Making Sense of Flexible Cutting Solutions: Laser and Waterjet

By Clyde Braviere, Icon Machine Tool, Inc.

In an industry as competitive as sheet and plate metal fabricating, it is becoming more difficult to set your business apart from the rest. Your customers are placing higher demands on shops to be more competitive on price, lead times, and quality. The most successful companies are staying ahead of the game by adding the most technologically advanced CO_2 lasers and abrasive waterjets (AWJ) on the market. While lasers and waterjets have been used in the industry for years, the daunting question for engineers, estimators, and shop owners is which of these technologies makes the most sense for their projects. To start to make sense of which of these processes is right for you, you have to ask yourself some basic questions first.

WHAT MATERIAL WOULD YOU LIKE TO CUT, AND HOW WILL IT REACT?

This is the most important question on the quest of choosing a cutting system. The answer to this question can sometimes eliminate one process over the other immediately. Lasers are able to cut materials that have low reflective properties such as carbon steel, stainless steel, and thinner aluminum at very high cutting speeds. Even though most of today's laser cutting in the industry is in the ½" and below range, today's high powered lasers can cut up to 1" mild steel, 1" stainless steel, and 5/8" aluminum. Reflective and heat resistance/sensitive properties set the limitations and exclusions for laser processing materials such as copper, brass, and bronze.

Thickness limitations are not usually a problem for the AWJ. Maximum material thicknesses are determined by how high the cutting head is off of the material. It is not uncommon to cut 6-8" thick on the AWJ. Materials with reflective, conductive, heat sensitive and heat resisting properties become ideal candidates for AWJ processing. Inconel, titanium, and hastelloy which are very heat resistant and sensitive can be processed without affecting the material composition. The AWJ process can be superior when processing aluminum, copper, and brass due to their less dense and softer properties. Higher speeds, dross-free cuts, and lack of discolored edges are the benefits here. Non metals, such as rubber, thermoplastics, glass, foam, stone, carbon fiber, and ceramics, can be processed on an AWJ. Piercing of these non metals needs to be done with care as they are prone to chipping and fracturing due to their brittle nature.

The heat affected zone created by thermal cutting processes will play a role in the secondary operations on your parts. In steel cutting, a hardened oxide edge is the byproduct of laser cutting that can affect secondary operations such as reaming, tapping, and profiling with lower tool life and added labor. Welding and powder coating will be affected if all edges to be welded or painted do not have their contaminated oxide edges removed before work is done.

AWJ cutting is a cold process, where little to no heat is introduced into the workpiece. An AWJ cut part is ready for any of those secondary operations straight off the machine. Many machine shops employ this application to rough out piece parts and complete them by only making finish passes. Tool and die companies use this process to do the same and need only do a skim cut on their slow and expensive wire EDMs. The results are shortened overall processing times and extended tool life.

As today's metal market prices continue to escalate, it is paramount to be able to bill out every single pound of your stock material. Lasers and AWJs both process parts by simply following a programmed path that can be laid out on a sheet irrelevant to rotation limitations. Thus, they are both able to achieve higher sheet yields than most punching machines. When nesting a laser cut sheet, the programmer has to allow for a web between parts that can allow laser-generated heat to flow, in some cases, equal to the material thickness. Nesting parts too tightly can result in welding of the part back into the sheet or relieving too much of the stresses in that sheet primarily from heat buildup. The cold cutting AWJ process allows shops to nest parts more tightly than laser cutting since there is no heat. In most cases, the only limiting factor in nesting AWJ nests is its own kerf, which is typically .045" to .060".

WHAT IS THE ACCEPTABLE EDGE QUALITY AND TOLERANCE OF YOUR PART?

An AWJ usually pumps its water/abrasive stream through the part at the maximum rated pressure. The edge quality of the part is determined simply by the feed rate the machine travels. The maximum feed rate is merely a speed that the machine can make a material separation cut. This is a cut that is typically not an aesthetically acceptable quality, but for example, if the part were to have secondary machined features on it, the edge quality does not matter and you can let the waterjet cut faster. However, if the AWJ cut part is finished off the machine, a slower feedrate will produce a more aesthetically acceptable part. Most AWJs can deliver acceptable finished parts at a speed 40%-60% of the maximum separation cut speed.

