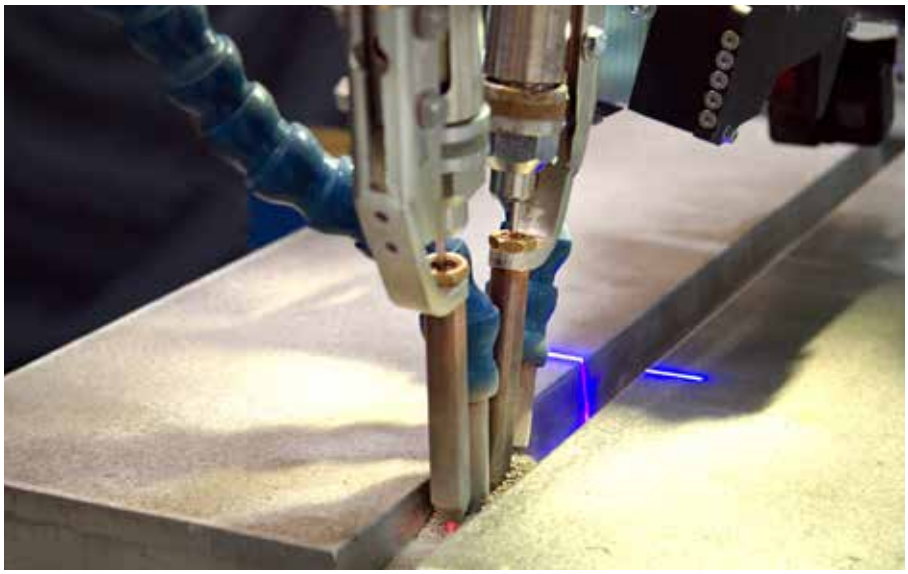
Automated semi-narrow groove welding solution for exceptionally thick plates

Pemamek LLC, a North American subsidiary of Finland-based Pemamek Ltd., has developed an automated semi-narrow groove welding solution with proven success in welding exceptionally thick plates ranging in size from 2 to 6.5 inches (approx. 50 to 165 mm). Called semi-narrow gap welding, this process uses significantly less consumables over the length of the operation resulting in a strong bond in less time and with fewer costs.



Semi-narrow groove long stick-out process (Photo: Pemamek)

Long stick-out process

Based on submerged arc welding (SAW), the long stick-out process employs a welding head equipped with 5/32-inch wires. Stick-out is defined as the distance between the contact tip to the wire end. Pemamek's tiltable welding head provides more control over the fusion process and weld bead creation for better accuracy and penetration. Full welds are possible from the root weld all the way through to the surface. For welding tubular structures, longitudinal and circular milling machines are used to mill the groove root; a 16° included angle is standard with an 8° radius on the base. The tiltable welding head helps direct the energy into the side walls of the semi-narrow groove for full penetration. Any unconsumed flux can be vacuumed, circulated and recycled.

Specialised milling machines

"Pemamek's specialised milling machines can mill both longitudinal and circular grooves. They mill the semi-narrow gap bevel immediately after the inside seam of the weld piece is welded hereby milling out the root to achieve a perfect fusion," said Michael Bell, Director of Sales, Pemamek North America. "By starting with a workpiece milled to the ideal welding groove geometry, the volume of the weld joint is minimised while the joint itself is geometrically correct with clean groove edges, which is especially important when working with the external side of a tubular structure. Additionally, deformations and tensions are kept to a minimum because inefficient and imprecise back gouging is no longer required."

Pemamek provides welding automation technology and integrated manufacturing solutions to a wide range of industries including shipbuilding, alternative energies, heavy fabrication, oil and gas, wind energy, and boiler manufacturing. The company's product portfolio includes comprehensive robotic welding stations and production lines, as well as welding positioners, column and boom units, and roller beds. Each "Pema" solution is based on proprietary "Pema WeldControl" operating and control software developed in-house. (According to press information from Pemamek; www.pemamek.com)

High quality pre-weld laser cleaning of metal surfaces

High quality welding begins with cleaning the base metal of any corrosion, contaminants or existing coatings that could compromise weld penetration and integrity. Ensuring the metal is properly cleaned from the start makes the job easier and eliminates the need to start over to achieve a clean weld.

The traditional techniques used for this purpose – such as sandblasting, chemical stripping and grinding – are often messy, though, and they require expensive consumables as well as substantial time for preparation and cleanup. These methods are also drawing scrutiny from regulators like the EPA (US Environmental Protection Agency) and OSHA (Occupational Safety and Health Administration) since they can pose risks to the environment and applicators.

High-energy laser beam leaves the substrate unaffected

Today, a more effective alternative is utilising industrial-grade, precision laser-based systems that can remove contaminants, rust, residues and paint from the weld surface with a high-energy laser beam that leaves the substrate unaffected. Preparation and cleanup time are minimal, and the low-maintenance equipment can last decades.

