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Applying Sensors and Cordsets in Welding Environments

White Paper - W1017

WHAT TO DO ABOUT WELD SLAG

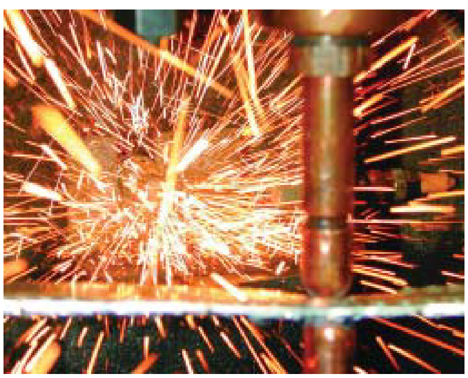
How often are sensors replaced in resistance welding applications? Imagine several sensors on several machines, all with a different degree of exposure to welding operations. This could be anywhere from a few sensors to a few hundred, depending on the application and industry. Also take into consideration where the sensor is in relation to the weld flash. Now imagine this: If a sensor fails in one operation and needs to be replaced it will cause a certain degree of downtime – maybe just a few minutes. But if another sensor down the line also fails and needs to be replaced, and so on down the line, this spirals into a productivity issue, not to mention a gross cost concern.

One of the most common applications where resistance welding occurs is in the automotive industry, where it is used to fuse parts of the car body. The welding temperatures are very high – often in excess of 1,200 degrees Fahrenheit – and currents can range from 15,000-35,000 Amps. Sensors are used in this industry for multiple operations, including sensing where metal car parts are located to ensure proper placement prior to welding. An automated (robotic) weld arm maneuvers into place and welds in multiple locations around the vehicle. This causes sensors in proximity to the weld flash to experience different degrees of exposure and vulnerability to the effects of the weld flash.

Sensors are affected by the conditions resistance welding produces. Strong electromagnetic fields can cause a standard (ferrite core) proximity sensor to false trigger (output) or lock-on. Weld slag and/or splatter can accumulate on the sensor or melt the housing material causing small 'pock' holes to form. These areas are particularly vulnerable for further accumulation of weld slag/splatter. Depending on the sensor's construction (i.e. how well their material withstands weld by-products), it will withstand different levels of accumulation before malfunctioning. This is an obvious problem when position sensing is in use, and raises concerns for downtime, maintenance and associated costs.

Sensors in severe welding environments can fail (false output) as much as three to four times a day depending on the amount of welding involved in the application and where the sensor is located in relation to the weld tips. Sensors that are mounted very close to the weld tips are frequently subject to the weld flash, while those located further away will be affected by the flash, but not nearly to the degree to which those that are closer. For example, a sensor that is within ten inches from weld tips can easily experience 1,000-2,000 flashes per day per switch.

To make a sensor with increased resistance to the weld flash, manufacturers have changed the sensors design to withstand varying degrees of weld slag/splatter. Some manufacturers use front caps made from Tefl on, stainless steel or other materials, or use different materials for housing, like PTFE or copper. Some manufacturers use proprietary weld resistant material on the housing and/or front cap. It is generally more important to ensure the front cap is more resistant to the weld field, slag and splatter, while the housing can be less impervious to the slag/splatter and more resistant to the electromagnetic field. This is because the face of the sensor more often is directly exposed to the weld flash, and the slag/splatter will attach to the face but skid off the sides of the sensor with less likelihood of accumulation. Sensors that use stainless steel front caps are particularly prone to false outputs, as the oscillator must be tuned to the resonant frequency of the front face to sense through steel. Users commonly cope with sensor malfunction by simply replacing the sensor. Some are "repaired" using a tool (screwdriver) to chip off built up slag. A sensor that has been "fixed" this way will probably work for a period of time, but fail again and again by fewer weld flashes until rendered useless.



Some sensors designed for welding environments incorporate technology that makes the sensors resistant to the strong electromagnetic field. Factor 1 sensors that use separate, independent sender and receiver coils on a PCB and remove the ferrite core are inherently immune to the magnetic field interference that often occurs during electricwelding operations, lifts and electronic furnaces. The absence of the ferrite core also allows factor 1 sensors to operate at a higher switching frequency.