Changing the feedrate with a laser will not produce a better cut, it simply will not cut. That feedrate is only one of the ingredients in the recipe of the laser process. However, operating with optimum parameters, the laser will have a smooth glass-like finish with very little vertical striation. These edges require little to no deburring or sanding.

Both systems can easily achieve tolerances in the +/- .005" range, but that is determined by the machine tool associated with the laser or AWJ.

Making Sense of Flexible Cutting Solutions: Laser and Waterjet - Continued

HOW FAST WOULD YOU LIKE TO CUT?

I want to cut fast! When it comes to sheet metal and thinner plate shape cutting, the laser has the speed advantage over the AWJ. Processing metals with a thermal tool such as a laser is much faster than an abrasive one, because heat leads to speed. With advancements in shop air cutting technologies, cutting speeds approaching 1200 ipm is commonplace. Total control over beam power, diameter and frequency during piercing can now get through the material faster than ever before. For example, lasers can now pierce through ¼" mild steel in 0.1 seconds and can even cut two 0.100" diameter holes in 1 second. Piercing through ½" mild steel can be done now with smaller piercing craters and little to no spatter on the surface of the workpiece.

However, when it comes to softer, less dense material, the AWJ has the edge. Aluminum that is able to be laser cut can be cut at speeds two or three times as fast on the AWJ.

WHAT IS THE COST LIMIT ON YOUR CUTTING PROCESS?

For that answer we need to look at the initial costs of the machines themselves and what they cost to operate. Let us assume we are looking at a 5'x10' table on both machines. We will also say we are comparing a 60k psi waterjet pump to a 4kW laser. A laser of this size and capacity can cost from $450k to $650k, and the AWJ can cost $150k to $200k. While that's a substantial difference, the operating costs can tell a different story. The laser will cost anywhere from $9.00/hr to $13.00/hr to run including electrical consumption, lasing gas, optics, resonator components, and consumables. The AWJ will cost anywhere from $25.00/hr to $32.00/hr including electrical consumption, flow through water, pump and cutting head maintenance, consumables, and the abrasive medium. The biggest difference in cost between the two systems is electrical consumption and maintenance. AWJs use far more electricity to run the pump than the entire laser machine, and require more hands-on maintenance. That does not mean that a laser cutting system is maintenance free, but it is not subject to the same mechanical forces as an AWJ. You see, the good thing about a waterjet is it cuts everything, but the bad thing about a waterjet is it cuts everything – including itself. Let's face it, anything that comes in contact with the forces needed to generate the AWJ's 60k psi, will wear out quickly. High pressure seals, hydraulic components, water and abrasive delivery lines, and nozzles need to be replaced often.

The laser's main enemies are heat and contamination. Maintenance on the laser is designed to combat the effects of heat applied to and contamination of optics. Water is the life blood of any laser system. Used as a vehicle to remove heat from resonator components and optics, it runs throughout the machine. A laser that cannot dissipate its own generated heat will not be up and running for long. The system's chillers require a careful eye to measure the level and purity of the water. Contaminated or dirty optics will be a quick downfall for the laser. Periodic examinations of the optics ensure the machine is delivering all the energy into the workpiece, and not absorbing it.

WHAT IS THE BEST SOLUTION FOR MY COMPANY?

We have looked at a few of the determining factors in choosing a cutting solution that makes sense for your facility. Lasers have the speed advantage and require less maintenance. AWJs offer much more material capacities and have benefits in secondary operations. While these machines process materials in different ways, they are extremely flexible complimentary systems. But maybe you are still not sure what to do next. This is not always an easy decision. Icon Machine Tool's team of qualified sales engineers are here to help. Please contact us today to evaluate your manufacturing process and give you the edge you need.

About the author

Clyde Braviere has been in the precision metal fabricating industry for over 10 years. Holding positions including technician, programmer, and operator for lasers, punching and press brake, production manager, estimator, and sales has given him the experience necessary to provide solutions and service to today's competitive industry.

Contact us at 314-277-6602 or visit our website www.iconmachinetool.com.