RESOURCE

Realize Time and Cost Savings with Precision Tube Bending

Utilizing a CNC Tube Bender for Your Next Project

AXENICS
Subassemblies to Complete Systems

www.axenics.com

Engineers considering the most effective methods for their next project should consider precision tube bending. Many don't realize that this service can be an efficient alternative to manual tube bending, and welds or fittings in many situations. Axenics offers precision tube bending services to a variety of industries, as an effective solution for building various types of complex assemblies.

To employ precision tube bending and reap the most benefits, the use of a CNC tube bender is recommended. The benefits of utilizing a CNC bender are quite extensive and, in many cases, it is the best solution to meet a wide range of project needs.

Benefits of Precision Tube Bending

There are many proven benefits to precision tube bending, though many of them are widely unknown.

1. By using a CNC precision tool bending machine, welds, joints and expensive fixtures can be eliminated from a complex assembly system.

2. In addition to making for a cleaner system overall, the entire project becomes much less expensive. Fewer fittings equals a lower overall cost. If you can eliminate 5 fittings from each of your 10 systems, you can effectively eliminate the cost of 50 fittings.

3. By eliminating welds and joints within a system, you can also eliminate the risk of leaks that may occur in welded or jointed complex assembly systems. The aerospace and semiconductor industries, in particular, can benefit from building systems without the wall thinning that can occur in welded systems. With precision tube bending, the integrity of the materials is maintained.

4. Precision tube bending also allows for a much smoother finish. Depending on how the system is being implemented, an engineer may prefer a system that looks better cosmetically.

5. Fewer bends in a system will minimize flow restrictions for chemicals and liquids that may otherwise get trapped in joints or sharp corners.

> *Precision-fit pipe systems can be produced clearly faster and more precise on CNC-controlled bending machines. These allow time savings of up to 95 percent as well as noticeable cost reductions.*
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> *Source: Oil and Gas Technology, "Bending Instead of Welding," Sept. 2015.* ***Link.***

Frequently asked questions about precision tube bending

Question: If the OD of the tube we plan to use is not a standard size, what are your flexibilities with the design?

Answer: Axenics' experts will look at your design requirements to see if there's a solution to bend a standard size tube into a shape or angles that will fit into your space requirements, with minimal fittings to ensure consistent performance without degradation.

Question: If the radii requested is not standard, what are your flexibilities with the design?

Answer: Our team will look at your design plan to see if the radius of the tube bends can be adjusted and still achieve your goals. One possibility is that we can perform the job utilizing both tube bends and high-purity orbital welding to achieve your goal.

Back-to-back bends are sometimes requested, as designers look to fit tubing into a small space. Our CNC tube bender is capable of some tight bends, as illustrated in the chart above. However, back-to-back bends typically require custom tooling, which adds cost to the project. If the size of the project justifies the cost of the tooling, that may be your best solution.

Question: Can we use tempered or heat-treated tubing in this project?

Answer: Does your research show the bending properties of these materials? Are you open to changes on material selection? Some tempered or heat-treated tubes are more likely to rupture, crack or damage internally when bent by a machine. Our team can demonstrate the attributes of different metals to qualify them for your project.

Equipment Utilized

At Axenics, we perform precision tube bending using a Horn Metric CNC Tube Bender, which produces bends ranging from ¼" to 2" in diameter. Our use of this CNC precision tool bending machine allows us to significantly cut time, materials and costs for our customers.

Extend the life of your critical subsystems with precision tube bending

The four attributes of tube bending that will make your systems last longer include the machine, material, tooling and lubrication used for the job.

Machine

Our dual stack hydraulic tube bender with roll forming capabilities produces bends ranging in a variety of diameters from ¼" to 2". A CNC tube bending machine produces bent tubing without kinks. The CNC bender also significantly reduces time, materials and costs for customers who need to safely and consistently transport chemicals and gases.

Material

We prefer using 300-series stainless steel for its long-lasting and strength attributes. A bending machine can also perform custom bends on copper, aluminum, Inconel, Titanium, bronze and other alloy metals. We recommend stainless steel tubing for its high corrosion-resistance properties and the ability to withstand long-term exposure to varying environments.

Tooling

The basic components of the CNC bender are the mandrel, the bend die, clamping die and wiper die.

Mandrel: The mandrel inserts into the tube for support during bending to avoid wrinkling, distortion, collapse, flattening, rippling or breakage during the process. Using a mandrel provides better control over the tube's ovality or roundness. Mandrel tube bending elicits highly accurate, repeatable results for jobs with tight or large radius bends. The firmness of a mandrel is very important, depending on the firmness of the tube. For extremely durable tubing, a soft mandrel is used, and a hard mandrel is used on softer tubing. This prevents the mandrel from sticking to the inside of the tube, which can damage the tube.

Bend Die: The radius of the bend die takes into account the durability of the tube to adjust for radial growth. Bending a harder material requires a bend die with a smaller radius.

Clamping Die: The ideal length of a clamping die is three times the diameter of the tube. Clamping short, puts too much pressure on a short section of the tube, resulting in a damaged component.

Wiper Die: The wiper die supports the tube on the inside of the bend to prevent wrinkles. Position the wiper die at a slight angle with its contact point extremely sharp at all times. Lubrication at the point of contact is important to avoid premature wear.

