COMPARATIVE CUTTING: WATER JETS, LASERS, AND PLASMA

Rapid advances in technology can make it quite difficult to decide which cutting method is the most beneficial for your shop and your applications. Hopefully the following discussion can be used as a guide to help you decide what type of cutting system to purchase based upon comparisons against material type, thickness, accuracy, cutting speed, operating cost and capital investment for each process.

Plasma Technology

Plasma cutting burns or melts through material using a high temperature ionized gas arc. A high velocity jet of plasma is delivered to the work piece so that the electrical arc can melt the metal. The gas is used to blow the molten material away.

This technology cuts ferrous and non-ferrous materials, but it is primarily best for cutting steel, stainless steel and aluminum. It performs best when cutting through thicknesses of 0.040 in to 1.25 in for mild carbon steel and 0.040 in to 5 in for both stainless and aluminum. Plasma applications have a mediocre to good surface finish and operate within a large heat affected zone (HAZ). High definition plasma uses higher amperage (up to 1000 amps) and improved nozzle technology to produce better cuts.

The standard process performs fair to good on fine feature cutting. Plasma tends to create large kerf with potential dross, depending on cutting speed, arc current (amperage), gas selection, and the type and thickness of metal. Too high or too low a cutting speed causes dross, but typically a “window” exists that provides dross-free or minimum dross cuts. Undesired beveling angle and taper may occur on corners and bevels, depending on torch squareness, the direction of the cut, standoff and cutting speed. For all of these reasons, secondary operations may be required.

Plasma cutting speed is typically very fast, and additional cutting heads can be added to increase the net feed rate across the surface area of the material. Higher power provides faster cutting capabilities. However, plasma is limited on thickness of cut, and it is not possible to stack materials. With a capital investment of about $60k to over $300k, the typical cutting tolerance for plasma is .015 in to .030 in. For a high-definition process that tolerance narrows to .010 in to .015 in.

Laser Technology

Laser technology melts through materials using the heat generated from a concentrated light beam. With a focal point of 0.05 cm, a 4 kW laser develops an intensity of 2.1 MW/cm2. Though best suited for cutting steel, stainless and aluminum, lasers can also cut a variety of other materials that fall generally in thicknesses of 1 in or less. A good to excellent surface finish can be achieved with a small HAZ.

The most popular laser technologies are solid state and CO2 in power ranges from 1.5 kW to those that use powerful 6 kW resonators. Lasers achieve good to excellent fine feature cutting with very small kerf. Also, a small amount of dross may be present, meaning secondary operations often are not required. Cutting speed is fast to very fast on material thickness less than ¼ in, especially steel.

Lasers are limited in their ability to cut thick material. For example, they can cut mild carbon steel up to 1.25 in, stainless steel up to 1 in and aluminum up to 0.75 in. They also experience process limitations due to their reflective and thermal conductive properties when cutting aluminum, brass, copper and titanium. A capital investment in this technology can run from around $400k to over $1 million for a typical cutting tolerance of .001 in to .003 in.

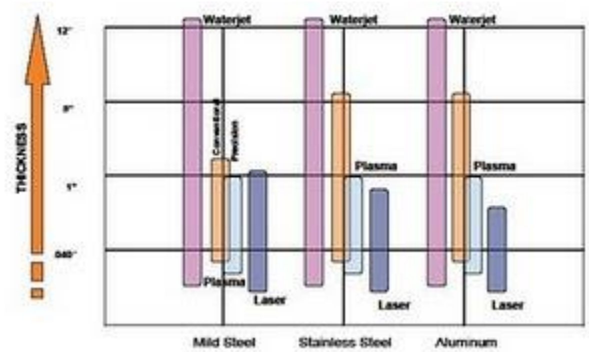
The Heat Affected Zone (HAZ) develops when metal is melted by the cutting process. The metal microstructure changes and develops microcracks and hardening. Slag formation and thermal deformation can develop. Structural components subject to large loads could experience catastrophic failure under a load stress. Hardening and slag formation cause excessive machining tool wear on secondary operations.

