Selecting the Right Waterjet for Your Operation

Growing Popularity Of Waterjet

The waterjet process is recognized as one of the most versatile and fastest growing cutting processes used in manufacturing across the globe. Waterjet complements or replaces other technologies such as milling, laser, EDM, plasma and routers. Because of its many advantages, waterjet is fast becoming the process of choice for many fabricators and machine shops.

These benefits are driving increased adoption of waterjet cutting technology. Its versatility, quick set up, easy operation, and high quality part production make it an ideal choice for any manufacturing organization looking to reduce costs and improve efficiency.

Getting Started

While making the decision to incorporate the waterjet process into your operation may be clear, selecting the right machine configuration requires some evaluation. You need to assess the requirements of your business and customer base and balance that with the practical concerns of space, personnel capability, and budget.

This paper will help guide you through the decision-making process by providing questions you should be asking to help you select the appropriate waterjet system.

What materials are you cutting?

The first step in determining the right waterjet is to define the kinds of materials you work with or plan to work with in your operation. When it comes to materials, the major considerations are: current and potential future material types, material stock size, material thickness, and part shape (flat, bevel, or 3D).

Types of Material

A good place to start is to determine what materials you work with 80% of the time. For many job shop contract cutters, mild steel might be more typical, but cutting less common materials such as titanium, glass, steel alloys, or stone can really allow the waterjet process to shine and yield higher margins

The versatility of waterjet is key here.

The ability to use the same equipment for all materials greatly enhances machine utilization and your return on investment.

Pure Waterjet

Handles soft materials that can be cut with a knife: gasket, foam, and plastic.

Switch between Pure and Abrasive with a simple two minute head conversion.

Abrasive Waterjet

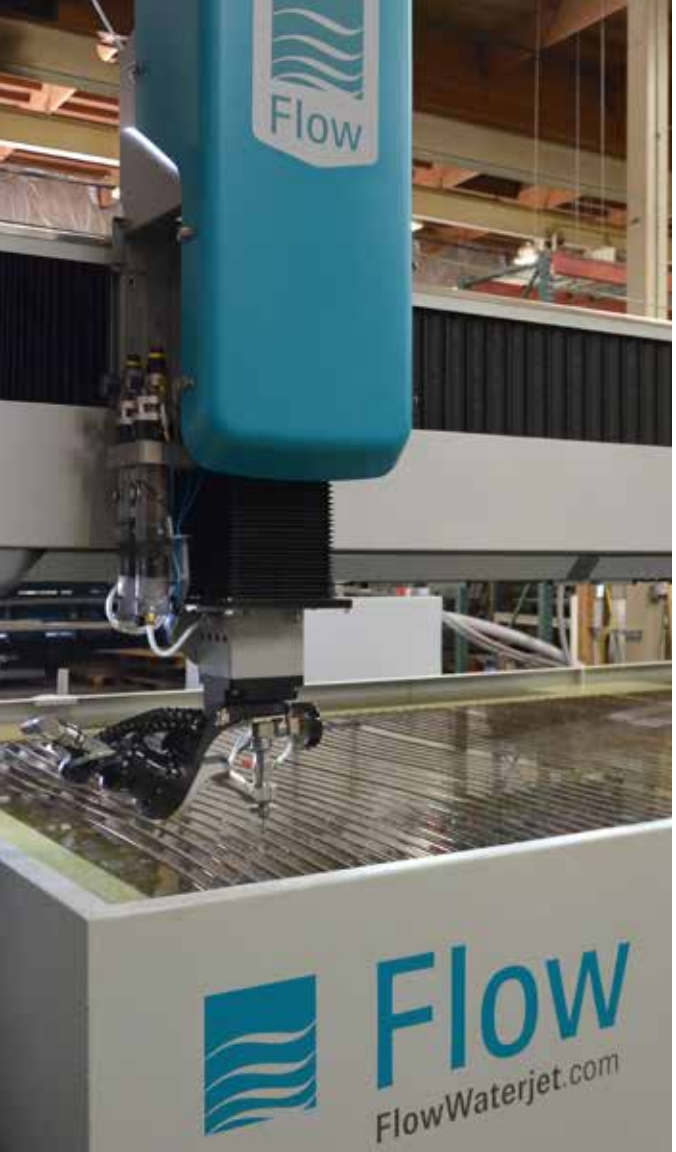
Handles tougher materials: metals, glass, stone, and composite.

