Fast, Clean Cutting with Abrasive Waterjet Technology

Waterjet systems are offering machine shops more productivity options with the latest high-speed cutting and improved software capabilities.

Patrick Waurzyniak
Senior Editor

Abrasive waterjets are versatile alternative metalcutting systems using a cold-cutting process that cleanly and quickly cuts metal and many other materials without any heat-affected zone (HAZ). The abrasive waterjet machines cut not only thick metals, but also are used for easily slicing through stone, granite, glass and foam materials, making the process a good choice for many metal-fabrication job shops.

The latest advances in waterjets include faster cutting speeds for higher productivity, and new software that improves waterjet systems’ precision and the overall reliability. Today’s abrasive waterjets typically boast high-pressure pumps that can reach 90,000 psi (621 MPa) or higher for speeding up the cutting process and improving job shops’ part cycle times.

Customers looking for waterjet systems today are interested primarily in productivity, reliability and service, noted Chip Burnham, vice president, marketing, Flow International Corp. (Kent, WA). “All machine tool users need these features. Our new products are designed to provide that,” Burnham said, “and Flow has focused our products and services on these three basic needs.”
Fast, Precise Cutting

Among some new refinements, Flow’s latest lineup for 2017 includes enclosed machines ready for machine shops or high-volume work, Burnham noted. “Software is improving radically on Flow machines [including 3D model-based software], small details like advanced contour followers with collision sensing are helping uptime, and last but certainly not least, Flow is now offering very comprehensive service offerings that maximize uptime,” Burnham said. This includes providing high-pressure units on an exchange program, he added, or performing all maintenance with parts, if preferred.

Flow’s 2017 lineup includes the Mach 500, the first of a new family of next-generation machines. Burnham said the new Mach 500 released at IMTS is faster and quicker than the company’s previous systems. “Quickness is key, as Flow waterjets can produce high-precision parts to great detail [0.015” (0.4-mm) inside radius is common]. The acceleration/deceleration capability of the machine, the g’s it can pull, are paramount when cutting detailed parts,” Burnham said. “Part cycle times have proven to be shortened by up to 30% for complex geometry—the kind of geometry that Flow waterjets handle daily.”

The latest systems from waterjet builder OMAX Corp. (Kent, WA) continue to push the boundaries of waterjet accuracy and precision, said Stephen Bruner, OMAX vice president, marketing, with the launch of the company’s next-generation MicroMax micromachining waterjet system. “The MicroMax uses advanced high-precision linear encoders, innovative vibration isolation, and proven software control systems,” he said. “The MicroMax is capable of a positioning accuracy of less than five microns while retaining all the advantages of abrasive waterjet machining.”

Bruner said the Intelli-Trax drive system used in the ultra-precise MicroMax is also used on the OMAX and Maxiem line of waterjets. “The MicroMax comes standard with our patented Tilt-A-Jet cutting head to eliminate taper,” Bruner said. “The product offers options like a catcher tank cooling package, our Precision Optical Locator accessory, our solids removal system, and many configurable cutting bed options.”

In addition to precision and accuracy, customers are looking for reliability and ease-of-use, he added. “We’ve engineered our EnduroMax pump to last 1000 hours between major rebuilds and continuously improve our system designs and software so that operators cut parts faster with less setup.” Another innovation is the addition of OMAX’s Large Solids Removal System (LSRS), which is designed for the larger OMAX and Maxiem JetMachining Centers. “These large tables, some of which can cut parts nearly 50’ [15-m] long, are production workhorses for large OEMs around the world, and uptime is critical,” Bruner said. “The LSRS is designed to remove high volumes of spent abrasive in order to reduce machine downtime for tank cleaning, keeping these systems operating at peak efficiency.”
Innovations in waterjet technologies are focused around increasing either machine capabilities or throughput, noted Scott Wirtanen, Northeast regional manager, Jet Edge Inc. (St. Michael, MN). “With our X-5 contour beveling and Taper Angle Control, or TAC, we can now produce multiple bevels and hold very straight edges or nearly any material and thickness,” Wirtanen said. Some examples are weld prep bevels, chamfer holes, beveling two sides of a plate at once, and multiangle beveling, he said.

“Using multiple heads increases productivity in a linear way. When we add a cutting head, we double the production, three heads equals 3x improvements,” he added. “Waterjet is a slower process in comparison to laser or plasma, for example, so adding this capability along with the flexibility of processing a much wider range of materials and thicknesses is what makes a Jet Edge system so attractive to customers.”