Lubrication

Proper lubrication is critical for top-quality bends. Lubrication lowers friction during bending for clean, smooth results. We prefer non-petroleum-based synthetic lubricants in a paste or gel. Durable metals often require more lubrication to prevent friction.

Types of production systems where tube bending is recommended include:

Control systems: In chemical engineering production, it's essential to have a seamless flow of gases or liquids. There are zero kinks in bent tubing systems to trap or slow materials flowing through the system.

Delivery systems: CNC machine bent tubing creates liquid-tight and airtight seals for consistent movement of matter through the entirety of your system.

Purification systems: Purifying processes often include the use of caustic chemicals, which can cause filler material on welded tubes to break down over time. Bent tubing has no filler material, but consists only of the base metal, leaving precise pathways for materials to flow.

Storage systems: Manufacturers in the chemical production industry may use tube systems to deliver potentially hazardous materials into temporary or long-term storage. The interior of tubes used to transport that material must remain clean. Bent tubing has no sharp curves inside to trap materials, so the interior remains uncontaminated after materials flow through.

Testing systems: Materials flowing through testing systems must retain their original properties. With bent tubing, there is a much lower risk of contamination as opposed to using a welded tube system or a system with multiple joints. The more components added to a system increases the opportunity for contamination.

Benefits of Using a CNC Bender

In addition to saving our customers time and money, there are many additional benefits to using a CNC bender. For example, the machine works well when large quantities of bends are being produced, as it allows the technician to run all the parts through the machine, which they will also manually inspect to ensure the quality of the bends. This eliminates most the manual work required to complete a job. In addition, the CNC bender offers consistent repeatability on high-volume or many-bend jobs.

For assemblies that need to fit into tighter spaces, the CNC bender allows Axenics to customize the design and radius of the bends, so that the products can fit into smaller or uniquely-shaped spaces. For customers requiring custom assemblies, Axenics can also purchase customized tooling to create bends for many different shapes and sizes. We offer both square and rounded tubing upon request.

By bending the tubing vs. welding the pieces or connecting with joints, there is a significant cost savings for the customers, as joints and other custom fittings can be expensive, and they can add up quickly. While there is an initial investment involved in utilizing the CNC bender equipment, customers can save a considerable amount of money in the long run.

In an article from **thefabrictor.com**, the benefit of decreased production times is highlighted, claiming a 10-fold improvement in productivity with a cumulative benefit of increased speed of using the CNC machine over manual processes.

Axenics' CNC50TBRE Hybrid CNC Tube Bending Radius Chart

Tube bending is the ideal solution for many jobs where accuracy and repeatability are essential.

Axenics' in-house computer numeric controlled (CNC) bending machine has vast capabilities, though we highlight a tube bending radius chart below to illustrate our standard or most-requested bends for drop-in replacement tubing for production delivery systems, custom tooling can be made available, upon request.

Tubing Outside Diameter (OD)	Material	Radius	Radius
0.25", 6.35mm, ¼-inch	Stainless steel	.5", 12.7mm, ½-inch	.5625", 14.28mm, 9/16-inch
.375", 9.52mm, ⅜-inch	Stainless steel and Copper	.9375", 23.8mm, 15/16-inch	
.5", 12.7mm, ½-inch	Stainless steel	.5", 12.7mm, ½-inch	1.5", 38mm, 1 ½-inches
.75", 19mm, ¾-inch	Stainless steel and Alumi-num*	1.125", 28.5mm, 1 -⅛" inches	
1", 25.4mm, 1-inch	Stainless steel and Alumi-num*	1.5", 38mm, 1 ½-inches	
1.25", 31.75mm, 1 ¼-inches	Stainless steel and Inconel	2", 50.8mm, 2-inches	
1.5", 38mm, 1 ½-inches	Stainless steel	2.25", 57.15mm, 2 ¼-inches	

**Tempered aluminum has bending limits.*

The chart above details Axenics' standard and most-requested tube sizes and radii. The machine is capable of a much wider variety of sizes, though some bends may require the addition of tooling for the machine, which adds cost to a job if a custom tool is required for your application.

Axenics' in-house bending specialists work with designers and engineers to examine and possibly update drawings / designs to find a solution to complete your job on budget.

We rely on our in-house Horn CNC50-TBRE for customers' large diameter metal tube bending needs (tube sizes .25"-2"OD). The primary metal tubing bent on the CNC tube bender is 300-series stainless steel, known for its ease of bending and not cracking, breaking or causing wrinkling within the tube — resulting in virtually no change to the internal finish of the tubing.

The CNC50-TBRE also bends aluminum, copper, Inconel and other metal alloys.

Benefits of Precision Tube Bending

Eliminate welds, joints and fixtures
Lower production costs
Eliminate risk of leaks
Cleaner and smoother finish
Minimize flow restrictions

Benefits of CNC Tube Bender

Lower production time for large quantities
Customized bends to fit tight spaces
Decreased costs overall

While precision tool bending doesn't require any specific certifications at this time, Axenics has achieved the AC7004 Quality System, which demonstrates our qualifications with regards to quality and service across the board.

Find out more about our precision tube bending capabilities and the cost savings Axenics can provide on your next project.

Contact us at **603-595-9939** or email **sales@axenics.com**