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WATERJET CUTTING

BEST PRACTICES FOR MANAGING WATERJET ABRASIVE

Efficient waterjet cutting isn't just about the cutting head and the pump

By Joe Morris, Stephen Podnorszki, and Dan Davis

Most people in the fabricating industry have a good idea of how waterjets work. A high-pressure pump generates an ultrahigh-pressure water stream which is focused through a 0.015- to 0.060-in. mixing tube in a CNC-driven cutting head. In abrasive waterjet cutting, garnet is pulled into the water stream, and when that ultrahigh-pressure stream of water mixed with garnet exits the cutting head, the abrasive is propelled at speeds that exceed Mach 3, successfully eroding away almost any material in its way.

While the equipment, particularly the cutting heads and high-pressure pumps, typically dominate most conversations about waterjets, a fabricator would be remiss in not also thinking about the consumable that actually does the cutting—the garnet. Garnet has been the abrasive of choice for waterjet cutting since the days the first commercial abrasive waterjet cutting system was sold in the early 1980s.

Knowing more about the abrasive can lead to better and more consistent waterjet cutting results. Let's cut to it.

What Does a Fabricator Need to Know About the Waterjet Abrasive?

Abrasive waterjets are capable of cutting steel over 1 ft. thick. Garnet abrasive is widely used to cut not only metals but also glass, marble, granite, stone, ceramic tile, composites, wood, plastics, and many other materials. The most common grade used in waterjet cutting is 80 mesh, which is suitable for cutting a wide range of materials. To achieve a faster cutting speed, or when cutting material thicker than 2 in., an operator could use a coarser abrasive (say, 50 mesh for example). For a narrower kerf and more precise cut, a finer abrasive might be the choice (say, 120 or 150 mesh).

All waterjet abrasives need to demonstrate hardness, density, and toughness. But perhaps the most important qualities are consistency in particle size distribution, shape of the particle, and purity of the abrasive. Continuity of these characteristics allows for consistent cutting performance over time.

Waterjets need abrasive to effectively cut various thicknesses of metal. Knowing more about the actual garnet abrasive and how to properly handle it can help to streamline waterjet operations. *OMAX*

The most common garnet used in waterjet cutting is known as alluvial garnet. At some point during its geological life, this garnet was liberated from the parent stone through erosion, tumbled in a riverbed, and deposited on a beach or riverbank. That erosion and tumbling results in a rounded grain.

However, for specialty cases, hard rock garnet might be the abrasive for the job. Hard rock garnet is mined from a quarry where it is crushed and separated from the host rock. Because it never went through an erosive process, hard rock garnet retains the sharp angular shape which makes it more effective. If you use the analogy of cutting with a razor blade versus a butter knife, the same holds true.

For instance, a fab shop cutting very thick, hard, or brittle materials (such as titanium, thick steel, or glass) might use the hard rock garnet abrasive because it has the ability to cut deeper and more quickly than the alluvial alternatives. The hard rock garnet also can deliver a superior edge finish with less burring and minimal taper. Barton recommends 120-HPX hard rock garnet for cutting glass and composites because it minimizes the chances of breakage while piercing. When cutting composites, 120 HPX also minimizes the chances of delamination.

Despite the more aggressive nature of the hard rock garnet abrasive, it isn't as taxing on the waterjet's mixing chamber and mixing tube as one might think. These components are engineered to stand up to the use of this type of garnet, as well as the much more common alluvial material.

It should be noted that aluminum oxide is sometimes used as an abrasive when waterjet cutting hard ceramics or similar materials. It does the job, but aluminum oxide significant-

This is what garnet abrasive looks like before it enters the waterjet stream. *Barton International*

The up-close view reveals the alluvial nature of the garnet abrasive. *Barton International*

All abrasives need to demonstrate hardness, density, and toughness. But perhaps the most important quality is consistency in size and shape of the garnet abrasive. This type of continuity allows for consistent cutting performance over time.

ly taxes the waterjet's mixing chamber and mixing tube, dramatically shortening the life of each. Because of this, aluminum oxide is used in very limited instances.

How Is the Abrasive Delivered?

Waterjet abrasives are typically packaged in 55-lb. bags or 2,200- or 4,400-lb. bulk bags. By far, the 55-lb. bags are the most popular package type.

A robust paper bag construction, such as a multilayered one comprised of a plastic liner sandwiched by high-strength paper, stands up to shipping and handling, while simultaneously keeping the garnet abrasive protected from humidity. Standard paper bags might struggle to match the same performance.

Packages weighing 1 and 2 metric tons, typically made from woven polypropylene, are known in the industry as flexible intermediate bulk containers (FIBCs). Often referred to as bulk bags, jumbo bags, supersacks, or big bags, these packages are designed to be handled mechanically by forklift trucks, cranes, or hoists when filled. The Flexible Intermediate Bulk Container Association (FIBCA) publishes FIBC safe handling guidelines and other resources useful to shops buying abrasive in this type of package.

