IMPROVING RESISTANCE WELD QUALITY WITH MONITORING: MAKING THE MOST OF A WELD MONITOR

by D.J. Livingston © 1995 The Fabricator

Weld current has been recognized as an extremely important parameter since the development of the resistance welding process. Together with time (cycles) and electrode force, weld current directly affects weld quality and appearance.

Fortunately, in many applications of resistance welding, some margin of error exists with respect to most weld parameters. However, with some newer metals, including coated and high-strength low-alloy (HSLA) steel and aluminum, the control of welding parameters over a narrower range has become more important. Also, special kinds of welds, such as those involving projection welded fasteners, pose unique requirements. Weld monitoring can help fabricators improve productivity when performing these types of welds.

In its simplest form, a weld monitor is a current sensor combined with a display that gives a readout of weld current in amperes. Some monitors allow the setting of high and low limits, or tolerances, on the acceptable range of current and weld cycles. Other monitors add sensing of electrode voltage and can calculate resistance. Still others can measure electrode force and displacement (tip movement during the weld).

Depending on your application, monitoring one or all of these parameters can help you make improvements in quality and productivity.

PUTTING MONITORING TO WORK FOR YOU

Example :
Consider the need to produce an assembly consisting of two pieces of 16-gauge steel. Published guidelines say that a welding current of 15-12 kilo-amperes, a weld time of 10 to 14 cycles, and an electrode force of 800 pounds will produce a good weld.

You can easily set the weld time, since almost all modern weld controls accurately control cycles. You can calculate the airline pressure required to produce the correct electrode force. Still, you need some kind of instrument to measure weld current. For this, you need at least a simple weld monitor.

Now, you need to determine what combinations of current and cycles produce good welds. By making a number of parts using various weld heats and cycles and then performing nugget pull tests, you can determine the correct heat setting for the chosen weld time without ever knowing current.

However, destructive testing takes time and may be difficult. In addition, parts with several welds may exhibit current shunting from earlier welds. Distance of the weld to the sheet edge can also have a major effect on weld quality. These are examples where advanced weld monitoring techniques - not just measurement - can help.

If your weld monitor is able to measure dynamic resistance, you can look for formation of the weld nugget by observing how weld resistance decreases toward the end of the weld. You may learn that some welds require more current or that you can shorten weld time for others. Thus, monitoring can help you better control your process and gain higher production rates through increased knowledge of weld dynamics.

MORE THAN MEASURING CURRENT

Weld monitoring can help you spot setup or electrical problems. Often, bad welds are produced because an operator improperly sets the welding control. Sometimes, unauthorized adjustments have been made. With wear, electrodes may have "mushroomed" until current density is too low, requiring tip-dressing or replacement. Electrical connections may have loosened, or cables may have been frayed.

A weld monitor can also help you discover mechanical problems. The airline regulator may fail to deliver the required pressure. Weld current may start to flow before adequate electrode force is reached. Tooling may have worn or fixtures may be improperly assembled. A fastener, such as a weld nut, may have been positioned upside-down. Hold time may not be long enough to ensure proper and consistent setdown.

From a process optimization standpoint, you may find that welding time can be shortened. The need for extra safety welds can be reduced because the primary welds you have made are known to be of consistently high quality. Of course, you may find that you need to extend welding time to improve quality.

In all these cases, measuring as much that goes on during the weld cycle as possible - current, voltage, cycles, resistance, force, and displacement - will help you develop the best weld schedule for your application.

This measurement will help ensure higher weld quality with less need for destructive testing. Your ability to describe in numeric terms what a good weld is and to recall its signature for comparison with subsequent welds will help prevent rejects. In short, the more you measure, the more you know.

Quality concerns are another driving factor behind the implementation of weld monitoring. Inadequate weld quality can involve both loss of productivity and safety issues. The definition of some automotive welds as MVSS (Motor Vehicle Safety Standard) means they must be monitored and known to be good. The failure of an MVSS weld may result in personal injury.

ISO 9000 requires that you know what your process should be and prove it with documentation. In many instances, the ability to evaluate welds according to a statistical process control (SPC) sampling plan is adequate. In other situations, the characteristics of each weld must be recorded. The existence of printed documentation of weld quality is a requirement for proof of process.

