 | 36 | 21.35 | 23.25 | | |
| 4.0 | 650 | 36 | 25.18 | 31.72 | | |
| 4.0 | 750 | 36 | 32.23 | 40.30 | | |

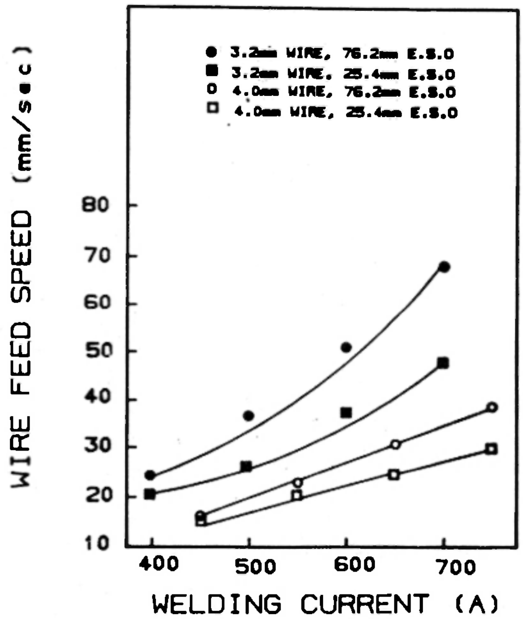


**Fig. 1** Effect of welding current, wire diameter and electrical stickout on the wire feed speed.

there is an increase in wire feed speed with an increase in welding current. The figure also shows that for a given current, higher wire-feed speeds are obtained when a smaller-diameter electrode and longer electrical stickout is used. The arc voltage and flux basicity do not seem to have any influence on wire-feed speed.

In order to develop a meaningful mathematical model relating wire feed speed and the welding parameters, a multiple regression equation of the type referenced above (1) was developed, which is as follows :

$$W.F.S. = 0.71 \frac{I}{d^2} + 0.000007 \frac{I^2 L}{d^2} - 9.7 \qquad \text{Eq. 3}$$

The validity of this equation is evident from its extremely high co-efficient of correlation and Figure 2, which shows the relationship between computed and measured values of wire-feed speed.

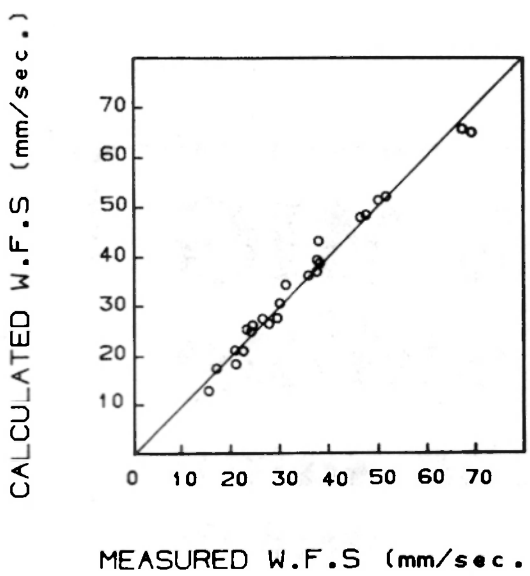


Fig. 2 Comparison of calculated and measured values of wire feed speed.

The above expression indicates that the co-efficient of the first term (which is W.F.S. due to arc heat) is higher than that for DCRP and lower than that for DCSP comparing Eq. 3 with Eq. 1 & 2. However, the co-efficient of the second term (which is W.F.S. due to Joule heating) is smaller than that of DCSP or DCRP. This indicates that resistance heating and the effect of electrical stickout is less pronounced during AC welding than DC welding. This is contrary to the findings of Demyantsevich (4) and Robinson (5) who reported that the resistance-heating effect was the same for AC and DC welding. Despite this controversy, the above relationship seems to be very useful and can predict wire-feed speed and melting rates during AC submerged-arc welding.

A mathematical expression has been developed successfully to correlate wire-feed speed and welding current, electrode diameter and electrical stickout.

## 4. CONCLUSION

- Wire-feed speed during AC submerged welding is influenced by welding current, electrode diameter and electrical stickout.
- Arc voltage and flux type do not have any significant effect on the wire-feed speed.

## 5. REFERENCES

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