

## The ABC's of Arc Welding

# What Is Heat Input, and How Does It Affect the Quality of Welds?

Heat input can be referred to as "the electrical energy supplied by the welding arc to the workpiece." In practice, however, heat input can approximately - if the arc efficiency is not taken into consideration - be characterized as the ratio of the arc power supplied to the electrode to the arc travel speed, as shown in the following equation:

$$HI = \frac{A \times V \times 60}{S}$$

where "A" is welding current (ampere: the quantity of electricity conveyed in one second); "V" is welding arc voltage (volt); "S" is the arc travel speed or welding speed (mm/min or cm/min); "60" standardizes the units for "A" and "S," since 1 minute is 60 seconds). In this way, the unit of heat input can be J/mm, kJ/mm, J/cm, or kJ/cm where "J" and "kJ" stand for Joule and kilo-Joule respectively.

The most important characteristic of heat input is that it governs the cooling rates in welds and thereby affects the microstructure of the weld metal and the heat-affected zone. A change in microstructure directly affects the mechanical properties of welds. Therefore, the control of heat input is very important in arc welding in terms of quality control.

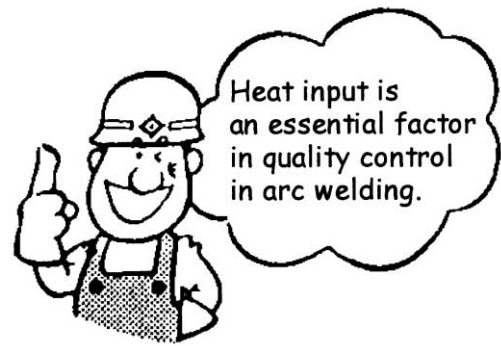


Figure 1 shows how heat input affects the cooling rates in welds. This figure suggests that the effect of heat input on the cooling rate is more significant in lower heat input ranges at every preheating temperature when the plate thickness is kept constant. Figure 2 shows the use of higher heat input (A: 2.5kJ/mm) causes more coarse microstructure when compared with lower heat input (B: 1.0kJ/mm). This marked difference in microstructure results in significant effect on the strength of welds as shown in Fig. 3.

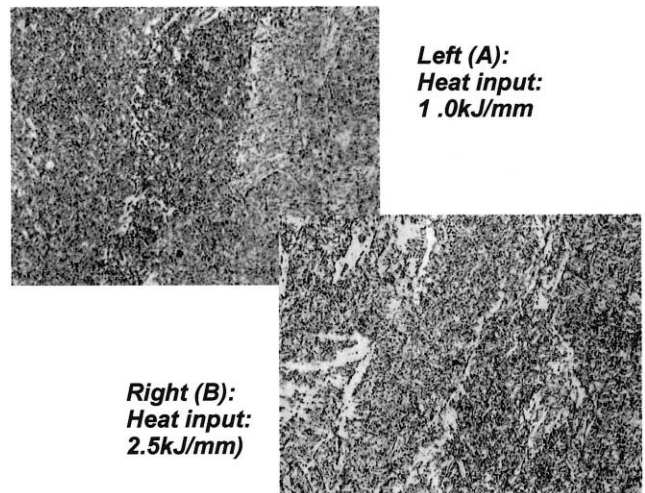


Fig. 2 - A comparison of microstructures of gas metal arc welded all-deposited metals of an ER80S-G trial wire, using two different amounts of hert input ( $\times 400$ ) (Source: IIW Doc. XII-1647-00, 2000)

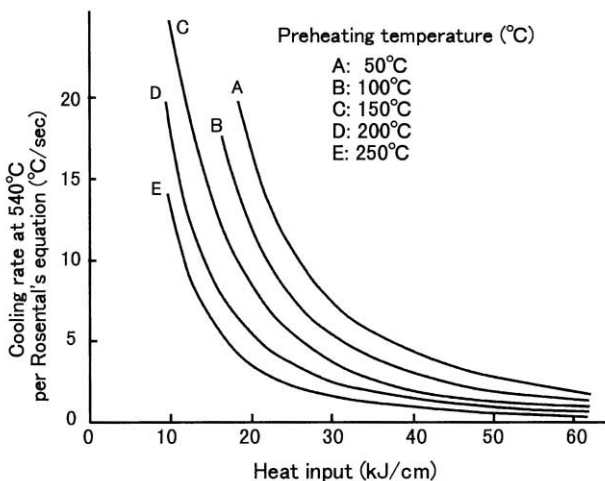


Fig. 1 - The effect of heat input on cooling rates in welds as a function of preheating temperatures (Plate thickness: 19mm)

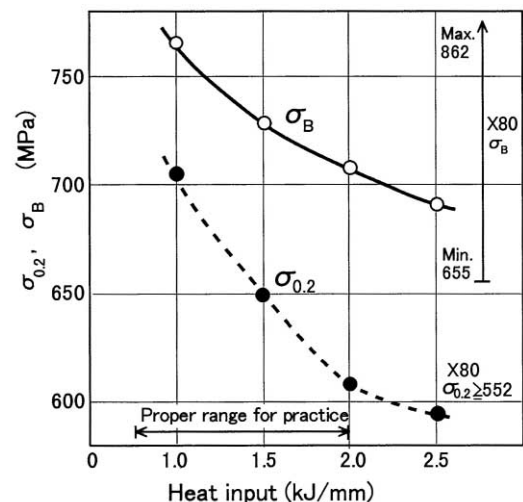


Fig. 3 - The effect of heat input on strength of all-deposited metals of an ER80S-G trial wire in gas metal arc welding (Source: IIW Doc. XII-1647-00, 2000)