Material Size and Thickness

The size and thickness of the materials you intend to cut determines the power and number of cutting heads, the pump requirements, and the size of the work bed you'll need. Thin sheet metal under .25" (< 6 mm) and especially down to the 8-12 gauge level can usually be stacked and cut with waterjet to increase your production – and profits. Optimal thickness for stacked sheet material is approximately 0.6" (15 mm) regardless of sheet thickness.

If the thin material is not stackable because of small batch size, you can improve efficiency by putting power through two cutting heads with smaller jets. With thin material, you don't need larger jets because, surprisingly, they don't cut much faster than smaller jets. However with thicker material over .25" (6 mm), going to a larger single head and increasing horsepower increases cut speed proportionally.

The size of the work bed, or material support catcher, should be big enough to handle the largest sheet or plate that you commonly cut. An occasional oversized piece of material doesn't justify an enormous and expensive machine tool since you can hang larger material off an end of the catcher. Although not optimal, it is a more cost effective solution.



If you plan to cut metal and/or stone, the most common sheet and plate sizes often dictate a 6.5 x 13 ft. (2 x 4 m) work bed size. In North America, aluminum is sometimes available in 12-foot lengths, so the 13 ft. bed allows for easy loading. Similarly, the 6.5 ft. wide bed accommodates stone slabs that are sometimes delivered with a width of 6 feet. You should get a work bed slightly larger than the stock material you intend to cut so that loading and fixturing is easy. It is not surprising that the most common machine size is 2 x 4 m, or 6.5 x 13 ft., since this size covers nearly all North American and European material plate sizes. A less obvious reason to obtain a relatively large work bed even when cutting smaller stock material is that the large bed provides room for installing multiple, semi-permanent tooling locations to enable quick changeover from one job to another.

If you're cutting brittle materials like stone and glass, you should equip your machine with UltraPierce™, a vacuum assist device that allows piercing of these materials without breakage.

Typical Customer Decision

Consider a shop currently doing a lot of mild steel fabrication work. They have a large bed plasma table, welding equipment, bend and break equipment but they don't have CNC chip making equipment (mills or lathes). Because the common, relatively lower tolerance fabrication work is extremely competitive, they decide to add a waterjet to expand to more material types and greater thickness and to eliminate grinding off of the heat affected zone left behind by the plasma cutter that is required on many of their jobs. They believe they can cover the workload in one shift.

