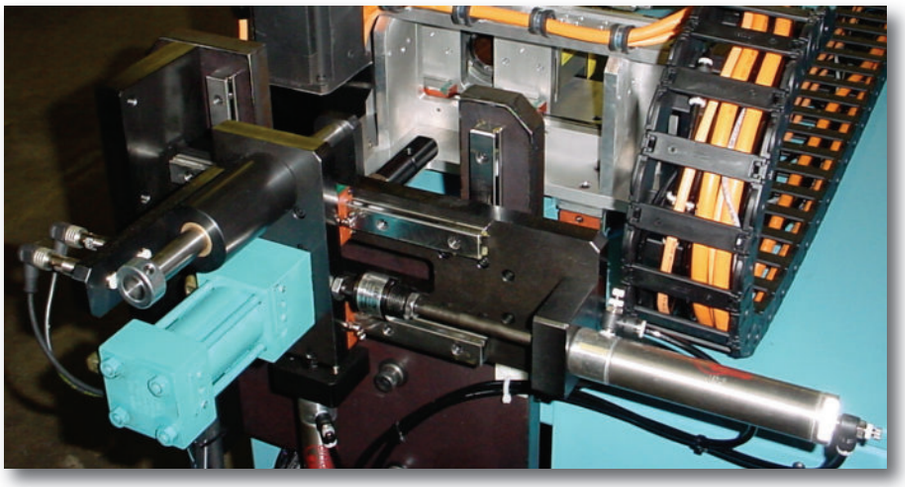
Shaping profits with a mandrel extractor

The basics of mandrel extractors and their applications



By George Winton, P.E.

BENDING a tube and preventing it from collapsing is a mystery to most folks, especially those whose livelihood does not involve bending tubes. For those who bend tubing for a living, knowing how to decrease ovality in the bend region can be of interest.

Before discussing strategies for reducing ovality, it should be noted that some tubes do not need to be round through the bent cross section; depending on the application, some ovality is acceptable. For example, shopping cart frames don't need nice round profiles through the bend zone. On the other hand, high-end furniture, medical carts, and aerospace fuel lines need minimum deformation in the bend zone.

A mandrel is a tool used on a tube bending machine to support the inside of a tube in the bend zone while the bend is being formed (see **Figure 1**).

However, the mandrel used is only as good as the mandrel extractor assembly and the control system that supports it. It is the job of a mandrel extractor to thrust the mandrel forward into the bend zone and then, at the right moment, retract it. A slight mistiming can cause extensive damage.

TYPES OF EXTRACTORS

One of the basic types of mandrel extractors is actuated by a mechanical linkage powered by an operator's foot. This type of extractor can be found on a small-diameter tube bender. One advantage of this type of extractor is the initial cost; it is inexpensive because it has no electric motor for extracting the mandrel.

The next step up from a mechanical linkage is an extractor that is hydraulic/manual. The operator activates the hydraulic pump manually to build the hydraulic pressure necessary to power the extractor. The advantage of this system is that it can extract mandrels from larger-diameter tubes than the mechanical extractor can.

The balance of the mandrel extractors found on modern tube bending machines are most often integrated into the machine's controller.

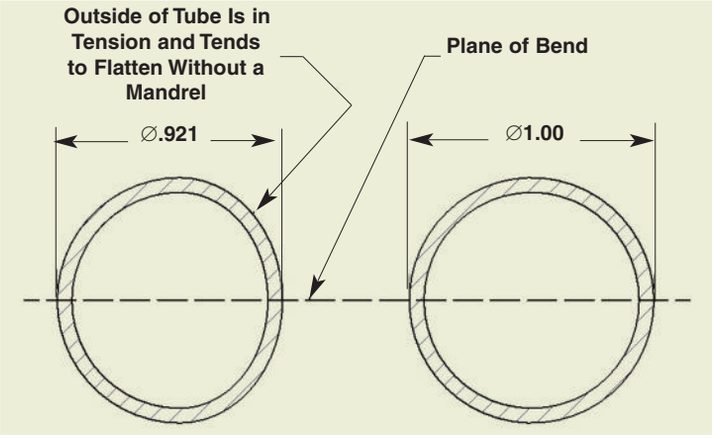


Figure 1

Two cross sections show the effect of using a mandrel. Bending forces cause flattening in the bend zone when a mandrel is not used (left). Using a mandrel helps to preserve the tube's shape (right).

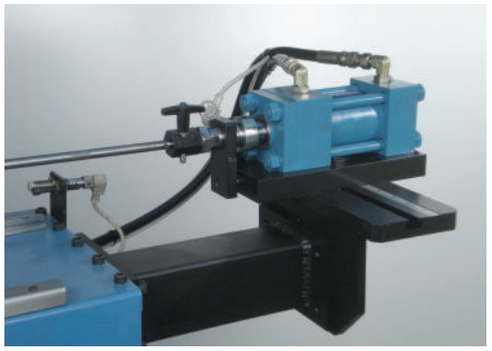


Figure 2

A proximity sensor on a hydraulic mandrel extractor sends feedback to a machine's controller to confirm that the mandrel has been extracted.

