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Advancements in plasma arc cutting technologies for foundries

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Abstract

This solutions brief explores the use of automated plasma cutting technology for cast trimming and degating in foundries. It explains the science behind plasma cutting, the tradeoff between cut speed and cut quality, and its benefits over traditional degating methods.

Next, it tackles the drivers of automation and the growth of cobots and industrial robots in plasma applications. Additionally, it reviews how the ease of entry into this technology has evolved, making it more accessible to foundries.

The solutions brief also addresses gate design, the capabilities of plasma technology, and future trends such as the integration of vision systems.

Plasma arc cutting technology

Basics of plasma arc cutting

Plasma arc cutting is a thermal, contactless cutting method that utilizes an electric arc . The arc extends from an electrode to the torch to the workpiece, passing through a nozzle, as shown in Figure 1. The arc is sustained by plasma gas and is surrounded by shield gas.

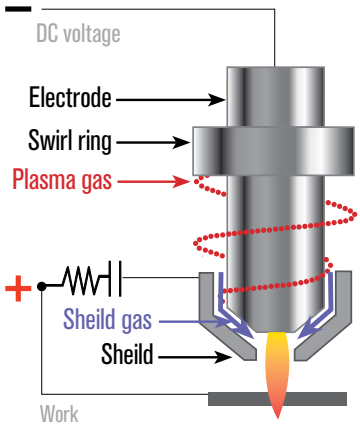

Figure 1 – Plasma cutting torch schematic

One of plasma's major advantages is that it's not highly sensitive to the distance to the workpiece. Generally, cast trimming is optimally performed at approximately 6 mm, providing a generous standoff of part variability.

Two main outcomes must be balanced: quality and speed. The material type and thickness determine cut speed. Cut quality is impacted by the combination of plasma and shield gas and optimal cut speed. Identifying and maintaining optimal cut speed is necessary to achieve optimal cut quality. It is critical to understand the key variables, material thickness and type, and whether the process is being optimized for speed or cut quality. This will guide the process settings.

Optimal conditions for plasma cutting

- **Material:** Mild steel, aluminum, cast iron, magnesium, stainless steel, and other electrically conductive metals.
- **Material thickness:** Ranging from 2 mm to 100 mm (1/8 in–4 in), it can cut materials up to 6 inches thick for severance.
- **Speed:** Varies from 10 inches per minute (ipm) to 1000 ipm, depending on material thickness; it is optimized for 80 to 150 ipm

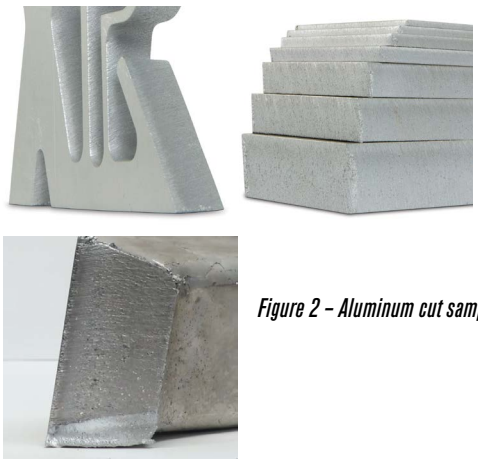

Figure 2 – Aluminum cut samples

Automation in foundries

There are handheld and automated plasma solutions for foundries to trim cast parts and degate.

Handheld systems provide a solution for foundries who aren't ready to automate but are looking for a more efficient and safer way to perform their cutting tasks.

Automation systems address labor shortages, improve worker safety, reduce costs, and enhance product quality and flexibility. It also minimizes waste and increases profitability.

Handheld systems

A handheld plasma cutting system is a portable tool that is used to cut through metal by guiding the tool by hand along the cut location.

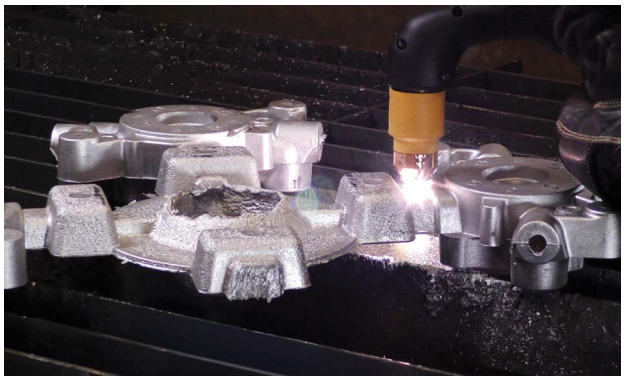

Figure 3 – Handheld plasma cutting

- **Safety and ergonomics:** Handheld plasma systems are a versatile tool, suitable for enhancing operator safety and ergonomics, while also being a viable solution for cutting into tight spaces and corners. The contactless nature of plasma cutting reduces the risk of injury, making it safer for operators. It is also a cutting tool that is much easier on the operator's body versus traditional methods, such as hammers and saws. Hand torches are ergonomically designed to reduce operator fatigue and make the process more comfortable and safer.
- **Flexibility and portability**: Handheld systems are lightweight and portable making them easy to move to different work areas. They are also versatile as they are an effective method for cutting up to 2 - 3 inches thick and can reach into tight spaces and corners.

