High Speed Variable Square Wave

AC Submerged Arc Welding

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The concept and procedure to use an Alternating output current (AC) for an alternative to DC submerged arc welding (SAW) has been around for a number of years. Initial AC power supplies out puts was limited to balance sine waves with a fixed frequency of 60 Hz. Improvements in power source designs now produce balance square waves with adjustable frequencies or non-balance square waves with fixed frequencies. The focus of the paper is to determine the effects that the frequency and balance of an AC wave form output will have upon a high speed submerged arc (SAW) application.

Weld test matrixes were designed where as the altering of the output frequency and or balance was the only variable. Each test matrix involved five output variables, which are shown in table 1 and 2.

Table 1

Frequency	Balance
90 Hz.	50/50 – Pos./Neg.
45 Hz.	50/50 – Pos./Neg.
30 Hz.	50/50 – Pos./Neg.
60 Hz.	66/33 – Pos./Neg.
60 Hz.	33/66 – Pos./Neg.

Table 2

Frequency	Balance
15 Hz.	50/50 – Pos./Neg.
18 Hz.	70/30 – Pos./Neg.
18 Hz.	30/70 – Pos./Neg.
18 Hz.	60/40 – Pos./Neg.
18 Hz.	40/60 – Pos./Neg.

Each joint type was a complete melt-through square butt with a linear travel speed of 65 IPM. 4” X 48” weld coupons were shear cut from a .250” X 48” X 96” hot rolled 1020 plate. All welds were performed in an 8’ seamer equipped with a pneumatic flux bed. Upon completion at both 16” and 32” distances from the start of the weld a ¾” strip was removed, polished, and etched for evaluation and measurements.

Looking at the various inputs of the weld profiles of the test matrixes one will learn that altering the AC waveform output has a dimensional effect upon the weld bead. In addition varying AC waveform balance and frequency also affected the weld characters and performance. The first point of observation of the weld profiles was consistency of bead quality. It was found that the lower frequency (15/18 Hz) resulted in a more consistent weld profile on the root side of the joint. This common dimension was both a measurement of width and height of the root bead. The second trend that was observed was that with the 70/30 and 60/40 balances (18 Hz.) it was seen that having the positive percentage of the output a lower value had shown favorable results. These two trends lead us to the three balance and frequency combinations that shown the best results. These balance and frequency combinations are 50/50-15Hz, 70/30-18Hz, 60/40-18Hz. In addition to the consistent bead profiles it was observed that the arc characteristic was smoother with each AC waveform output respectively. It was also seen that the amount of plate distortion was reduced along with the ease of effort to remove the slag coating

In a conclusion to the work of this paper the lower frequency (15/18 Hz) AC waveform out put proved to be advantageous in three areas. The first being a more consistent weld bead, second was minor reduction of plate distortion, and third an increase ease of slag removal. When looking at the AC output that had a non-balance waveform it was the lower percentages of DC positive which resulted in more consistent weld beads. The optimal combination for our application was found to be 60/40 balance, 18 Hz., with 40 percent positive.