When processing materials with a single cutting head, higher pressures can achieve 35% faster cutting speeds, he said, and the Jet Edge XP pumps with 90,000-psi capability provide that ability. Refinements are always being made to the three most critical aspects involved in abrasive waterjet (AWJ) technology, added Dave Anderson, Jet Edge international sales manager, which include “the UHP [ultra-high-pressure] pump, XYZ motion system, and the CNC control system that uses various computer software programs needed to operate it.

Software is a critical part of all waterjet performance since it affects precision, speed and ease of operation.

“It’s not new, but at Jet Edge we design, engineer, and build all three of these crucial parts of the waterjet system to work together smoothly and safely with each other, they are all interconnected,” Anderson said. “Much like your heart, brain, and the circulatory and nervous systems of your body are all interconnected, you want them all made to work together by the same company.”

Software Leads the Way

With most waterjet suppliers, software innovation also leads to more precise, productive cutting processes. At IMTS, Flow introduced its new FlowXpert 2016, which leverages the 3D-modeling capabilities of SpaceClaim software through Flow’s partnership with simulation software developer Ansys Inc. (Canonsburg, PA).

“Flowjet technologies like OMAX’s IntelliCAM enables easy 3D path creation for waterjet cutting operations.

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“Advanced yet simple interface,” Burnham said. “The pathing and part sequencing function is a ribbon selection atop the menu bar of the model software. This integration reduces countless steps, and allows a strong geometry-to-path linkage between the shape and the waterjet path program. The end result is the easiest to use, smartest, and most productive programming software we’ve ever offered.”

Flow also released its Compass contour follower and collision sensor, he added. “What is unique about this product is that Compass tracks the actual surface through an articulation of the height tracking ring,” Burnham said. “It’s hard to explain in words, but traditional height setters have a horizontal ring that touches the material. When running up a slope the outside edge of the horizontal ring touches the material, and the nozzle tip will be lifted up by the sine of the angle. This can cause surface frosting and kerf width errors,” Burnham stated. “But if the cutting head is angled to 45° to cut a bevel, then every millimeter that the head is lifted off of the desired point creates an error of that same amount, a 1-to-1 error.”

Compass has a special articulation that makes sure the ring will angle and articulate around the tool center point, he said. “If you cut a 45° bevel with Compass in action, the nozzle tip will stay at the desired 0.100” [2.54-mm] standoff at all times, allowing for a high-precision part to be cut.”

Software is a critical part of all waterjet performance since it affects precision, speed and ease of operation, OMAX’s Bruner said. “It can also provide valuable predictive data such as how much abrasive will be used for various edge quality and cutting speed settings so you can optimize for your specific needs. Our fourth-generation cutting model empowers our software to calculate the best cutting strategies for part quality, geometry and material. It provides comprehensive predictive data, reporting capability and maintenance information so you can keep production moving.”

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OMAX continues to refine the cutting model to achieve optimal part accuracy, speed, and resource utilization, such as power and abrasive, Bruner said, and the OMAX software supports over 90 different file formats so customers can use a variety of CAD products.

Continuous improvement cannot be overestimated on the software side, noted Jet Edge’s Wirtanen. “After introducing our X-5 beveling capability, the Bevel Zone product for our HMI or controller was critical. Also, additional improvements were necessary to the HMI to handle the complex movements when adding two additional axis for a total of five,” he said, adding that partnering with waterjet software developer IGEMS (Borås, Sweden) enables the company to offer customers the best Jet Edge products.

“It is important that the different waterjet computer software programs available continue to develop side by side with our equipment improvements to allow our customers to easily operate the system and achieve the results they want quickly with a high degree of accuracy and repeatability,” noted Jet Edge’s Anderson. “This allows them to make a good profits with their waterjet machine and then they keep coming back to us when replacing or adding additional machines.” Five-axis cutting software continues to improve, he said, as does 3D pipe and tube cutting, laser material mapping, material nesting and placement with the use of a CC camera connected to the cutting software.

Software development is extremely important in waterjet cutting, said Arion Vandergon, product application engineer, Hypertherm Inc. (Hanover, NH). “While pump technology can improve water pressure and signal being delivered to the cutting head and reduce the cost of pump operation, software is important to provide consistent high-quality parts as fast and efficient as possible,” Vandergon said.