How Is the Abrasive Introduced to the Waterjet?

Garnet abrasive is fed to the waterjet from a pressure pot to the abrasive regulator, which controls the abrasive feed to the cutting head. Standard pressure pots have capacities from 110 lbs. to 600 lbs. Larger pressure pots with 2,200 or 4,400-lb. capacity can be purchased if you are looking to do longer uninterrupted cuts.

Typical feed rates for waterjets range from 0.75 lbs./min. to 2.4 lbs./min., depending on pump capacity, orifice size, and mixing tube size. A general rule of thumb is that a shop will use approximately 1 lb. of abrasive per minute while waterjet cutting.

Customers looking to minimize the labor associated with the handling of 55-lb. bags may choose to install a transfer hopper over the top of a standard pressure pot. This allows the customer to use bulk bags to fill the hopper with up to 4,400 lbs. Switching to bulk bags minimizes the risk of a piece of a paper bag getting caught in the abrasive feed, potentially causing a clog.

What Should the Operator Be Aware of When Looking at the Abrasive?

An operator will want to ensure that there are no foreign materials mixed in with the abrasive. Additionally, any evidence of wetness, such as clumping, in the material would indicate a potential clogging problem. Extra care should be taken when using material from a damaged bag as the garnet could have been contaminated with foreign material. Spilled garnet should not be swept up from the floor and used for cutting.

Poorly graded garnet could include excessive fines (particles that fall outside of the target particle size distribution). These fines are most evident when a bag is poured into a pressure pot and a dust plume emerges. While the dust is an inconvenience for the technician operating the waterjet, it is a potential threat to the machine's cutting ability.

How Should the Abrasive Be Stored?

The garnet abrasive should be stored indoors and in a dry area, which typically means away from the waterjet. As most waterjet operators can testify, when piercing, the waterjet ends up spraying water beyond the table. That splash of water ending up in a bag of abrasive is not desired.

Waterjet abrasive typically comes in 55-lb. paper bags and bulk bags, such as this 1-ton bag. *Barton International*

For continuous operation of a waterjet, a metal fabricator might rely on an abrasive transfer hopper, which is positioned above the pressure pot and near the waterjet cutting machine. *Barton International*

To keep the garnet free from contaminants, the abrasive bags should be stored away from other processes that produce excessive dust, chips, or other byproducts that could contaminate the abrasive. For instance, pallets of garnet stored near a blast room might wind up with the much coarser abrasive used in the blasting process clinging to the outside of the packaging of much finer waterjet abrasive. That much-larger abrasive could inadvertently be introduced into the waterjet's garnet delivery system, which will result in clogs and unnecessary downtime. It also could wreak havoc on the waterjet's cutting performance.

Dust should be blown off bags that have been stored before opening, and a sharp knife should be used to open paper bags to avoid pieces of paper getting mixed in with the abrasive. To further protect the pressure pot from contamination, it should be topped with a trash screen.

How Should a Fabricator Handle Removing Spent Abrasive From the Waterjet Tank?

It's time to remove spent abrasive from the waterjet tank when the abrasive levels in the tank rise toward the bottom of the slats on which the workpieces rest. The frequency of this task depends on the cutting activity on the waterjet.

Some waterjets have integrated garnet removal systems. These systems involve pumps and catch basins that are typically affixed to the waterjet, preventing them from being able to be used on other tables and taking up valuable shop floor space. They also represent an added expense to the waterjet when it is installed. Even with an automated system, the waterjet has to be shut down periodically to remove drops and the abrasive that the system failed to reach.

On the opposite side of the spectrum is manual cleaning of the waterjet tanks. Typically, the waterjet is shut down and the slats are removed. The spent garnet can be removed by shovel, a small excavator, or by hiring a vacuum truck service.

A portable abrasive collection system, which can be operated while the waterjet is still operating without removal of the slats, has become a popular manual extraction alternative. This device, sold exclusively by Barton International, uses an extraction wand powered by a standard pressure washer that can remove up to 3,000 lbs. of abrasive per hour.

What Do Waterjet Owners Need to Know When It Comes to the Disposal of the Spent Abrasive?

Garnet itself is a nonhazardous material, but local municipality waste regulations need to be followed when disposing of spent abrasive. Municipal, state, and federal officials are concerned with metals specified within the Resource Conservation and Recovery Act as being potentially dangerous to humans. These metals include arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver That's why a toxicity characteristic leaching procedure (TCLP) test should be done prior to disposing any abrasive. This test alerts the owner if any heavy metals are present. The test also acts as proof that any spent abrasive is comprised of nonhazardous materials. **FAB**

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