ABRASIVE

can be good

By Jim Blackburn

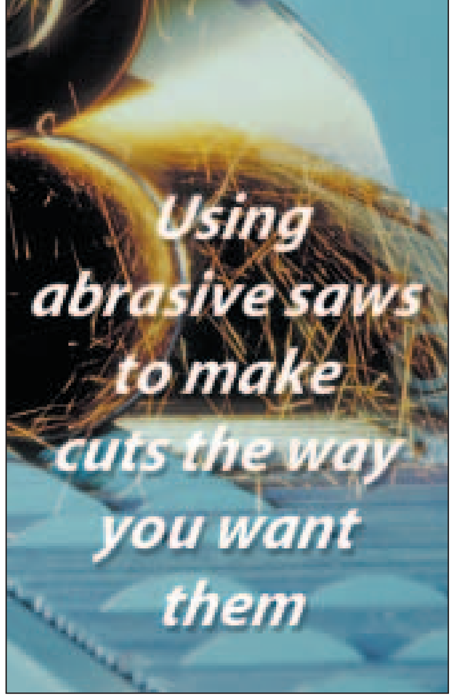
The pipe fabrication industry is faced with an interesting development.

Pipe cutting formerly was restricted to machining, band sawing, and thermal cutting processes. Abrasive cutting now is an emerging technology worthy of renewed consideration. With recent installations in commercial mechanical contracting and HVAC shops, abrasive saws are gaining popularity for a variety of reasons—an established technology is satisfying new quality standards.

Each cutting method has its own distinct advantages, but abrasive cutting now can be recognized as a viable alternative to other traditional cutting methods. Using both pipe rotation and precision hydraulic feeds, high-speed abrasive blades can sever pipe in one operation and bevel it in a subsequent operation. Straight-cut and beveled pipe spools are prefabricated in the shop and delivered to the field for final assembly and installation. Centralized cutting and automated welding procedures within a controlled environment can help to improve quality and reduce labor costs as well.

The Challenges

The unique nature of pipe offers opportunities and challenges. As a hollow, circular section, pipe either can be held rigidly or rotated. The cutting medium can move through the entire cross section, as band saws and chop saws do, or can contact one point on the pipe as it turns, like lathes and turning rolls do. Likewise, pipe can be rolled laterally, unlike other structural shapes such as



H-beams and rectangular tubing, so material flow can be more flexible.

Larger diameters and thicker wall bring new obstacles to simple chop saw operations. Manually moving longer lengths (and heavier weights) becomes unmanageable, so material handling efficiency emerges as a challenge.

Other challenges include fixturing workpieces to ensure squareness of the end prep; ensuring operator safety and work space cleanliness; and maintaining efforts to restrain the cost of consumables, parts, and labor.

Consequently, new machines combine technologies borrowed from chop saws and machining operations. Proper machine design shifts the burden of manual loading and unloading from operators to machine frames. Pipe can be supported and rotated without operator exertion. Roller conveyors ease material flow from raw storage racks to fit-up stations downstream from the cutting process. No longer must operators balance cutting devices and workpieces simultaneously. No longer are overhead cranes and pipe stands necessary for the cutting process.

Hip to Be Square

Squareness of the finished cut is the highest priority. To fit up to fittings and flanges, end profiles must be perfectly perpendicular to the centerline of the pipe. Squareness of the finished cut depends on several factors:

1. The workpiece must be secured horizontally and vertically, yet be free to rotate in turning rolls.
2. The cutoff assembly must be aligned perfectly with the workpiece.
3. Abrasive blades must be of high quality.

Any exception to these conditions can introduce pipe creep during the cutting process, which causes a helix pattern on the cut and excessive wear on the abrasive wheels.

Securing the Workpiece. Mechanical stops on the rear end of a workpiece ensure precise fixturing. During the cutting operation—and especially during the beveling phase—friction forces the workpiece away from the grinding blade. To cope with this, movable stops that travel along ways mounted on the machine frame can be used. Once located and locked into position by an operator, the pipe cannot move longitudinally. Successive pieces can be loaded and processed without interruption by using the hollow pipe rollers.

