HEAD

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Comparing air-cooled and water-cooled MIG guns

Before putting air-cooled and water-cooled MIG guns head to head, it's helpful to begin by understanding duty cycle. We all know what it is, but in case anyone needs a quick refresher: Duty cycle is the proportion of time that a device or system is in operation.

For welding, the duty cycle is a rating measurement of 10-min. increments using CO_2 gas. So, if we take a 350-amp gun as an example, at its maximum it can weld 10 min. at 350 amps with a constant current using CO_2 gas.

To fully understand duty cycle, it's also helpful to take into consideration the factors that affect it, such as the current, pulse mode and the gas that's used. Argon-based gas, which mixes argon at 75 percent and CO_2 at 25 percent, doesn't cool a gun like 100 percent CO_2. Other gas mixes used in welding, such as argon 90/10 and argon 95/5, can also affect the duty cycle. As different variables are introduced according to ▸

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the applications at hand, inevitably tradeoffs must be made, such as sacrifices to duty cycle.

Therefore, consider that an air-cooled gun rating is reduced 40 to 50 percent using argon-based gases and another 20 to 30 percent when pulse welding is used. Water-cooled guns, on the other hand, get a duty cycle reduction of 10 percent for argon-based gas and a negligible reduction for pulse welding.

In regard to duty cycles, there's also the consideration of constant voltage and polarity. Constant voltage, or current, is used in MIG welding. Polarity, the direction of the current flow, can be either straight or reverse in nature. In MIG welding, it's common to use reverse polarity constant voltage.

In this process, the heat produced is created on the ground side of the work while the nozzle and the contact tip are exposed to reflected heat. CO_2 acts as the cooling agent, with smoke acting as the filtering agent, shielding the reflected heat.

Pulse welding is the process of pulsing the weld current several times per second instead of holding it constant. Pulsing causes the arc to act like it is welding hotter than it actually is. The torch reacts like the current is at the peak of the pulses rather than the "average" as read on the current meter of the power source. That's because the arc is starting and stopping constantly, which takes more power. Also, pulse welding creates less smoke, considerably less, in fact, and doesn't filter the reflected heat to the nozzle and contact tip. Lots of people now use pulse welding with argon 90/10, which reduces their duty cycle up to 50 percent.

CARRY THE TORCH

So, how do lessons on welding duty cycles affect the torch you may want to use? Well, it's all a matter of the heat you're generating. Air-cooled torches depend on thermal transfer to conduct the heat from the contact tip through the handle and into the power cable before radiating into the air. And this is where the duty cycle becomes important – how much heat is generated and how fast can it be conducted and radiated?

A simple design, with just a power cable, handle and neck, makes air-cooled guns "plug and play" in every sense.

For example, aluminum power cable guns are a little better at radiating heat than copper guns, but are also less capable of conducting current. The nozzle is insulated electrically and thermally from the gun and radiates heat on its own.

Water-cooled guns act differently. With water-cooled (or gas or liquid-cooled – they all mean the same thing), water (or liquid) transfers heat into the power cable, contact tip and the nozzle. Systematically, it is a more efficient system for cooling. Heat in the water is transferred to a radiator into a holding tank where it is cooled and circulated back to the torch, which is what lets it stay cool enough to run at 100 percent duty cycle.

WEIGHING THE OPTIONS

Clearly, there are ample pros and cons to both MIG gun types, but it's helpful to break them down by category.

Air-cooled pros: A simple design, with just a power cable, handle and neck, makes air-cooled guns "plug and play" in every sense. Less ancillary equipment costs and chemicals to use to keep the gun running add to their simplicity.

Cons: The longer or hotter the weld, the bigger and heavier the torch because you need a higher rated torch to withstand the load. Higher rating means heavier materials, which adds to the weight of the torch and increases fatigue on the operator.

With a water-cooled MIG gun, the water system removes heat from tips and nozzles anywhere from 30 sec. to 2 min. after welding is complete.

Water-cooled guns are surprisingly lightweight; the liquid and the pressure flowing through the cable makes them somewhat buoyant.

This includes the nozzle, the tip and, especially, the cable.

On top of the weight involved, nozzles and tips are always hot, and depending on the delay between welds to cool, they can wear faster due to heat overexposure. After maximum duty cycle has been reached once, the duty cycle the next time is reduced because it puts a strain on the materials like the copper and brass on the torch, which lessens their ability to handle the same load the next cycle. It could be a minimal effect at first, but over time, the effect will wear out materials. In these situations, welders are always spending less time welding just because of the design of the gun.

Water-cooled pros: These guns are always cool. The water system removes heat from tips and nozzles anywhere from 30 sec. to 2 min. after welding is completed – no matter the length of welding time – to the point of touch. Obviously, it's not recommended to weld bare handed.

Nozzles and tips also last longer. When welding for long periods of

Abicor's CR 1250 water cooler complements a water-cooled MIG gun for a permanently "cool" welding process.

time at low amperages, tips may reduce their ability to conduct to the point it could damage the gun. It's always recommended, therefore, to change tips at least once a day or more, depending on the amount of wire used. Water-cooled guns are also surprisingly lightweight; the liquid and the pressure flowing through the cable makes them somewhat buoyant. A 500-amp water-cooled gun, for instance, feels as light as a 350-amp air-cooled gun.

Cons: Water-cooled guns are more expensive to manufacture because of the added expense of a cooling system. Connections and fittings on the gun are easier to damage and break, mostly because there is just more opportunity to do so. On air-cooled guns, the power pin and trigger lead are the two main connections. Water-cooled guns have these two connections plus the coolant itself, which needs to be plugged in and maintained. The gun also has a hot water out/cold water in connection. So basically, your opportunity for damaging a fitting is increased by a factor of the number of added fittings you're using by opting for a water-cooled gun.

Water leaks in the welding area can also be messy. Furthermore, the thermal transfer for the nozzle is a pressed ceramic and can be broken if abused, which reduces the gun efficiency. Cooling systems that are not maintained or improperly set up can also damage the gun. Lastly, while water-cooled guns can reach amperages that air-cooled guns can only dream of, it's difficult to reach full duty cycles for 500-, 600- or 650-amp guns.

Unjustly, water-cooled guns have received a bad reputation for related maintenance problems. However, with operator training and the proper setup, they're more comfortable for the operator and increase arc-on time and overall productivity. ■

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