WHITE PAPER:

Latest Innovations in Tip Dressing Yield Greater Control and Consistency, While Extending Tip Dressing Service Life

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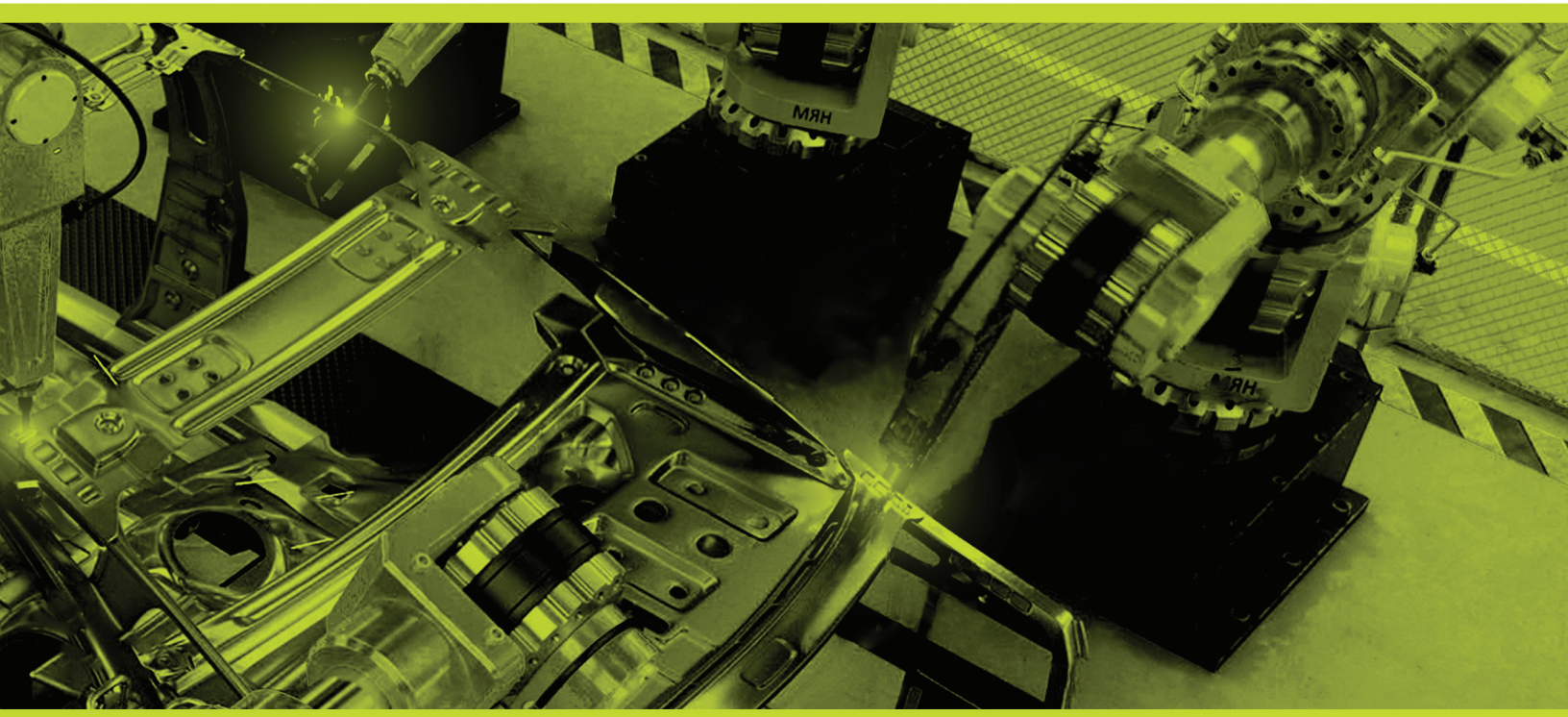

Automatic electrode tip dressing is the process of milling robotic copper spot welding tips to remove the weld deformation and restore the intended weld face geometry, which prolongs the service life of the tip. Tip dresser technology provides product engineers with greater flexibility in metal combinations, weld joint design and material selection, while manufacturing engineers benefit from rapid setup and verification of new processes. Although four-blade cutters and holder systems for tip dressing have yielded numerous advantages, additional improvements in the geometry of a single piece, four-blade cutter with a hugger style design have resulted in greater control and consistency, and even longer tip dressing service life.

