

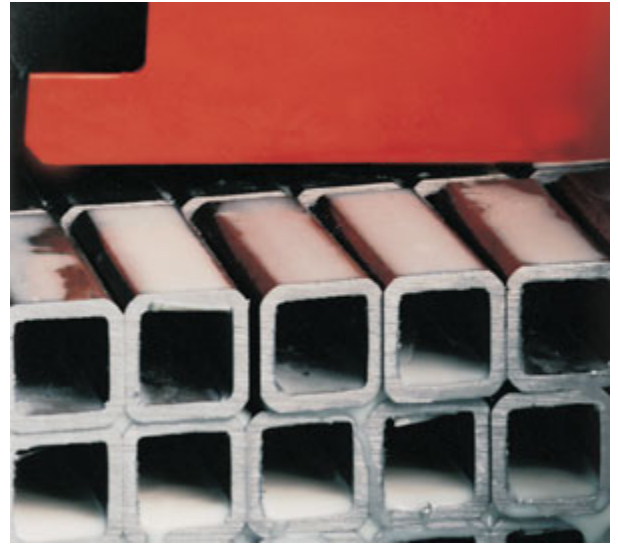
Band saw cutting of tube and pipe: Tips for blade selection and machine settings

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Production quantities of cut tube and pipe can be produced economically with a band saw. Band saws use a thinner blade than do cold saws, so they minimize kerf loss, and their design is conducive to nesting or stacking stock for simultaneous sawing of many pieces. With a band saw, however, the choice of which blade to use is very important in maintaining a low cost per cut.

Workpiece geometry can make sawing tube and pipe more difficult than sawing solid bars or plate because the saw blade is performing two types of cuts. As it enters the workpiece, it is cutting a solid. After the blade penetrates the inner wall of the hollow workpiece, it is cutting two thin solids with a space between them (called an interrupted cut).



If there were such a product as a "magic blade" for tube and pipe, it would start cutting aggressively with a coarse pitch (fewer number of teeth per inch), have deep gullets to carry away chips, and have a positive rake to help the blade penetrate the solid. As the blade cut through the walls, it would magically change to a neutral rake blade with more teeth and shallower gullets. To finish the cut, the blade would change back again to a coarsepitch, aggressively configured blade.

Since there is no such thing as a magic blade, blade variables and band saw settings have to be selected to provide the best overall performance for sawing tube and pipe.

Blade Pitch

Pitch, or number of teeth per inch, is a significant variable in cutting tubing because the number of teeth in contact with the workpiece determines both blade performance and durability. Among the forces acting on the teeth as they cut are the downward force of the saw head pushing the teeth into the cut and the pulling force as the blade moves through the cut.

If only one or two teeth are in contact with the workpiece, the teeth can be stripped from the blade, bent, or prematurely dulled. At the other extreme, when too many teeth are engaged, the force on each tooth is so low that it either has too little penetration or none at all. Cutting is slowed, or if the teeth are unable to penetrate the workpiece, work hardening may occur, making the tube uncuttable.

Manufacturers recommend that at least three teeth and no more than 25 always be in contact with the workpiece. Within that range, shock levels are tolerable, the pressure on each tooth is enough to ensure penetration of the workpiece, and there are enough gullets to carry away the chips produced by sawing.

More About Blade Pitch

The pitch can be either a single or multiple configuration. Multipitch blades vary tooth spacing and are designated by two numbers. The first number indicates the coarsest single-pitch equivalent, and the second number shows the finest single-pitch equivalent. A blade designated as having a 4-6 pitch has teeth spacing that varies between four and six teeth per inch. By varying the tooth spacing between fine and coarse, sawing rhythms are broken up and vibration is reduced.

Figure 1 illustrates the minimum suggested pitch for the tube and pipe wall thicknesses that most fabricators are likely to encounter. For instance, for a 5.25-inch wall thickness, the minimum for effective sawing would be an 8 pitch, so a multipitch blade around 6 to 10 pitch would be chosen as the most effective.

While single-pitch blades are available for certain specialty applications, a multipitch blade is a better choice for sawing tube and pipe. When teeth are spaced uniformly, as they are on a single-pitch blade, they create a rhythm as they enter and exit the workpiece. In some cases, the rhythm can harmonize with the natural frequency of the work or machine, amplifying a minor vibration into a blade-damaging squeal and subjecting the blade to extra shock. Harmonic vibrations typically are encountered on long stock lengths with thin walls.