A pneumatic extractor is a good choice for small-diameter tubing. This is an environmentally friendly piece of equipment, but the typical shop air (80 pounds per square inch [PSI]) found in most fabrication shops isn't enough to handle large diameters.

More common on modern tube bending machines is a hydraulic extractor. With the right hydraulic cylinder size, a hydraulic mandrel extractor is an efficient way to extract the mandrel. While a pneumatic extractor is limited in capacity, a hydraulic extractor has no such limit.

A chief characteristic of hydraulic extractors is that they don't hesitate when they receive the command to retract. Some pneumatic extractors delay before the mandrel starts to retract from the bend zone, which leads to a longer cycle time. Even if the delay is short, it can add up over a year, a month, or even a week.

Another type of extractor uses an electric servo drive. Greener than a hydraulic extractor, an electric servo extractor can work to shave the cycle time from the overall bending process. Electric servo extractors aren't as limited in capacity as pneumatic extractors are; the drawback concerns the costs, both the initial investment and replacement parts. It is never fun to purchase a configured servo drive from the original machine tool builder when the bender is down.

Mandrel extractors are as varied as tube bender tooling itself. Variants include extractors for nonround tubing, multistack vertical positioning, and those that position a mandrel in more than two horizontal locations. Instead of having just two positions (inserted and retracted), some tube loaders require that the mandrel start in one location (before the bend starts); move to a second location to support the tube during the bending process; and retract to a third location after the bend is finished.

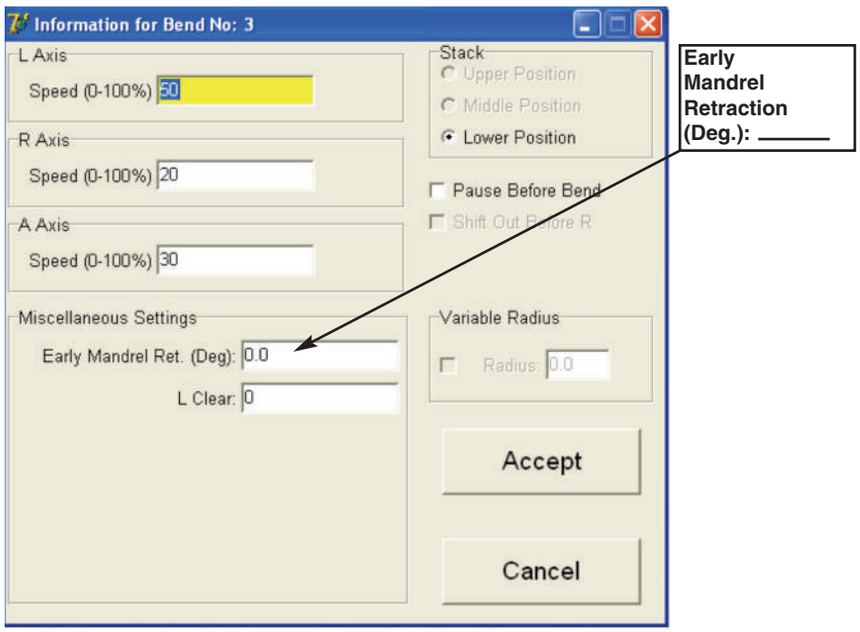


Figure 3

To program the controller for early mandrel extraction, the operator enters an angle. This angle determines how far before the end of the bend the mandrel is to be extracted. A sophisticated controller allows the operator to enter a unique value for each bend.

CONTROLLING A MANDREL EXTRACTOR ON A CNC TUBE BENDER

The goal of the machine's controller is to get the mandrel into and out of the bend zone at the right time in the bending process. For the most part, this is not too difficult. A mandrel extractor typically pushes the mandrel into a bend zone before the clamp closes. Then, after a bend is finished, the mandrel extractor pulls the mandrel out of the bend zone before the clamp and pressure dies open. It is most important for the machine's controller to confirm that the mandrel is extracted from the bend zone before the clamp and pressure dies open (see **Figure 2**).

In some tube bending applications, the extractor must retract the mandrel from the bend zone before the bend is complete. When the bend is formed at 120 degrees per second, the machine's controller must be able to react quickly to retract the mandrel consistently from bend to bend, part to part. This technique is known as early mandrel extraction. High-end tube bending controls usually allow for this feature through the operator interface (see **Figure 3**).

ALTERNATIVES TO A MANDREL EXTRACTOR

Some mandrels don't need to be extracted. For example, some bending applications use a low-melting-point alloy for the mandrel. The operator heats the alloy, pours it into the tube, and allows it to cool before bending the tube. After making the bend, the operator heats the tube and pours the mandrel out.

Another approach is pinch-roller tooling. Pinch rollers are designed to control the ovality of a tube in the bend zone and do not require a mandrel. TPJ

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