"Many people are unfamiliar with the use of lasers to treat metal surfaces," says Vincent Galiardi, owner of Galiardi Laser Clean, a surface cleaning operator based in St. Charles County, Missouri, USA. "When I do a demonstration, at first the people in attendance are skeptical. But after I use the

laser to treat a small area, everyone starts talking and getting excited. By the end, when I let them try the equipment, everyone is having a good time and saying how great the laser works."

For welding applications, Galiardi says, "Pre-weld, laser technology can effectively clean the surface so there is no contamination [to interfere with the weld.] Post-weld, lasers can remove discolouration due to oxidation, which can help to improve stainless steel welds." Given its effectiveness treating metal surfaces, industrial laser systems are increasingly being used in welding applications. Technicians can use mobile handheld units, or the systems can be integrated into automated inline processing lines.

Resolving conventional cleaning challenges

Pre-weld, any impurities on the surface of the base material such as grime, residue, corrosion, mill scale or old coatings will compromise the weld's effectiveness. Any contaminants can interfere with the process, cause resistance, or result in a weld splash when small metal particles become airborne or remain loosely attached to the welding area. Contamination on a weld's surface leads to porosity, or bubbles of trapped gas in a finished weld that can weaken its mechanical properties and requires rework.

Post-weld cleaning is also necessary, particularly for stainless steel. Stainless steel offers natural corrosion protection through an ability to "passivise" itself if the environment provides enough oxygen to repair a surface film comprised of chromium oxide. However, welding can cause a "heat tint" – a discoloured, thickened top layer on the stainless steel around the weld bead within the heat affected zone – that compromises the corrosion resistance. Removing the heat tinted top layer is necessary to restore the full corrosion resistance as well as aesthetic value of stainless steel.

To treat weld surfaces, sandblasting, chemical stripping or grinding are traditionally used as industrial cleaning processes. However, these options have limitations.

Sandblasting

Abrasive sandblasting involves forcefully projecting a stream of abrasive particles onto a surface, usually with compressed air or steam. The silica sand used in abrasive blasting typically fractures into fine particles and becomes airborne, which can cause serious or fatal respiratory disease. Sandblasting also is time-consuming to clean up since the sand essentially scatters everywhere, even though it is usually considered a "fast" cleaning method.

Chemical stripping

With chemical stripping, harsh, even toxic chemicals or pastes are used to strip welds and metal-based objects of contaminants, rust and paint to bare metal. However, for operators, exposure to corrosive acids and noxious chemical fumes is inherently dangerous. The process can also be time-consuming to prepare, achieve the required level of cleaning, and dispose of the waste. In addition, disposing of toxic chemicals is costly and closely regulated.

Grinding and sanding

An angle grinder can remove large contaminants, and a sanding disc can remove rust, paint, and mill scale. However, the aggressive nature of the grinding can quickly ruin the metal to be welded if great care is not taken.

Safe, effective laser cleaning

Laser-based systems have significant advantages over these traditional methods, including ease of use in which an operator simply points and clicks a high-energy laser beam at the surface. The substrate is not affected by the laser, and the systems do not create any mess or byproducts. The approach is eco-friendly, energy-efficient and completes the job in half the time of traditional methods when preparation and cleanup are considered.

"In our experience, laser cleaning is as fast at removing rust or old coatings as other methods, but without the same amount of cleanup," said Vincent Galiardi. "When we treat a surface with lasers, any fumes or dislodged particulate is extracted into a HEPA filter and the job is done. There is no media [sand, chemicals] to replenish or clean up."

Galiardi Laser Clean uses laser systems made by Orlando, Florida-based Laser Photonics, a leading provider of patented industrial grade "CleanTech" laser systems for cleaning and surface conditioning. The American-made laser systems are available in portable and stationary models ranging from 50 to 3,000 W (a 4,000 W version is in development) with chamber sizes from

Laser-based cleaning systems remove residue, corrosion and existing coatings from metal weld surfaces quickly. (Photos: Laser Photonics)

3' × 3' in size to 6' × 12'. The systems can also be installed in manufacturing lines in cabinets or operated by a robotic arm.

Galiardi says that laser treatment of metal surfaces can be used to streamline weld cleaning processes even in relatively remote areas in the field. He relates how he used a portable "CleanTech" laser system for a welding project for the iconic skywalk at the Grand Canyon in Arizona, USA. The skywalk extends over the rim of the canyon and provides a clear view thousands of feet to the canyon floor below. "When I did the skywalk job at the Grand Canyon, I removed paint [from the skywalk welds] with the laser system to allow non-destructive testing of the welds [before repainting]. The system's portability made it quick and easy to use in the field without the cleanup or safety issues of conventional cleaning processes," says Galiardi.

He adds: "As people become more aware of laser-based systems and compare them to traditional methods, they need to factor in prep and cleanup time, which can significantly impact project cost. When the improved operator safety, equipment longevity, and lower maintenance of laser systems are also considered, the clean laser technology has a much higher ROI. CleanTech laser systems can last for 50,000 to 100,000 hours – that's many decades working eight-hour days. After purchase, there's virtually no maintenance necessary."

More information about laser cleaning is available at www.laserphotonics.com.

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