Understanding Tip Dressing

Tip dressing technology emerged in the 1980s with the use of robotics in manufacturing, particularly in the automotive industry. The tip dressing process mills copper electrode tips back to their designed face geometry in order to extend the service life of electrode tips, weld guns and to reduce power consumption.

During tip dressing, electrode tips are consumed at a controlled and predictable rate. Consumption of the electrode is mostly due to loss of length from mushrooming during the weld process. Ideally, the electrode is dressed to develop a clean weld face and nothing more. Pre-dressing of new electrode tips establishes the proper weld face diameter and at the correct angle for each application.

After a predetermined number of welds, the face will grow or mushroom to a larger size, due to the heat and stress absorbed by the relatively soft copper alloy of the electrode. The mushroomed face, which typically does not exceed 1.3 times the diameter of the dressed face, must then be re-dressed back to its proper size.

HU MODEL
16 - 20 MM Design

With tip dressing, the following goals are achieved:

- Accurate control of the weld face diameter.
- Accurate control of cap consumption rate.
- Balanced consumption of upper and lower electrodes.
- Pre-dressing (dressing a new cap before welding).
- Re-dressing (dressing a mushroomed cap after welding).

The use of tip dressing and tip dresser technology has a direct impact on the throughput and quality of the welding process. Innovations in tip dressing cutters over the last decade have resulted in improved performance stability and consistent high-quality manufacturing tolerances. This provides product and manufacturing engineers with several benefits.

Product Engineering
Along with greater flexibility in metal combinations, weld joint design and material selection, tip dressing offers tighter control of the electrode shape and diameter for improved cosmetic appearance, weld quality and reduction of weld flash.

Tip dressing allows for greater flexibility in combining metals of varying thickness. For example, thickness ratios greater than 3:1 may be successfully welded using tip dressing, as the cap is never allowed to mushroom to the point where welding problems begin. It also allows welding processes that typically require an oversized nugget, such as the welding of advanced high-strength steel, by simply increasing the cap face diameter. In addition, a reduction in flange widths is possible due to less weld face growth.

Product designs requiring custom weld tip geometry may be improved by tip dressing, provided the tip geometry allows it. Tip dressing also yields more precise control and much less overwelding, thereby reducing heat distortion. Some customers find tip dressing as a solution to custom welding applications with advanced steels, aluminum and unique weld applications.

Manufacturing Engineering
In the manufacturing environment, tip dressing offers reduced setup time and process verification, which increases uptime and reduces tool degradation rates.

Since weld face diameters are only permitted to grow by approximately 1 mm before the tips require to be re-dressed, the entire weld stepper validation process can be accomplished with only a few weld quality checks or eliminated. Because only a minimal weld stepper is required to support weld face growth, the traditional practice of oversized transformers and weld cables is no longer necessary. With a reduction in weld current requirements, smaller, leaner equipment components is now standard, saving both time and money.

Since tip dressing generally improves tip life, tip changes may be less frequent and more carefully planned, which minimizes throughput interruptions. A traditional “break-in period,” where the stock cap is forged to a weld face diameter stabilized at the strength of copper divided by the weld force, is eliminated by properly sizing the weld face. Simply stated if a 6mm weld face is stabilized at the weld force then pre-dress the cap with a 6mm cutter to eliminate “break in” periods.

Tip dressing also makes it possible to use one common electrode tip throughout the entire manufacturing facility, as the same tip size may be pre-dressed to the face size required for each operation (provided you do not exceed the force requirements to the tapers on your electrodes).