Hinged hold-down arms under pneumatic pressure can secure workpieces vertically to prevent them from rising and falling in turning rolls. *To maximize quality and prevent excessive wear or damage to cutting blades, pipe must rotate concentrically under the blade, provided there is some allowance for pipe seams.*

For hold-down purposes, pneumatic pressure is slightly forgiving because air can be compressed (hydraulic fluid is virtually incompressible). A series of hold-down wheels can be positioned to rest on the pipe as it rotates to distribute pressure evenly on either side of the grinding wheels. In addition, building in the flexibility to feed material from both directions and the ability to cut and bevel both ends without end-for-ending the pipe can improve throughput.

Aligning the Workpiece. One way to ensure good alignment and smooth, controllable motion is to rely on a precision hydraulic system. Hinged on precision bearings, mechanical arms can be used to lower the cutting and beveling assemblies directly onto a workpiece. Under operator control, abrasive wheels contact workpieces lightly. As contact is made with the entire circumference of the pipe, pressure is increased until final separation occurs. Similarly, an operator can lower the beveling head to achieve the desired bevel shape, whether knife-edge or with a land. *Rapid entry into the pipe material can subject blades to extreme friction, leading to excessive wear or damage.*

Choosing a Wheel. A final challenge in ensuring squareness is finding the right abrasive cutting wheel. Different materials, compositions, and laminations can have a profound effect on the quality and squareness of cuts. Uneven wear on the blade can impose longitudinal force on the pipe, encouraging the pipe to walk on the turning rolls. Blade quality and operator diligence can reduce blade wear significantly.

Be Safe, Be Clean

Other challenges presented by abrasive cutting are safety and cleanliness.

The natural by-product of abrasive cutting is a stream of sparks and abrasive grit. While optimizing operator visibility, it is imperative to protect operators and co-workers from flying particles. Fabrication shop managers should be cognizant of the immediate environment and the disposal of contaminants. Adequate physical protection, interlocking electrical operations, blade and belt safety covers, and proper collection of fumes and dust should be designed into whatever cutting machine a shop chooses.

Centralized cutting and grinding can minimize the shop space that is subjected to noise, fumes, and dust. Above all else, operator safety and health take precedence.

The People Behind the Wheel

The most significant variables in efficient abrasive cutting are the skill and attention of the operator.

The operator dictates the speed of material handling and is responsible for thoughtful scheduling of operations. For example, knowing approximate setup vs. cutting and beveling times, the operator must decide whether to process a single piece in its entirety or perform a single operation on multiple pieces before proceeding to the next operation.

By staging work efficiently, the operator makes or breaks the overall production process. Balancing cycle times and delivery deadlines, the operator makes rational operational decisions. Similarly, the operator monitors cutting speeds and cut quality while overseeing total output.

Making the Cut

Abrasive cutting machines include a bed of turning rolls integrated with flat conveyor rolls for loading, positioning, and unloading pipe. Pipe is raised off the conveyor rollers between a set of powered turning rolls and a set of movable idler rolls. Mechanical pipe stops and pneumatic hold-down rollers secure the pipe to prevent it from creeping forward and back as it rotates.

Synchronizing pipe rotation with hydraulic feed of the grinder arm, the abrasive blade contacts then severs the pipe. By limiting the vertical travel of the abrasive blade, the machine also can produce sealed coupling grooves, commonly referred to as “Vic” (for Victaulic) grooves.