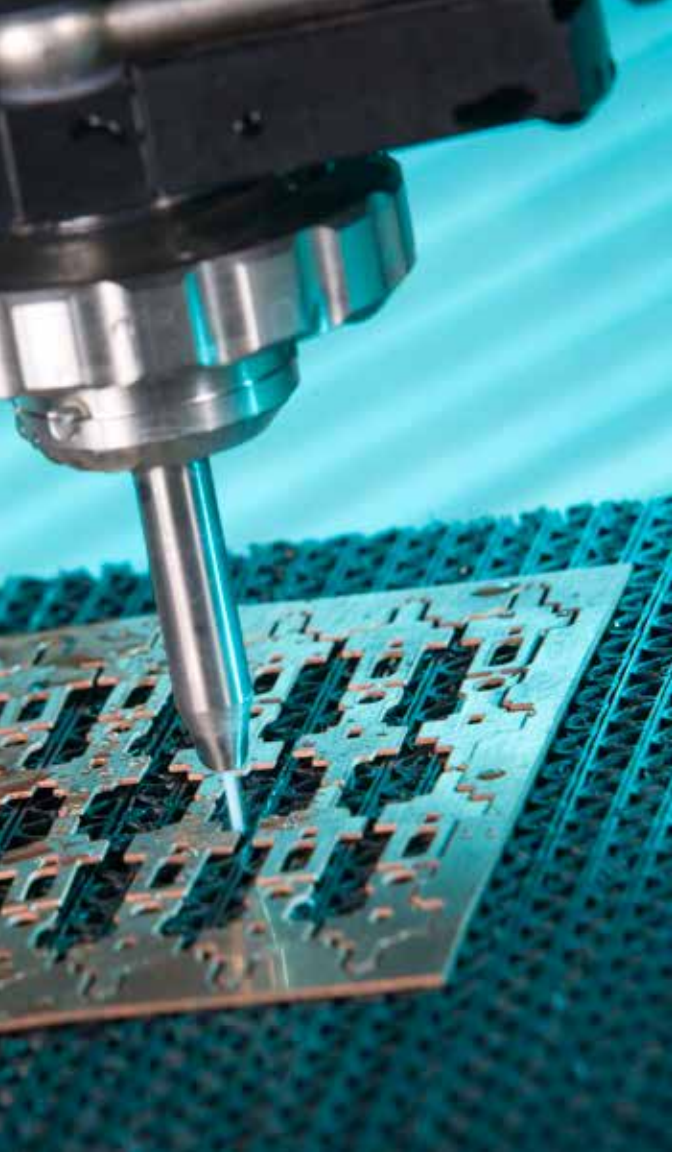
As a fabricator, they are used to working with large plates, utilizing an overhead crane and fork lifts to load any machine easily. They work with steel and sometimes aluminum sheets and plates up to 1 inch (25 mm), with the most common between 1/8" and 3/8" (3 to 9 mm) thick. They very rarely work with material thicker than 1 inch. They purchase stock material in sizes 4 x 8 ft., 5 x 12 ft., or occasionally 5 x 20 ft. (1.2 x 2.4 m, 1.5 x 3.6 m, or 1.5 x 6.1 m).

They have room in their shop for a medium or large waterjet so this fabricator would likely choose a unit with a minimum bed size of 6 x 12 (1.8 x 3.6 m) because nearly all plate sizes can fit on the table. When they need to work with an oversized plate they can hang it over the edge (safely with proper support) to work on one end, or cut it in half on the plasma. The incremental cost of going from a 4 x 8 ft. to a 6 x 9 or 6 x 12 ft. table is small. However moving up to a 6.5 x 24 ft. (2 m x 7.3 m) table is more costly. They also decide to forego investing in a heavy-duty catcher capable of holding a 6 inch thick piece of material since they had never worked with material thicker than 1 inch in the past. On the rare chance such a need arises, they could support the material with blocks to enable thick cutting.

In the end, they choose a single head 6.5 x 13 ft. (2 x 4 m) machine with medium power (50 hp) because they know they can upgrade later to a larger sized pump and add a second head when productivity becomes key.

What level of precision do you require?

Another factor to consider when choosing a waterjet is the level of accuracy and tolerances you need.



Most operations are either fabrication or machine shops. Each have different needs when it comes to the level of cutting precision required. In general, machine shops normally need more accuracy than fab shops but some shops have both the precision chip making equipment of a machine shop and cutting, forming, and welding equipment of a fab shop.

Flow waterjet systems are available with different levels of precision capability. A machine tool equipped with a basic waterjet cutting head, sometimes called a conventional waterjet head, can cut a +/- 0.005" accurate part out of any material up to approximately three inches thick. Beyond that the finished part accuracy will be less. To cut to +/- 0.005" (+/- 0.13mm) tolerance with this conventional head the machine cut speed must be reduced to approximately 15% of maximum cut speed. This slow speed is needed to minimize corner washout caused by stream lag, and part taper caused by the V-shaped kerf created by the jet at high speed. Slower cutting reduces these errors, but takes longer so is more expensive.

Most systems Flow provides are equipped with Dynamic Waterjet® with Active Tolerance Control. Dynamic Waterjet is patented technology that automatically tilts the cutting head impingement angle to compensate for stream lag and taper in a behind the scenes operation based on cutting speed and type of material being cut. The result is two to four times faster cutting and finished part precision of +/-1 to 3 thousandths of an inch

(+/- 0.03 to 0.08mm). The technology allows the machine to move very fast, create a taper and stream lag, and then compensate for it automatically by tilting the head by up to 10 degrees.

