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TECHNICAL APPLICATION BRIEF

The Effects of Polarity on the Resistance Welding Process

GENERAL:

In resistance welding, both the weld heat and the size of the weld nugget can increase or decrease depending on the polarity of the current passing through the parts. This is caused by a phenomenon known as "The Peltier Effect", which is present when the weld current flows in only one direction. The Peltier Effect can be used to help balance weld heat in certain applications. This can be very beneficial when welding parts of unequal thickness or dissimilar composition. Power supply technologies affected by this phenomenon include Capacitor Discharge, one-half cycle AC, Linear DC, and High Frequency Inverter. Although this effect is dominant only in the first few milliseconds of the weld, the increase or decrease of weld heat can be significant and should be considered any time one of these technologies is used.

BACKGROUND:

The Peltier Effect is the opposite of the thermocouple effect. In a thermocouple, a voltage potential is produced when two dissimilar metals are joined in intimate contact. The amount of voltage produced corresponds to the temperature of the junction. An increase in temperature at the junction results in a higher voltage potential. In contrast, if a potential is applied across a dissimilar junction, the junction will heat up or cool down in relation to the magnitude and polarity of the applied potential. This is The Peltier Effect. The junction will cool down when the most conductive material is made negative (-) and will heat up when the most conductive material is made positive (+). It is important to note that this heating is not related to the Joule heating produced by the passage of current.

THEORY OF OPERATION:

In an opposed weld, there are three material interfaces: two electrode-to-part interfaces and one part-to-part interface. Since conductive electrodes are generally placed against resistive materials, and vice-versa, it is not uncommon to have dissimilar junctions in welding. To take advantage of polarity, the negative electrode should be placed on the most resistive part and the positive electrode against the most conductive part. This will increase the heat at the interface of the two materials and reduce the heat at the electrode–to-part interfaces. Reversing the polarity will cause the material interface to be colder and may cause electrode sticking (Figure 1).

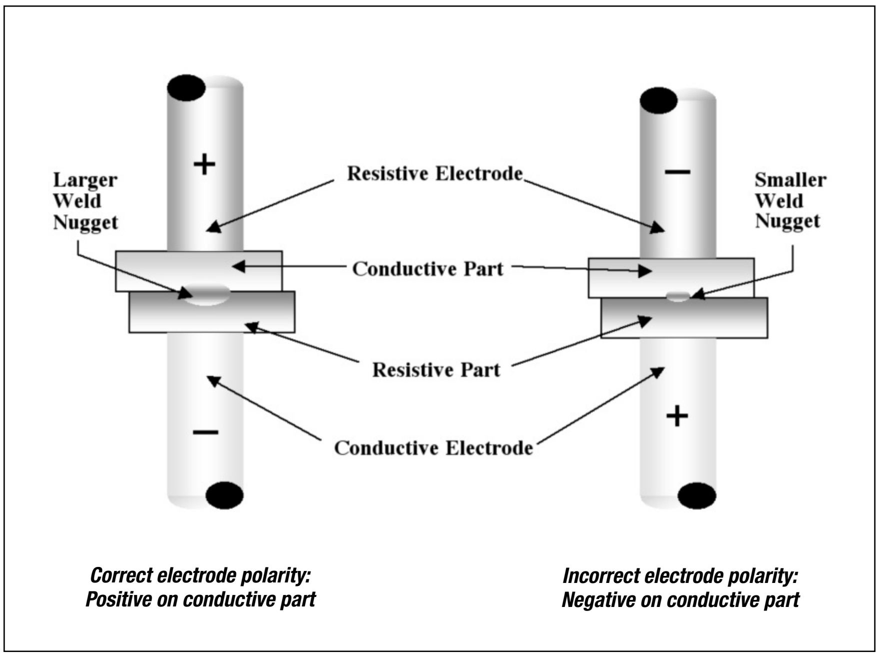

Figure 1: Opposed weld polarity effect

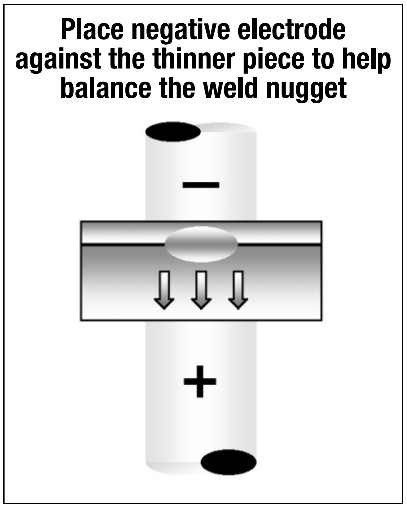

Figure 2: Welding resistive parts of unequal thickness

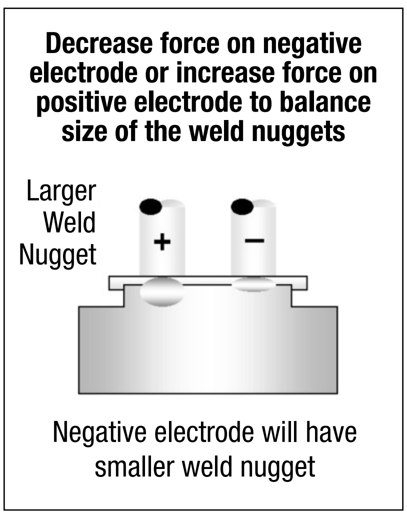

Figure 3: Series welding of a battery tab to cell

When welding two resistive parts with conductive electrodes, The Peltier Effect will cause the weld nugget to be drawn towards the positive electrode-to-part interface. If the parts are of unequal thickness, The Peltier Effect can be utilized to help balance the nugget. The negative electrode should be placed against the thinner piece (Figure 2). Alternately, when welding two conductive parts with resistive electrodes, the negative electrode should be placed against the thicker piece.

In series welding, where both electrodes are in contact with the top part, The Peltier Effect can cause one weld nugget to be larger than the other. Figure 3 depicts the typical series electrode configuration used for welding Nickel plated steel or Nickel 200 connecting tabs to cold rolled steel battery caps.

In this example, the tab material is common to both electrodes, but The Peltier Effect still exists because the current flows through the low resistance electrodes and high resistance tab material. Assuming equal electrode forces and electrode diameters, the weld nugget under the positive electrode is typically larger. Adjusting the weld force on each electrode can normally compensate for the difference in weld nugget size. Referring to Figure 3, reduce the force on the negative electrode or increase the force on the positive electrode to balance the nugget size.

SUMMARY:

In resistance welding, the effects of polarity should be evaluated whenever the weld current flows in a single direction. The Peltier Effect, which is opposite to the thermocouple effect, can be used to help balance the weld nugget in certain applications. It can be especially useful when the parts to be welded are not the same thickness. In series welding applications, polarity can cause the size of the weld nuggets to be unequal. Adjusting electrode forces can help to compensate for unequal weld nugget growth.

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