APPLICATION NOTE

Improving welding processes with the Fluke 345

As technology continues to improve welding processes it becomes important to update evaluation and troubleshooting methods in order to ensure weld quality and productivity.

With the Fluke 345 set to read Single-phase watts, the heat input applied to a given length of weld can be determined.

As technology continues to improve welding processes it becomes important to update evaluation and troubleshooting methods in order to ensure weld quality and productivity. Knowing power supply issues, understanding advanced waveform manipulation and the commonly used Pulsed Gas Metal Arc Welding (GMAW-P) technology, often referred to as "pulsed MIG," is important to determining what is happening at the end of the welding gun.

In pulsed MIG welding, a high-speed inverter in the welding machine pulses the output current between the wire electrode in the welding gun and the weld material. The current pulse is usually a square wave, pulsing from a maximum flat peak value to a minimum or background value up to 5,000 pulses per second in some machines. During each pulse the weld bead is squeezed off from the wire feed through the arc and into the weldment. If the pulsed current drops too low, the arc will not be maintained and the weld puddle may cool creating problems. Improperly applying current and voltage can result in welding spatter and create metallurgical issues at the weld. In short, improper waveforms at the weld gun can reduce production.

While some welding machines can now monitor the output waveform through their controls, external troubleshooting with handheld test tools is still often necessary to ensure weld quality. A tool such as the Fluke 345 Power Quality Clamp Meter measures ac or dc voltage and current, power in watts, displays waveforms, and utilizes sample rates at just over 15 kHz.

Weld quality is so important, that where safety is concerned, the International Boiler and Pressure Vessel Code, the code that establishes rules for pressure integrity of boilers and pressure vessels revised ASME IX, "Welding and Brazing Qualifications," in 2010 to allow the use of either of two methods to measure the energy being delivered per unit length of weld.

- When voltage or current are held at constant values on the welding machine output, a conventional formula of volts times amps divided by the length of weld can be used to monitor the heat input per unit length of weld. Such measurements are required as part of the welding qualification process by this code section.
- With pulsing outputs, a more technologically advanced equation using test tools for power and energy measurement can be used. (see sidebar on page 2)

Joel Pepin is the Quality Systems Engineer at the PCL Industrial Fabrication Facility located in Nisku Alberta, Canada. He is a licensed professional engineer and recognized expert on the effects of advanced waveform variables on the welding of pipeline steels.

Pepin says with a portable tool such as the Fluke 345 Power Quality Clamp Meter you can squeeze the trigger and clamp around a conductor to

Understanding heat input measurements

The Heat Input Measurement has been a long-standing quality control measurement for the welding industry. A fairly simple formula, it is volts times amps divided by travel speed. Since voltage times amperage is power, the question answered by the basic formula when holding voltage and current values constant becomes: "How much heat are you putting into a length of weld."

This conventional formula for Heat Input is:

$$\frac{\text{Voltage x Amperage x 60}}{\text{Travel Speed (in/min or mm/min)}}$$

Knowing this is important because heat energy input can affect the characteristics of the weld. As the melting of the base metal and filler metal occur to form the weld, the cross-sectional area of the weld and other metallurgical properties such as tensile strength and hardness are established. Inconsistent arcs or the wrong amount of energy into the weld can cause quality problems.

The AMSE IX allows for calculations using more complex power measurement tools when the waveform is being controlled. If the measurement is in joules (which can also be obtained by conversion from watts), then this formula applies for Heat Input:

$$\frac{\text{Energy (Joules)}}{\text{Weld Bead Length (in or mm)}}$$

Power is the rate of energy per unit of time. The Fluke 345 displays power in Watts. For meters displaying this power measurement, this formula applies to determine Heat Input:

$$\frac{\text{Power (or Joules/s if used) x Arc Time}}{\text{Weld Bead Length (in or mm)}}$$

read ac or dc amps or view the current waveform. Attaching the voltage leads allows for reading of voltage values in addition to the current values, and the display of voltage and current waveforms together on the same screen. The meter also has a Watts function.

Because of its ability to capture and download data, the 345 can be used to record and analyze baseline information when evaluating a new process. Spikes and average maximum values can be observed.

"We get a better idea of the envelope we are working within," Pepin said. Observing waveforms is critical. A square wave indicates the polarity shift is virtually instantaneous. This means that all of the energy input is occurring along the top of the square wave thus creating the most advantageous of all pulsing effects. A sloping waveform would indicate current is decreasing during the delivery process.

Pepin recalls one particular troubleshooting problem when welding issues occurred for an unexplained reason. The welder power supply output was not performing as well as needed. Under normal conditions the power supply output should be the square wave form indicating weld current values are switching instantaneously. One look with the Fluke 345 revealed that under the stressful requirements of thinner wire and high current at the very high frequency required for the application, the power supply was not able to deliver the square wave at this increased demand, but dropped to a triangular shape. Thus, the current, when being delivered to the weld, was not always at peak value.

"As technology evolves, welders determine if they like the technology. Equipment is set up and all possible data is recorded. Welders must be comfortable with the equipment and it must be user friendly.

Some manufacturers are providing built-in monitoring systems with their welding equipment. But those are often missing information. "We still need the ability to screen capture the waveform image, not just instantaneous power output to the weld," Pepin said.

While scopemeters or power quality analyzers may provide more functions, they also provide more complexity than what is needed for the task at hand. With an automatic calibration feature and no special leads or complex hook-up requirements, the 345 shows an advantage. "The portability, the ability to pull something out of the box and put it to use is very valuable," adds Pepin.

The science of advanced welding technology using complex methods involving welding machine inverter outputs for increasing welding process quality is not simple to understand. Yet the ASME requires certain measurements to ensure welds for pressure vessels and pressure piping meet their intended requirements. As welders and engineers evaluate new processes and develop welding procedures specific data and waveforms must be recorded for quality control purposes. In the event of a problem, the pulsed outputs of current to the weld must be observed and evaluated along with other factors.

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