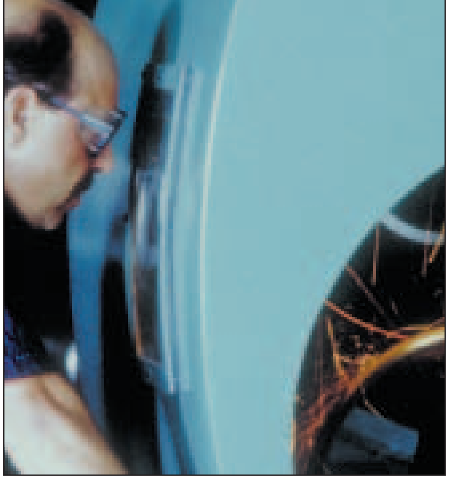
Upon completion of the cut, the pipe is advanced under a reversible grinding wheel, where the beveling operation takes place. By controlling the beveling wheel elevation, the operator can produce either a knife-edge shape or a bevel with land configuration, a profile that is almost impossible with flame cutting machines and band saws. All three operations—cutting, beveling, and grooving—are consolidated into one area by a single operator.

What Can We Do?

Abrasive wheels can process almost any type of material, from carbon steel to ceramic pipe. Stainless, alloy, plastic, cement-lined, and even ductile iron with bell-shaped ends can be cut and beveled.

The resulting finish is uncontaminated, so no subsequent dressing is necessary. In addition, there is no slag or dross adhering to the pipe’s inside diameter (ID). With no heat-affected material, spools are ready for immediate fit-up and welding. The machinelike finish lends itself to automatic and computerized welding equipment.

A recent field experiment with abrasive cutting yielded cutting times of 20 seconds on 4-inch-outside-diameter (OD) pipes and 50 seconds on 14-inch-ID ma-



terial. A test using 24-inch-OD Schedule 40 pipe resulted in cutting times of five minutes by abrasive saw. On small-diameter, thin-wall pipe, abrasive saws reached speeds of 50 inches/minute. As wall thickness increases, abrasive cutting speeds remain relatively constant as well.

What Can’t We Do?

Limitations of abrasive cutting include the inability to process contours like saddles, miters, and holes. Abrasive cutting relies on a straight-plane process, not a single-point process, so it is restricted to straight cutting and beveling. For general pipe fabrication and low-volume production, this alternative might be less versatile than other cutting methods.

The bevel angle is approximate, unlike computer-controlled burning machines in which the bevel angle can be programmed to within ±1 degree. Grinding a weld prep bevel satisfies general welding codes, but grinding cannot make perfectly accurate angles or J-grooves that sometimes are required on high-pressure or nuclear work.

With abrasive wheels, the bevel angle depends on where the operator locates the workpiece relative to the vertical motion of the grinding wheel. If the pipe is located under the centerline of the beveling wheel, the bevel angle will be quite oblique. If the pipe is located away from the wheel centerline, the bevel angle will be acute.

A simple shortcut for preparing approximate bevel angles is to mark the bevel wheel with approximate protractor angles. This method allows the operator to locate the workpiece at the designed bevel angle, secure the workpiece vertically and horizontally, and then perform the operation. This method is adequate for most welding standards.

Upkeep

Abrasive blades are replaced during each eight-hour shift during typical production schedules. The beveling wheel generally is replaced every three to four months.

Unofficial audio tests indicated that abrasive cutting machines are comparable to general background sound levels of 90 decibels.. Under current design, abrasive grit and sparks are contained within a hinged hood and bag-house plenum system.

Wrapping Up

Diameters from 1 to 24 inches OD and lengths up to 40 feet can be conveyed and rotated. Producing everything from simple welded coupons and spacers to long-distance water and steam lines, the process can be attractive for isometric spool work.

All diameters and shapes flow through the machine at a common passline height. An abrasive cutting machine can process other structural shapes, such as rectangular tubing, channel, H-beam, and flat stock up to 6 inches in cross section. Noncircular material remains stationary atop the hollow rollers instead of the turning rolls as the abrasive wheel severs the piece.

Jim Blackburn is CEO of Vernon Tool Company, 503 Jones Road, Oceanside, California 92054, phone 760-433-4850, fax 858-757-2233, e-mail jdblackburn@vernontool.com. Vernon Tool Company manufactures automated machinery, specialty tools, and safety valves for the petrochemical, power generation, and industrial construction industries.