In summary, the precision parameters are:

Conventional Waterjet
+/- 0.005 to 0.015" (+/- 0.13 to 0.4mm) finished part accuracy

Dynamic Waterjet®
+/- 0.001 to 0.003" (+/- 0.03 to 0.08mm) finished part accuracy

Dynamic XD®
same accuracy as Dynamic Waterjet, except provides bevel and 3D cutting

Typical Customer Application

To illustrate, consider an operation that started out as a fab shop with laser and forming equipment, then over the years added machine shop equipment such as CNC mills and lathes. They decided to purchase a Dynamic XD because as a fab shop they wanted the bevel capability and they knew with waterjet they would never have to grind the edge for weld prep or painting. They also wanted the high precision of Dynamic Waterjet because they found they could greatly simplify or eliminate some welding jigs by cutting high precision parts with interlocking notches on the waterjet.

Lastly, they knew the higher precision would complement their machine shop. By doing the initial cutting on the waterjet to a couple thousands of an inch and then finishing the part with pocket milling and hole tapping they would significantly improve throughput.

What kind of operation do you have?

In addition to the type of materials and amount of precision required, you must also consider the overall operation of your business. Workload, staff talent, type of jobs you will likely run, and facilities all play a role.

Utilization

A key factor is how many hours and shifts per week you intend to run the equipment. If you're planning to operate four hours a day or one shift a week, then it may not make sense for you to invest in the fastest, most powerful waterjet. Instead of investing in a larger HyperJet® pump to increase speed, you're better served selecting a simpler, energy and space efficient, direct drive HyPlex® pump. You'll still get the necessary work done, but at a lower capital expense.

In general, all shops would prefer to complete their work with fewer shifts. If a faster, more productive waterjet machine can reduce two shifts of work to one, the labor, overhead, and machine operating cost savings are significant and will dramatically improve your ROI.

If you have the work for more than one shift in a growing business, your best bet is to invest in a machine that will deliver high output such as a Dynamic Waterjet with a HyperJet pump. These two upgrades will vastly improve throughput. With a HyperJet pump, Dynamic Waterjet, produces parts two to four times faster than conventional waterjets. HyperJet is an intensifier based pump (as opposed to direct drive) that increases water pressure to 94,000 psi, from the 50,000 to 60,000 psi of typical intensifier or direct drives pumps. The higher pressure increases efficiency and productivity enabling faster cutting with significantly less abrasive. This allows more work output and approximately half the abrasive to load and unload — a significant value to a shop running multiple shifts.

Cycling

Another consideration is your requirement for cycling — the number of times a jet turns on and off. Higher cycles create slightly more pump fatigue and wear. The intensifier pumps, whether 60,000 psi or 94,000 psi, tend to be more resilient to fatigue and wear associated with cycles than HyPlex direct drive pumps.

Operators and Maintenance Staff

It's important to review the proficiency and skill levels of your operators, programmers, and maintenance staff. Are your operators capable of programming? If not you may want to invest in an intelligent control system designed specifically for waterjet. These controls often have been optimized to know how to cut materials, pierce holes with proper lead in and lead out entities, and other techniques that help programmers and operators cut parts effectively. These intelligent CAD/CAM/Controls are designed specifically for waterjet and are often much easier to learn than the more complex CAM to CNC based systems.

If your operators are going to be multi-tasking and the waterjet will be running unattended at various points of the day, you should include diagnostics and sensors to protect the machine and the parts you are cutting. For example, a part recently cut might tilt upwards slightly, catching the waterjet nozzle tip as the machine moves from the end of one cut path to the start of another. Collision and height sensors are

designed to detect and prevent collisions and obstructions that could damage the cutting head. When a collision is about to occur, both the waterjet stream and cutting head motion will stop until the impasse is removed and the machine told to resume.

Proper maintenance of any machine tool is key to uptime. Today it is common to handle basic maintenance issues, such as replacing a mixing tube or adding garnet to the system, in house and then rely on a service contract for preventative maintenance service. Purchasing additional OEM service contracts can be a wise investment and will maximize uptime and ensure peak performance of your system.

Facilities and Utilities

Finally you need to consider the physical capabilities of your plant and whether they can support the system you choose. These issues include available floor space, power, water, compressed air, drainage, material storage, material loading, clean room area for high-pressure maintenance, and programming office area.