Hypertherm recently launched support within its ProNest and Phoenix (CAM and CNC software) to allow the use of E-commands, he noted. “E-commands are used to provide a controlled acceleration or deceleration into and out of corners to provide smooth speed transitions. In the past, speed steps were often used to ramp down speed into corners and ramp up speed out of corners,” Vandergon said. “This method separates a section of the line into and out of a corner into smaller segments. Each individual segment is assigned a speed. The machine acceleration and deceleration settings control the ramping between segments. Under certain circumstances, stepped corner ramping can be visible on the part.” E-commands change this method of ramping to a controlled acceleration or deceleration so that the ramping segment and resulting corner has no speed transition marks.

In addition to E-commands, there are other software developments to optimize the delivery of abrasive to the cutting head, he said. “These developments involve timing the abrasive on-and-off signals to make sure that abrasive arrives at the cutting head at the same time the head is turned on [important when piercing fragile materials],” Vandergon said, “as well as making sure all abrasive is cleared from the head prior to turning off the cutting head [important to avoid clogging].” Hypertherm Phoenix software can automatically calculate the proper timing based on the length of the abrasive feed line and the length of the cutting head air supply line.

“Pierce optimization is also important in waterjet software to provide the fastest pierce for a given profile,” Vandergon said. “ProNest and Phoenix software can utilize four pierce types [dynamic, circular, wiggle, and stationary] depending on the profile of the part or hole being cut.”
Each pierce type is used in different profiles based on the profile shape and area, he added. “Dynamic piercing [pierce along the lead-in] takes the shortest amount of time. In cases where the lead-in for the profile can be long enough to accommodate a pierce, this is the ideal pierce method,” Vandergon said. “Stationary piercing takes the longest amount of time because the jet stream is bouncing off the material back into the jet. This significantly increases the time required to pierce.

In some cases though [e.g., very small holes], stationary piercing is the best method.” ProNest software will select the ideal pierce technique, he said, based on the cutting profile and export the code required for Phoenix to implement the pierce technique.

Keeping Shops Running

Reliability remains the high priority for most job shops and manufacturers cutting parts with waterjets. “Every waterjet company can introduce new technology that will improve their system, but not every company can consistently prove to their customers that the products they’ve placed in their facility will last beyond their expectations,” noted Jim Fields, national sales manager US, Techni Waterjet LLC (Lenexa, KS). Top requirements for waterjets today, he added, include ease of maintenance, minimal downtime and cost to maintain the machine, and ease of setting up a job in the software.

Among Techni advantages are the company’s pump technology, and Fields noted the Quantum NXT Electric Servo Pump is the only electric servo pump in the waterjet industry. “The Quantum Electric Servo Pump [ESP] from Techni Waterjet combines the advantages of the two most prevalent ultra-high-pressure pump [UHP] types [direct drive and intensifier] while avoiding their drawbacks,” Fields said. “Quantum NXT uses an electric servomotor to drive plungers that are directly attached to a reciprocating ballscrew, and is the subject of numerous technology patents. The ballscrew directly houses the ceramic plungers, which reciprocate back and forth to create the pumping action, in much the same way as a hydraulic cylinder works on an intensifier pump.”

The infinite control of the servomotor and precision of the ballscrew enables extremely accurate control over the output pressure and volume of the water displaced, and eliminates pressure spikes when deadheading, Fields added. “This design can generally match or surpass the performance of both direct-drive and intensifier models in efficiency, maintenance and footprint,” Fields stated. “With less than 68 dBA, it is also significantly quieter than a standard hydraulic intensifier pump, making it the quietest pump in the waterjet industry.”

Techni recently released its Advanced Diagnostics Package for the Quantum ESP, he said. “The Advanced Diagnos-
tics will ensure the Quantum ESP will perform at its capacity without unplanned downtime due to general maintenance. The package is designed to protect the Quantum Electric Servo Pump against damage due to poor maintenance issues and unforeseen utility failures.

“By simply changing the mindset of reactive maintenance to proactive maintenance, it will ensure that business owners achieve the maximum return on their investment,” he added. “This Advanced Diagnostics package will help an operator maximize the output of the ESP without causing unnecessary maintenance downtime by diagnosing potential maintenance issues before the ESP fails, and then advise the operator how to perform the maintenance.”

One of the keys to longevity for waterjets is ensuring shops are using the proper water softness, noted Christopher Goodson, manager of business development for Choice Waterjet Parts, a division of Jet Edge launched earlier this year that offers customers all brands of OEM waterjet replacement parts. If shops aren’t using good water quality, wear on nozzle parts such as focusing tubes and orifices can quickly wear out, he said, so using a proper water conditioning system is essential.

“We’re pressurizing the water at a 13-to-1 factor, so any calcium in that water is like little BBs,” Goodson said. “Hard water is the worst—hard water eats all of your parts.”

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