Light automation systems

Light automation refers to using a collaborative robot, also known as a cobot, on a movable cart to perform the plasma cutting. A cobot is a robot that can safely operate alongside humans, because it's designed with safety mechanisms that cease operation if it senses resistance.

This solution offers the same safety/ergonomic and flexibility/ portability benefits as handheld plasma cutting, along with some additional ones.

Figure 4 - Cobot plasma cutting

- **Entry to automation:** Cobots offer a more approachable method of entry to automation than industrial robot systems. Cobots are commonly the first entry point into automation as they are easy to program, portable, and require a lower investment than an industrial robot system.
- **High mix, low volume applications:** Cobots are easily programmed, which makes them ideal for automating high mix, low volume production. Cobots can be programmed by simply grabbing the end of the robot arm, moving it to the desired location, and clicking a button to log a reference point. Programming a part can be done in minutes and saved to the teach pendant to be called up when that part is produced again.
- **Flexibility:** Cobots are often mounted on tables with rollers which allow them to be easily moved from one workstation to another. Cobots can be set up to operate in an isolated or collaborative environment. While cobots are designed with safety features, the plasma torch requires safeguarding. Even though the robot will cease operation if it senses human workers, humans should take precautions around the plasma torch.

  Cobot systems also offer flexibility by quickly disconnecting the robotic plasma torch and plugging in a handheld torch. This allows an operator to do touch ups or additional scrap cutting using the same plasma power supply system.

Heavy automation systems

Heavy automation refers to an industrial robot system used to perform plasma cutting. They operate in an isolated environment as these robots will not cease operations if they experience a collision and require safeguarding around the system. An industrial robot system requires higher capital expenditure in comparison to a cobot system, however, there is a strong return on investment for large scale production.

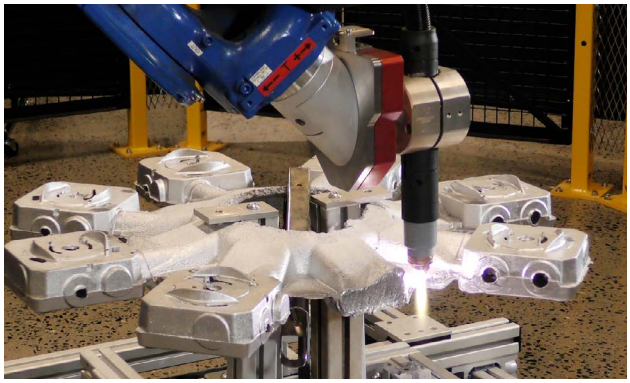

Figure 5 – Industrial robot plasma cutting

- **Large scale production:** Industrial robots are ideal for larger scale, high precision operations with low-mix and high-volume production. Programming industrial robots can also be accomplished easily using programming software that reduces the robotic, programming, and process expertise required to effectively program an industrial robot.
- **Improved equipment:** Industrial robots are more precise than collaborative robots and can also handle more powerful plasma cutting solutions to cut thicker materials quicker and more effectively.

  Robot manufacturers have foundry-specific robots designed to withstand harsh environments and ensure a long-lasting investment.
- **Reduced cycle times:** An industrial robot system can drastically reduce cycle time as it's an automated system that does not require human intervention and can continuously process parts. A benefit of using a fully automated system is that parts can be cut while hot. This results in faster processing time and provides the opportunity to quickly return the scrap to the furnace while still hot, saving energy costs.

Automation drivers

Foundries, like many other manufacturers, are looking at automation for a variety of different reasons. The two main drivers in industrial settings are the labor shortage and workforce challenges. The generation that makes up most skilled workers are retiring. Younger generations are not attracted to the skilled trades, making it a challenge to fill the labor gap. There is also increasing pressure to produce more, faster, which is an extra layer of pressure on the workforce challenges.

For foundries, the major driver is safety. Traditional cast trimming and degating methods put workers at risk of injury. This is further deterring the young generation from pursuing a position in a foundry. They are known for being a dangerous and hazardous environment. In addition to safety, the opportunities to reduce cost, eliminate waste, improve product quality, and increase productivity have made automation very attractive.