There are several waterjet configurations that can reduce the necessary footprint for the system. For example, Flow offers integrated units with a pump located inside the machine. In other cases, the pump can be located remotely to free up the floor space immediately surrounding the machine while still having all pump control features and diagnostics present at the operator control station.

Real World Application

For example, consider a machine shop that had been outsourcing waterjet for years but because of an increase in cutting demand, decided to bring waterjet capability in house. They had the selected OEM give cycle time estimates for a number of their parts so that they could accurately determine their throughput requirements. With the help of the OEM running data on different pressures (HyperPressure™ vs. normal pressure), Dynamic Waterjet, and number of heads, they established the following: An estimated need of about 35 hours of "jet on" time per week with an entry-level machine powered by a HyPlex direct drive 60,000 psi pump and conventional cutting head. The typical material was ½ to 4 in. (12 to 100 mm) stainless steel, nickel alloys, aluminum, and titanium, and their raw material stock sizes were fairly small.

They opted for a 4 x 4 ft. Mach 3b machine with an integrated pump to minimize floor space. They chose a Dynamic Waterjet to ensure faster cutting and high precision. Although they were dealing with plate material (as opposed to sheet material) and could have chosen the HyPlex 60,000 psi rated pump (4,100 bar), they went with the HyperJet 94,000 psi rated pump (6,500 bar) to reduce abrasive consumption and provide even faster cutting.

They decided on a small system because they were a machine shop dealing with relatively small material sizes. However they were dangerously close to needing a second shift and they knew they were better off spending a little more to increase cut speed and avoid the need for a second shift. They calculated that just one month of a second shift would pay for the advanced features the Dynamic Waterjet and HyperJet provided.

What is your available equipment budget?

The advantage of waterjet is that there is a system available to fit almost any budget. Understanding your needs and matching that to the appropriate waterjet solution is the best way to maximize your capital equipment dollars.

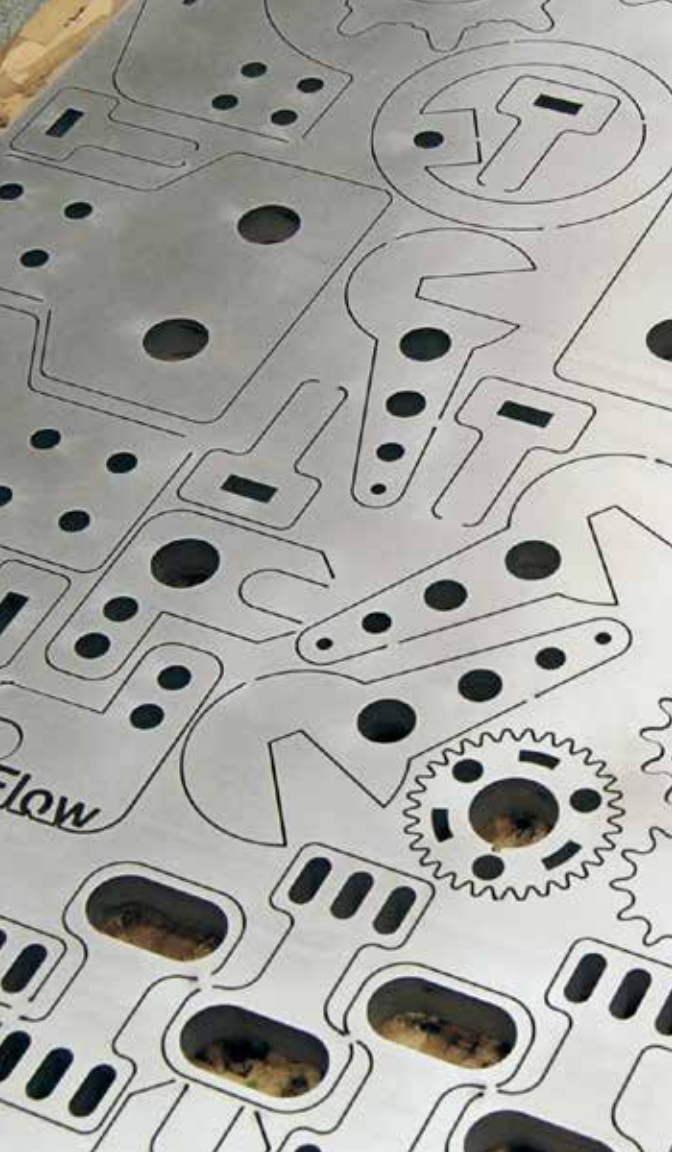
In case of a limited budget, you can purchase a smaller unit now, and then upgrade to a faster system later as the workload builds. Many systems can receive upgrades in pump size, pump pressure, and cutting head technology (for example, conventional waterjet head upgraded to Dynamic Waterjet or a HyPlex direct drive pump upgraded to a HyperJet pump).