Waterjet Technology

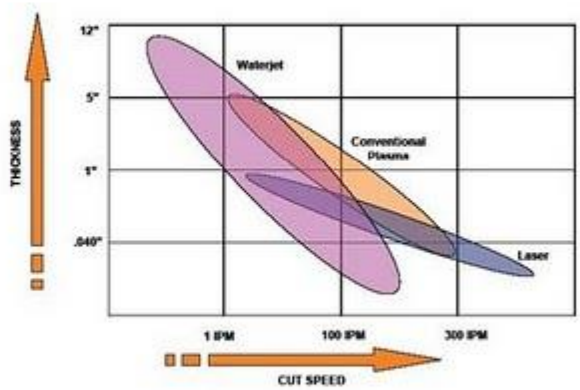
Waterjet machining is an erosion process that operates like high-speed liquid sandpaper. Virtually any type of material, up to 24 inches thick, can be cut using a waterjet. This process typically gets a good to excellent surface finish with no heat affected zone. It performs good to excellent in fine feature cutting, with small kerf and no dross.

Angular compensation technology in waterjet processes provides greater part accuracy and faster cutting. For this reason, secondary operations are often not required. Waterjet cutting speeds are moderate to fast, depending on material thickness and machinability. The cutting head can significantly increase net cutting speed. By increasing the flowrate for higher pressure, cutting speeds get faster. Multiple cutting heads increase the net feed rate and stacking thin sheet material increases net cutting speed and net productivity.

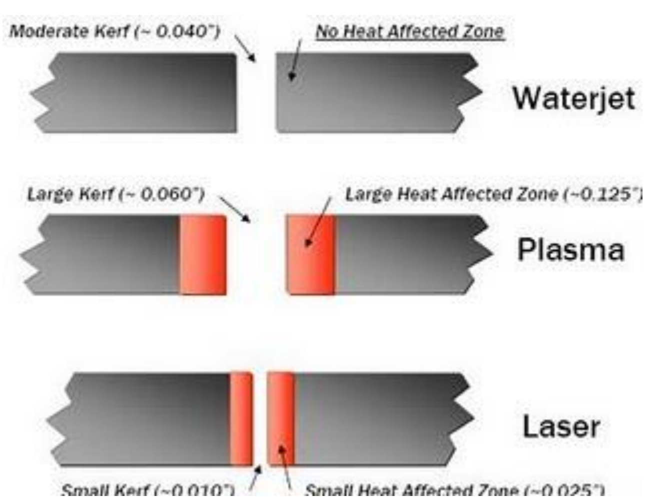
Increased kinetic energy transfer in the abrasive particles results in more effective and more efficient use of the abrasives for cutting. Waterjet is versatile enough to cut any material at any thickness. In fact, it can cut thin gauge sheet metal over 24 inches thick. Capital investments typically range from $60k to over $300k for a standard cutting tolerance from .003 in to .005 in. A precision tolerance process narrows down to .001 in.

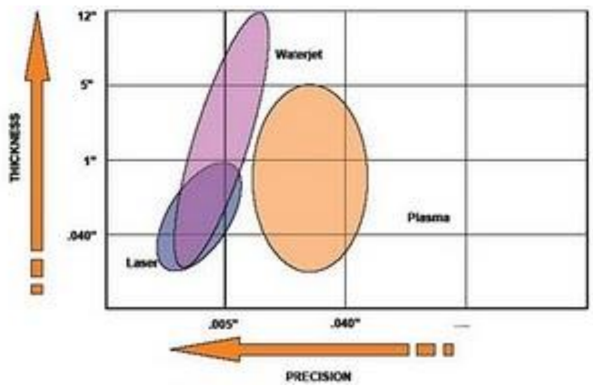


Process application by thickness and material type

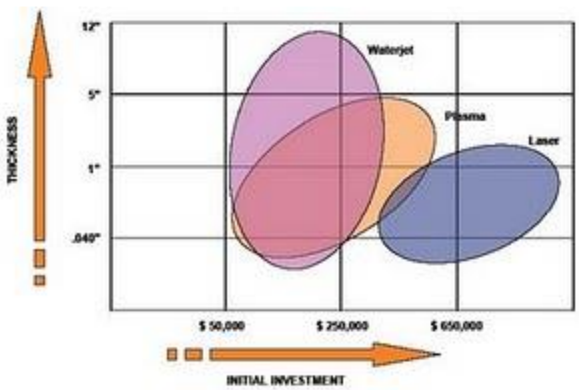


Process application by thickness and cut speed.





Process application by thickness and precision



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