Recommended Saw Blade Pitch for Tube and Pipe	
Wall Thickness	Pitch (Minimum Number of Teeth)
Up to $\frac{1}{2}$ in.	10
$\frac{1}{2}$ in. to $\frac{3}{4}$ in.	8
More than $\frac{3}{4}$ in.	6

Figure 1:

Different wall thicknesses call for different blade tooth pitches for proper cutting.

Blade Metallurgy and Rake

Metallurgy. While blade pitch may be the most important factor in selecting the best blade for sawing tube and pipe, it is not the only factor. Another important consideration is tooth tip composition. Bimetal blades with a Matrix II 8 percent cobalt tooth tip are generally considered the best choice for mild steel tube and pipe. The Matrix II edge provides superior tooth toughness with good abrasion resistance, so tooth chipping is minimized.

For cutting tougher and more abrasive materials such as stainless steel, bimetal blades with M42 teeth sometimes are recommended because of their superior abrasion resistance.

Rake. Tooth geometry is another factor in blade choice. A saw blade's rake describes the angle of the tooth tips in relation to the cut. A neutral-rake blade's angle is 90 degrees — perpendicular to the workpiece. Positive rake describes blades with tooth tips that are angled toward the direction of the cut so that they are drawn into the workpiece as the blade moves across the cut.

While a positive rake is best for cutting the solid portion of a tube or pipe because it is pulled into the cut, it is not as effective for cutting the walls. That's because the digging action of being pulled into the cut makes it too vulnerable to tooth damage. Neutral-rake blades are a better choice for tubes and pipes because their geometry provides more physical support to the teeth, making them less susceptible to damage.

Neutral-rake teeth are strong and preferred for cutting thin sections that are prone to tooth-damaging vibration. Positive rake ensures penetration in large or tough work, but the more acute angle of positive-rake teeth makes them more prone to damage.

Band Saw Settings

Even with the correct blade, the saw must be tuned properly to cut tube and pipe successfully.

Vise Pressure. When a bundle of round workpieces is being cut, the blade can cause the inside pieces to spin as it passes over them, not cutting them and abruptly leading to damaged teeth or a broken blade. Tightening the vise can stop the rotation, but too tight pressure can crush thin-walled tubing. Variable vise pressure control allows the operator to set the pressure to hold the stock firmly, but not so much to crush the walls. An alternative is to tack-weld ends together, which prevents spinning.

Coolant Application. Another sawing problem can occur with stacked stock if the cutting fluid is not flowing into the cut properly. A bundle of tubing or pipe has numerous cavities where the coolant can be diverted, keeping it from reaching the cut. If coolant is not evenly supplied to both sides of the cut, the blade will deflect, resulting in an inaccurate cut.

One way to solve the problem is to use a saw that applies coolant through the saw blade guides so the blade pulls the coolant into the cut. Setting the flow rate for maximum flow also helps ensure that sufficient coolant is reaching the sawing area. It not only lubricates the blade, it also washes away any errant chips caught in the spaces in the stack.

Band Speed. Band speed must be matched to the work metal. Excessive band speed overheats, softens, and dulls teeth quickly. It also exacerbates penetration problems in tough work and contributes to work hardening that can halt cutting action and dull teeth. However, too slow a band speed not only reduces the cutting rate, it also increases tooth load to make work spinning and tooth stripping more likely.

Feed Force. Feed force also is a factor in determining cutting rate. Inadequate feed force, at best, reduces the cutting rate and, at worst, causes work hardening. Excessive feed force, like low band speed, increases tooth load and makes spinning and stripping more likely.

Proprietary Sawing Programs

The most expedient method of determining batch sawing configuration, blade choice, and machine settings is to use a proprietary sawing program. These computer programs have been developed to let users change variables such as stack pattern, blade choice, feed pressure, and blade speed to determine the least expensive cost per cut.

For example, the lead-in photograph illustrates a stack of 1015 carbon steel rectangular tubing, four high by seven wide, so the saw is cutting 28 pieces at a time. By entering the metallurgy, shape, dimensions, and stack configuration into a computer, the operator can adjust variables such as blade type, blade speed, cutting fluid, etc., and end up with the best choices for minimizing the cost per cut. In this case, the operator could expect to obtain 893 cut pieces per hour at a cost of 5.58 cents per piece.

A Helping Hand

Yes, tube and pipe can be difficult to saw, but they are cut so frequently that blade and machine manufacturers have had years to overcome the problems associated with them. Don't be reluctant to call on them to help you get the most out of your sawing equipment. They have been trained to help you select the right components and to help tune up your machine to make your tube and pipe sawing operation a success.