Real World Application

To illustrate, take a shop looking into waterjet. They find machine tool options of $70,000 to $130,000 for an entry-level machine, such as the Mach 2, to $125,000 to $180,000 for a typical Mach 3 machine, to over $200,000 for a Mach 4 machine. By working with an OEM providing a full range of products like Flow, they can determine an appropriate solution that meets their needs and fits into their budget.

What else should you consider?

There are a number of other issues to think about when choosing the right waterjet for you.



Nesting

If your workload includes a requirement to cut a number of different parts on one sheet you may need a nesting package. Waterjet specific nesting packages are reasonably priced, simple to operate and include full geometric nesting capabilities. Unless you want to tie your nesting package into your ERP system, or program for more machines than just the waterjet, these simpler waterjet nesting packages might be a better option than large generic nesting packages.

Brittle Materials

If you're going to be working with brittle materials, it makes sense to include Flow's optional and patented UltraPierce™. This package allows the standard cutting heads to accept a simple attachment that easily enables piercing of brittle materials like stone, glass, carbon fiber composites, and fiberglass without damaging the material. In effect, it pulls abrasive through the head a split second before the waterjet turns on to ensure the first bit of water that hits the brittle material is cutting, rather than just smacking, the material.

Environmental Concerns

Closed loop water filtration systems are available to eliminate the need to send water down the drain. Manual clean up and emptying of the catcher tank can be avoided by contracting a vacuum truck to remove the waste material. Alternately, you can get a continuous waste removal system that sends material waste directly into a dumpster.

Summary

Selecting the right waterjet requires buyers to understand the technology so they can wade through the hype and deal with facts. Working with an OEM who provides all pump models, head technologies, machine configurations, and price ranges allows for informed consultation that matches equipment to needs. As the world-leading waterjet machine tool supplier, Flow Waterjet offers the widest range of products to meet your waterjet cutting needs. We make small, entry level machines for simple production, higher end waterjets for intricate five axis cutting in high production running companies, and specialized equipment addressing unusual applications for companies such as Boeing composite wings and Kimberly-Clark disposable diapers.

Options Summary

Choosing the appropriate waterjet solution involves making a series of decisions. Here is a quick checklist to help summarize your options:

Cutting Systems

- Mach 2 – The Essential Waterjet
- Mach 3 – The World's Most Popular Waterjet
- Mach 4 – Years Ahead
- Advanced and Custom Systems for specific applications

Pump Technology

- HyperJet 94,000 psi for more efficient cutting using less abrasive. Fastest and easiest maintenance
- Intensifier 60,000 psi is the original pump used since the beginning of waterjet
- HyPlex Prime 60,000 psi for more efficient cutting as related to input power to nozzle power
- Horsepower range from 25 to 200, with most common machine tools running between 30 and 100 hp.

Accessories

- Dynamic Waterjet with Active Tolerance Control
- Dynamic XD (the power of Dynamic Waterjet for flat, bevel, and 3D work)
- Paser 4 Abrasive Waterjet Cutting System
- UltraPierce Vacuum Assist for the piercing of brittle materials
- Dynamic Contour Follower with height sensing and collision sensing
- Laser Edge Finder for quick, visual part location
- Filtration Systems for preparing waste water for drain or recycling waste water for cutting
- Waterjet Brick to help cutting of pure waterjet parts or small abrasive waterjet parts
- WaterVeyor Abrasive Removal System

Our application engineers are available to answer any questions or review your current manufacturing issues to see if waterjet might be right for you.

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