Many sensors designated for welding applications by their manufacturers are not truly so, and fail after very few weld flashes. In fact, some sensors specially designed for weld resistance cannot function after 5,000 weld fl ashes. Sensors that can withstand 10,000-20,000 flashes are impressive on the low end and exceptional on the high end, though a select few can function beyond 20,000 weld flashes without failure. It is good to keep this in mind when choosing a sensor for welding environments to determine what level of resistance is best suited for your application.

To determine if your application would benefit from sensors specially designed for welding applications, you may consider auditing the rate at which sensors are expended in your current applications. How often are sensors failing? How often do you replace sensors? How much time does it take to diagnose or remedy the problem? The answers to these questions should help you determine how rugged a sensor you really need. Keep in mind that the effects of weld slag and splatter are not just harmful for sensors, but often affect surrounding components. Furthermore, sensors in these environments may be susceptible to human and mechanical damage. Some manufacturers incorporate fitted steel covers into the sensor housing prior to sealing the sensor so it's not a separate part – making the sensor impervious to physical damage from the side and weld damage from the front (when used with weld resistance front caps or coatings). In any sensing situation, it is important to examine all aspects that contribute to the success or failure of your sensors to make an informed decision regarding which sensor is right for your application.

CONNECTION COMPONENTS

Weld slag can also significantly affect the cordsets used to connect the sensors to higher level control systems in these locations. Weld slag build up is generally most harmful to the cordset where it mates with the sensor, or the quick disconnect area, if using a quick-disconnect sensor/cordset combination. If enough slag is present, it will effectively fuse the sensor to the cordset's coupling nut and require the cordset to be replaced along with the sensor. This may not sound like a big deal, but replacing the cordset can be very time consuming. Imagine removing 20 feet of tie wrapped cable – some of which is covered in solidified weld slag – and lying out, installing and tie-wrapping 20 feet of new cable.

There are ways to help avoid some of these cabling pitfalls. Depending on your application, you can choose from many different levels of protection. Cable jackets, plug bodies and coupling nuts are all components of the cordset that can be altered to provide weld slag protection. For instance, coupling nuts may be coated with PTFE to improve weld resistance.

Not just any cable jacket material can be used in these environments, as the slag will cause the cordset to melt or burn on contact. Instead, cable jackets are made from materials that are more resistant to weld slag build up. The cable jacket most commonly used for welding environments is rubber (chlorinated polyethylene, CPE) for its ruggedness and durability. A thermo-set CPE jacket over EPDM rubber insulation is impervious to flame and temperature extremes. CPE jackets also provide superior resistance to tears, cuts and abrasions. The drawback of this cable type is that it is more difficult to strip and is not recyclable.

If the welding environment doesn't require cable as rugged as CPE, thermoplastic elastomer (TPE) jacket material may also be used. TPE cable, sometimes called TPR (thermoplastic rubber), provides very good resistance to weld slag build up. It is also more flexible, less expensive than rubber, and easier to strip. TPE material may also be used as molding for the cordset plug body.

If specifying different material is not enough to protect your cordsets, there are other options to further a cordset's resistance to these extreme conditions. If the weld slag is so extreme that the coupling nut is fusing to the sensor, adding a protective sleeve over the cordset should be the first option you consider. The sleeve, often made from fiberglass, fits over the cordset and the coupling nut to where it meets the sensor to protect it from weld slag. The sleeve is usually coated with another substance so it is better able to withstand the brunt of the damage from the weld slag. Sleeves can be made to fit most cordsets in lengths that are specifi c to the application. A second protection measure involves an expandable silicone rubber coated fiberglass sleeve. This method of provides a 'heat shrink' type fit around the cordset and the coupling nut.

Another option is to use a short extension cordset between the sensor and the second, longer cordset. Since most of the slag damage occurs near the sensor, adding the extension cordset, also called a sacrificial or shorty, to this area means you'll only have to replace the extension cordset and you won't have to go through the hassle of replacing a 20 foot cable.

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