Gate design requirements

Traditionally, parts have been designed to have gates and runners located anywhere along the part where the flow meets the requirements to complete the part without any defects. This is generally in the middle range of the part as shown in Figure 6.

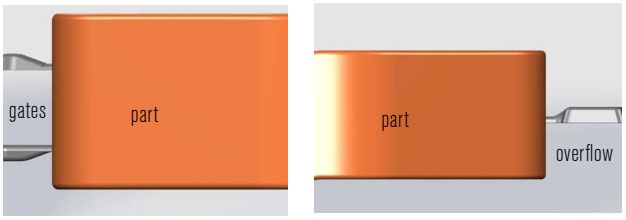

Figure 6 – Traditional gate and runner design

This location can pose some challenges when trying to get a near net cut using plasma where the plasma nozzle would need to be close to the end of the gate. But as shown in Figure 7, that results in a collision between the torch and the part. To avoid the collision, the plasma cut would have to be made further away from the part. This results in cutting thicker material, which increases cutting time, and extra material left behind which means more time is spent on secondary operations.

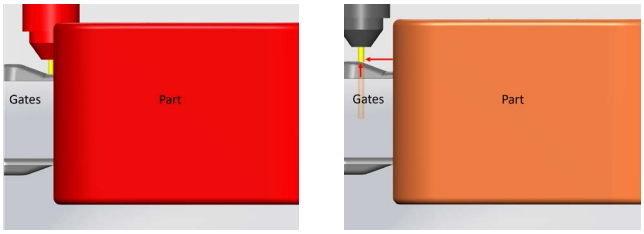

Figure 7 – Design challenges for plasma cutting

By simply shifting the gate up or down, such that the gate is closer to the edge of the part, as demonstrated in Figure 8, these challenges are removed and a near net cut is achieved. If secondary part grinding and finishing is being performed regardless, the torch can be tilted slightly so that no dross ends up on the material and minimal gate material is left.

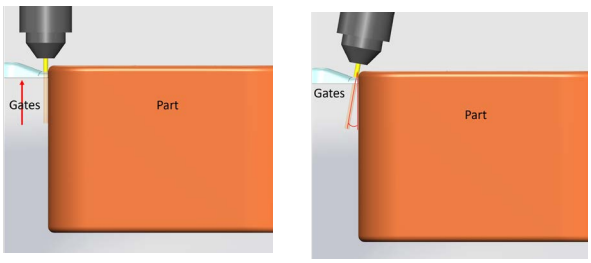

Figure 8 – Ideal gate design for plasma cutting

Proper placement of gates and runners can reduce collision risks and improve accessibility for plasma cutting, leading to faster production times and lower costs.

AI in automation

Automation can often be a challenge when there is a lack of part CAD models and fixtures. Foundries, in particular, experience part variability between the first part that is cast and the last part. Furthermore, consistently locating a part without proper fixturing is nearly impossible. These factors can make automation a challenge.

The latest in AI and cutting technology is a camera system that takes a photo of the part and creates a cut path along the identified area. Once the system understands where the part is and where it needs to cut, it can optimize for the cut process, create a robot program free of robotic errors such as singularities, joint limits, and outer reaches, and then generate the code that is automatically sent to the robot.

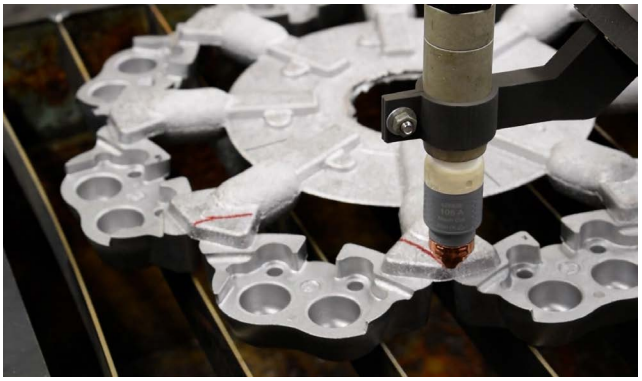

Figure 9 – Cast part that has been photographed, path created, and program generated using AI and automation.

AI can address the challenges foundries face with the lack of part models and fixtures and accommodate part variations. This technology enhances automation by reducing human intervention and improving accuracy.

Conclusion

The integration of plasma cutting, automation, and AI in foundries offers significant benefits, including improved safety, reduced costs, and enhanced productivity. Companies are encouraged to explore these technologies to optimize their operations and stay competitive.

For more information on how these technologies can be applied to your specific scenario, please contact us to discuss tailored solutions that meet your needs.

Learn more at www.hypertherm.com/solutions/applications/cast-trimming/