Joule Heating Consistency in Controlled and Non-Controlled Short Circuit Metal Transfer

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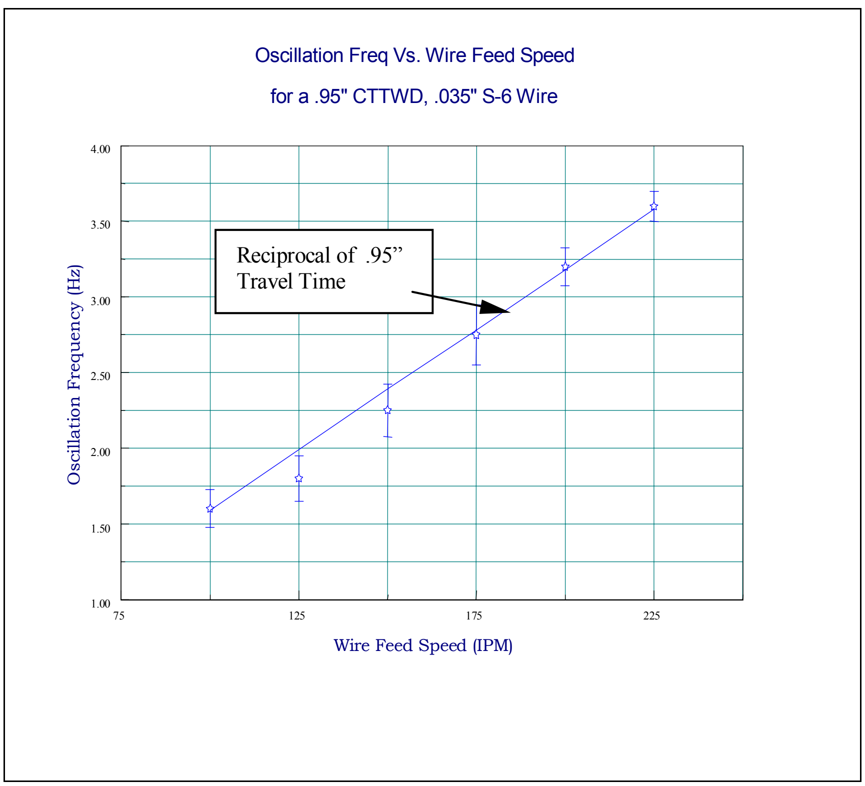
It is common knowledge in the welding industry that the Joule heating ($I^2 \cdot R$) of the wire in the MIG-short arc welding process plays a significant role in the rate at which the electrode is consumed. It is also understood that the heat content in the wire due to this resistive heating can be affected by changing the stick-out (contact tip to work distance-CTTWD) of the electrode. The focus of this paper is to examine how different current control schemes of short circuit transfer will affect the Joule heating consistency in the weld wire.

The inverter power source chosen has control schemes allowing both controlled and non-controlled short-circuit transfer. Materials used were various thickness' of cold rolled plain carbon steel, 0.035" S-6 welding wire, 75/25 Ar/CO_2 shielding gas and 100% CO2 shielding gas. The effect on the arc stability is presented in terms of voltage and current fluctuations. Information from the electrical parameters were also fed into a model that calculates the heat input in the wire. CTTWD was measured for each weld and the frequency of the modulation of the electrical parameters was then compared to the reciprocal of the transit time of the wire.



A plot of the oscillation frequency vs. wirefeed speed for a non- controlled short circuit metal transfer is shown along with the predicted frequency. The good correlation between the data and the expected oscillation frequency support the hypothesis that the instability is related to heat input in the wire. Comparisons of controlled to non-controlled wire heat calculations indicate that the magnitude of the controlled short circuit transfer wire heat fluctuations are relatively much smaller than those of the non-controlled.

In conclusion, it is shown that the controlled short circuit metal transfer produced more consistent heat content in the welding wire. This more uniform temperature distribution in the wire results in a more stable welding current waveform. Enhanced arc stability has a positive impact on all aspects of the final weld.