Capacitor discharge resistance welding emerges as important projection welding option

Doesn't need the same power requirements as traditional resistance welding

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BY: DAN DAVIS

Capacitor discharge welding delivers a laser welded-like joint without the expense and extensive setup.

Figure 1
Tom Snow, CEO, and Jeffrey Morgan, welding engineer, with resistance welding equipment supplier T.J. Snow, hold parts that have been formed using the capacitor discharge welding method. While not widely known in the U.S., the technology is quite popular among manufacturers of automotive transmission components and airbag assemblies.

If you aren't familiar with capacitor discharge resistance welding, you might not have to wait that long. The technology is forcing people to rethink resistance welding technology.

Capacitor discharge (CD) welding is a form of resistance welding that pulls on energy stored in a large capacitor bank instead of drawing directly from a power distribution network. Because of this ability to rely on stored energy, these projection welding devices have welding times that are short and concentrated, around 12 milliseconds, as opposed to about 100 milliseconds on a typical resistance welding machine. In a mass production environment, such a time differential can really make an impact (see **Figure 1**).

So where's CD welding been all this time? It's been around for a while. Just think about the advent of inverter technology and what that's done for fusion welding power sources over recent years. The evolution of the technology has allowed capital equipment manufacturers to "sample" energy more frequently and stabilize the process, according to Jeff Morgan, welding engineer, T.J. Snow, a supplier of resistance welding equipment. Forty years ago, a manufacturer could only turn on or turn off an energy source; today that same manufacturer is using custom energy forms to deliver welds with specific characteristics.

"A real improvement that has come about in recent years with capacitor discharge technology is that users are now able to recharge the capacitors a lot quicker," said Tom Snow, the company's CEO.

“I would say with 99 percent of the CD welders out there, you are using a silicon-controlled rectifier to turn on the power to the capacitors and then one to discharge the capacitors,” Morgan said. “In the past these devices were not able to handle that kind of inrush of energy. They were more fragile than they are today.”

Snow added that several injuries were tied to the usage of CD welders in the early days. A lack of safety training for operators of equipment that could be charged to several hundred volts was a recipe for accidents.

Equipment design has improved to the point where safety is not as large of a concern (see Figure 2). For instance, the doors that provide access to the capacitor banks are now interlocked, and an operator can’t open them without de-energizing the banks.

With the safety concerns resolved and the technology able to improve upon conventional resistance welding technology, Morgan and Snow see CD welding taking off for several reasons:

Virtually Eliminates the Heat-affected Zone. It delivers a laser welded-like joint, meaning that the metallurgy of the steel retains virtually the same characteristics as it did before the CD weld takes place. Like the laser weld, a CD weld delivers a joint that substantially limits surface deformations and spatter. The CD welding process also doesn’t come with the expense of laser welding equipment and the accompanying housing required to make such an operation safe.

Does Not Require a Robust Power Supply. The approach to using CD welding technology in many instances is that it doesn’t require a large draw on a power distribution network, which can be an issue in some areas, such as rural communities. In some instances, a CD welding machine can be run with the same electrical service that is used to run a residential electric dryer, say 60 amps. Morgan said this can prove cost-effective if a manufacturer ever has to rearrange a shop floor layout and needs to have electrical work done; a system designed to deliver 400-amp service, for example, is going to cost much more than something catering to less power. Additionally, some manufacturers find themselves in locations where, because of a lack of available AC power, they have to interlock their resistance welders so that only one or two fire at any one time, limiting the strain on the power distribution network; CD welding technology alleviates the need for this type of electrical coordination.

Figure 2
Capacitor discharge welding equipment has evolved to keep operators safe and operations up and running. The equipment looks like similar resistance welding equipment. The operator takes the two workpieces, places them accordingly into the machine, and watches the copper electrodes come together to make the joint.

Electrodes Last a Long Time. Because the energy, even at very high levels, delivered in the CD welding process is concentrated for such a short time, the wear is less on the electrode compared to conventional resistance welding processes. As a result, Morgan said, electrodes last as much as four to 10 times as long, depending on the application.

Parts can be handled quickly thereafter. Again, because the electrical discharge is so quick, the part does not heat up after the CD weld is complete. A person wearing gloves, which is typical when handling sheet metal, should have no problem comfortably handling the part. (It should be noted that stainless steel will retain heat, unlike mild steel, because it has higher resistance than other metals.)

Morgan said the CD welding process is widely used in manufacturing automatic transmission components. A good example of such a part is a clutch basket, which basically is a stamped part that has a shaft CD welded to it. In the past, those parts were machined out of an ingot, or a stamped part and the shaft were joined by laser welding. CD welding emerged as a way to do that more cost-effectively, so manufacturers gravitated to the technology.

“What has driven a lot of this is everything about the automotive industry needing to get vehicles lighter and stronger,” Morgan said. “So that has driven the steel companies to develop products that are extremely difficult to weld. The capacitor discharge process solves many of those problems.”

Those new materials are influencing the actual design of the CD welding machines. “Follow-up” has become much more important with these exotic materials, Snow said. It makes sense as some of the new high-strength steels have tensile ratings of around 1,400 megapascals, which is at last three times greater than mild steel.

In this scenario, a piston applies forging force to the object being CD welded as the object is entering its plasticized state. The necessary follow-up is supplied by springs, air bladders, or urethane pucks, depending on the application, Morgan said.

While CD welding has been in use for several years in the manufacturing of transmission components and airbag assemblies, the technology is still not widely embraced in other areas of automotive manufacturing and other industrial segments. Morgan said it’s just a matter of time as people become more aware of the benefits associated with the process.

He described the interaction with a customer that was looking to explore the weld strength of a CD weld for an application. Testing in T.J. Snow’s lab proved that the CD weld was at least three times stronger than the minimum weld strength required for the application.

Now traditional inspection efforts for such an application test would focus on weld penetration, but Morgan said the focus needs to be on the weld strength, which the CD weld process can deliver consistently and effectively. It’s a new way of thinking about projection welding, and it may require some time to change people’s mindsets.

“That’s why we are equipped with a lab for testing,” Snow said. “We want to be able to prove that the process works for them.”

T.J. Snow Co. Inc., www.tjsnow.com