Remember that monitoring itself is not a solution to weld problems. You need to make monitoring work for you, and learn what monitoring trends are telling you.

For example, if welds are suddenly rejected, you might find that the welding control settings have been changed. By noting the monitor's time and date stamp on the weld record (if the monitor provides this), you can determine when the change was made. In another instance, you may find that current and voltage are decreasing over a large number of welds. This might point to problems with the secondary connections or cables.

QUESTIONS TO CONSIDER

Since resistance weld monitors come in many configurations, answering a few questions will help you decide the kind of monitor your application requires.

Which weld parameters are critical to your process? Since resistance welding machines tend, by nature, to exhibit constant current characteristics, current monitoring alone may not be an adequate indicator of weld quality. Tests show that some welders may produce nearly the same current under tip-to-tip conditions as when the work is present between the tips. Voltage measuring capability helps a monitor accurately determine the weld quality.

Will displacement information play a critical role in determining weld quality? As described in the case of an incorrectly positioned projection weld fastener, measuring displacement may save you money by helping to reduce back charges. Displacement information will also indicate inadequate setdown, which results in a low-strength weld.

By monitoring electrode force - either directly as with a load cell or strain gauge or indirectly as related to airline pressure - will you be able to spot problems before rejects occur? Too much pressure may produce unwanted part deformation. Too little pressure results in expulsion and the inability to form a weld nugget.

Do you need to measure only? For machine setup or when records need not be kept, measurement alone may be adequate. On the other hand, do you need to set high and low tolerances? Tolerances allow you to define accept and reject limits. With these properly set, the monitor instantly alerts the operator to weld problems and identifies reject welds.

Many monitors have built-in electrical interlock relays that can be wired to your welding control to prevent further operation if a reject is detected. You may also be able to divert rejects to a different bin when they are ejected from an automatic welding machine.

Will the monitor work with your process? Most monitors work well with alternating current (AC) spot welders. However, frequency converters, high-frequency direct current (DC), capacitor-discharge (stored energy), and seam welders impose unique requirements on the monitor.

Can one type of monitor handle all the resistance welding processes you use in your plant? For example, seam welds usually exceed the 99-cycle limit imposed by most monitors. You may need a monitor designed to record welds lasting several thousands of cycles.

What will you do with the monitored data? If it is for temporary use only, during machine setup, for example, storing the data is not very important. You should still consider whether or not it would be helpful to print a record of the weld for future reference. Does the monitor print waveforms, numeric data, or both? Does it provide a time and date stamp for future reference?

How does the monitor handle the data? If you routinely weld coated materials, you may want to ignore or "blank" the first few weld cycles during which expulsion may occur. When monitoring an impulse weld, are cool times ignored or averaged in with heat times? Are the current (and voltage) readings in root-mean-square (RMS) or average units?

Since each weld has a distinct pattern, does the monitor look for a single average current for the entire weld, or can it recognize the weld's signature, including slopes or pulsation? Some monitors are not able to distinguish such weld features. Others apply the specified tolerance to each half-cycle of the weld.

Can the monitor learn what a good weld looks like and then store the parameters for future recall as a master weld? If you plan to use the monitor with several welding heads, can the monitor store and recall a different signature for each head? Do you have to be a rocket scientist to use the monitor? Some monitors have almost no setup requirements. Others display English language prompts which give helpful instructions during setup. Still others require a skill level beyond that of the typical user.

WHAT MONITORS CANNOT DO FOR YOU

Resistance weld monitors, in themselves, do not solve welding problems, nor do they replace skilled welding engineers and time-proven experience. You will still need to evaluate your process using techniques such as "design of experiments" to determine the interaction of various weld conditions.

Weld monitoring is not a substitute for weld machine maintenance. Too often, when such maintenance is neglected and poor-quality welds are made, the weld monitor is turned off. Ignoring such problems is a sure indication that worse problems are ahead.

Weld monitoring is also not a substitute for setup and operator training. Numerous courses in resistance welding are available that teach important basic skills. When these are learned and mastered, weld monitoring can serve its intended purpose - control of the welding process.

CONCLUSION

Weld monitors are powerful tools when used properly. They can help you refine your processes, recall what a good-quality weld looks like, and alert you when things go astray.

Becoming familiar with weld monitors and their use can help you maintain and improve your position as a quality supplier in today's increasingly technical metal fabricating industry