Improved control of the weld face on the tip enables tighter control of the weld nugget size. Along with improving the weld appearance and the cosmetics of the welded part, it also enables consistent ultrasonic testing of the welds.

Tip dressing allows better control of weld flash, as well as a corresponding reduction in sharp burrs on weld surfaces. This improves health and safety, and creates a cleaner manufacturing environment since there is less buildup of flash on tools and the floor.

Innovations in Cutter Geometry

Recent innovations in cutter systems include a single piece, four-blade hugger design featuring a unique cutting form. Four control zones stabilize in situ weld guns, reduce chip size formation, and provide a controlled and consistent cut rate, pre-dress capabilities, and larger openings for chip clearance. A weld face control zone provides for a slow down of cutting continuation once the original copper face center point is achieved.

This design builds on the four-blade cutter design that features four flutes spaced evenly at 90 degrees for mechanical stability. The reactive force from each flute upon the cap has the best opportunity for support from the next flute when it is exactly 90 degrees away. The hugger design configuration of the cutter further reduces the chatter that may occur with precision tip dressing. Through the use of hugger trim tabs, the “capture” stage of holding the cap in place is improved, while maintaining the precise amount of cutter aggressiveness for adequate milling.

Another advantage of this design configuration is enhanced cutter life, as the four-blade cutter has been proven to last three times longer than traditional cutters. The hugger design produces small chips, instead of long curls of copper, which is more desirable from a health/safety and environmental maintenance standpoint.

The use of certified tool steel that is heat-treated to very high target hardness ensures cutter strength and durability for impact. Cutter edges are polished and deburred to maintain consistent sharp edges. The cutter then receives a special coating process that produces a carbide surface hardness, while the use of double-coated materials provide superior coverage for additional lubricity, durability and performance at 4500Hv.

Technical Considerations
Improvements to the cutter geometry, including the single piece, four-blade design and hugger configuration, as well as other design considerations, have addressed common technical challenges in tip dressing.

Chatter and Electrode Bounce
In order to accurately cut the weld face, it is essential that the weld cap remain in contact with all of the flutes without jumping around or causing chatter. Designing chatter-free cutting blades is complicated and involves several critical parameters, including the number of cutting flutes, grinding and finishing tolerances, and hard coating of the flutes to prevent copper adhesion.

Cutting Blade Clogging
To prevent clogging of the cutting blade, chip management is important. It is preferred to limit the length, width and thickness of the copper chips produced from tip dressing. Additionally, the amount of open space between the flutes must be sufficient to allow the chips to pass without clogging.

Tip Dressing at High Angles
When dressing at higher angles, the side of the electrode tip begins to mill away, creating contact between the electrode tip and non-cutting edges in the cutting blade assembly. Cutting away the side of the tip can breach the cooling water jacket inside the tip. To correct these problems, a flared-out flute geometry was developed to create clearance for high angle dressings.

Extending Cutting Blade Life
The abrasive erosion of the tool steel hardened surface of the electrode tip mushroom leads to dulling of the cutting blade. Blade life may be improved by increasing substrate hardness, selecting a properly adhering hard coat layer, and avoiding grinding burrs.

Conclusions
Tip dresser technology offers numerous benefits to product engineers including:

- Improved weld appearance and cosmetics
- Improved flexibility in metal thickness combinations
- Improved welding capabilities with advanced high-strength steels
- Improved welding capabilities of aluminum metals and combination alloys
- Reduction in flange width weld requirements
- Improvements in custom weld tip geometry
- Reduced heat distortion

Tip dresser technology also offers numerous benefits to manufacturing engineers including:

- Reduced setup time for new weld systems
- Reduction in weld current requirements
- The ability to use common electrodes in every application
- Improved throughput
- Improved weld quality
- Improved health/safety and facility housekeeping

While four-blade cutters and holder systems for tip dressing have yielded numerous advantages, improvements in the geometry of the single piece, four-blade cutter with a hugger design provide greater control, consistency, and performance, while extending the service life of the tip dressing.

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