PUTTING A FEW END FORMING BASICS TO WORK

Understanding the forming action, friction, lubrication

By George Winton, P.E.

END forming processes are used to change the shape of a significant majority of fabricated tube ends. Quite often one or both tube ends must be formed to mate to another part. The mating part might be another tube, a small component such as a fuel pump, or a large component such as an engine block.

Forming a specific shape takes planning. An understanding of a few basics during the planning stage can go a long way.

RAM END FORMING

One of the most common types of end forming machine is a ram-type end former. Usually the machine holds the workpiece stationary in a set of clamp dies while a hydraulic or pneumatic ram advances; a tool secured to the ram forms the tube's end (see **Figure 1**). A simple example is forming a bead. One application maintains the tube end's diameter; another reduces it.

Maintaining the OD. When the forming tool contacts the workpiece, the ram tool causes the tubing to cold-flow. The flow path is the path of least resistance. In this application, beading, the ram tool holds the tube end captive and compresses it as it forces it toward the clamp dies. The unsupported section of the tube—in the area between the clamps and the ram tool—buckles under the compressive loading, forming the bead.

In this particular case, the tooling's surface finish is not that critical to making the end form successfully. Likewise, lubricant in this case is not critical.

Reducing the OD. A setup that forms a bead and reduces the OD is similar to the one shown in Figure 1. The only difference is the shape of the forming tool. Its ID decreases; this feature forms the tube's OD, so it too decreases during the forming process (see **Figure 2**).

In this case, the ram tool performs more work than it did in Figure 1. Moreover, the surface finish and lubricant are critical for product quality.

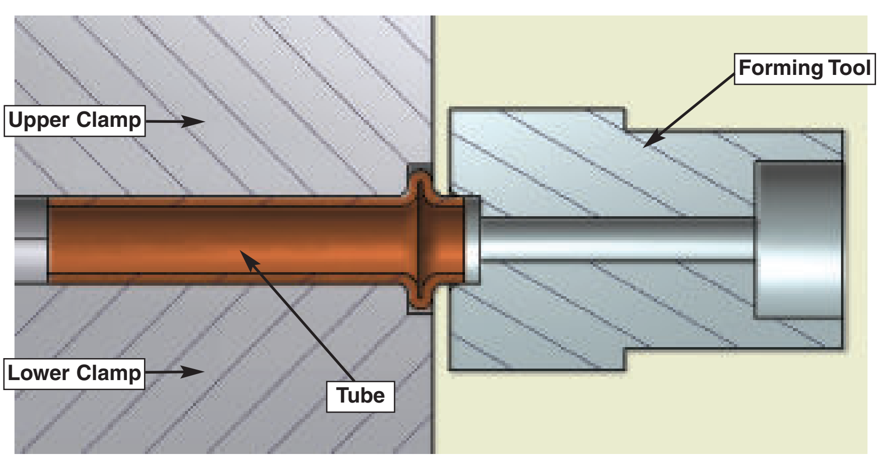

Figure 1

A basic ram forming setup has a clamping device to hold the tube stationary and a forming tool advanced typically with either hydraulic or pneumatic pressure.

SURFACE FINISH, LUBRICANTS, AND COATINGS

As the tool advances onto the tube, the tube first necks down. Long-term success for this application depends on a smooth interface between the workpiece and the tooling.

How smooth is smooth enough? One way to quantify smoothness is root mean square (RMS), a mathematical average,

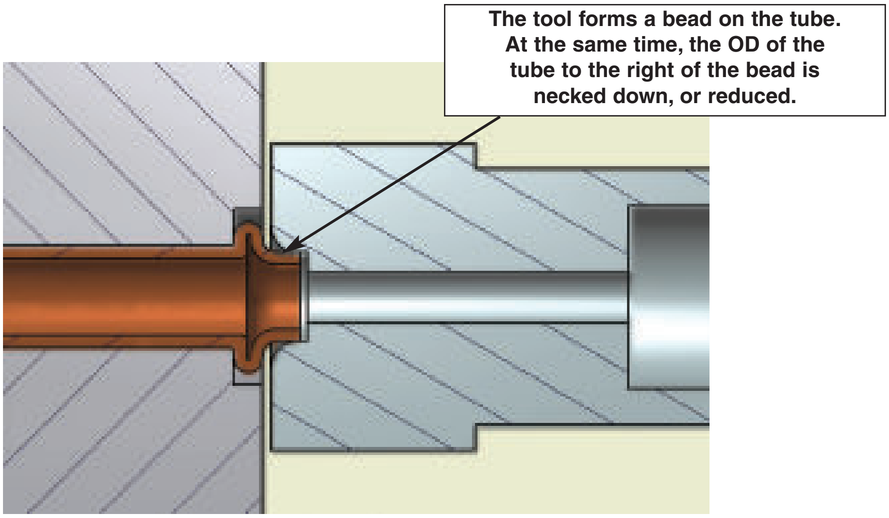

Figure 2

The tooling is different from the tooling in Figure 1; a decreasing ID where the tooling contacts the tube forces the tube's OD to shrink.

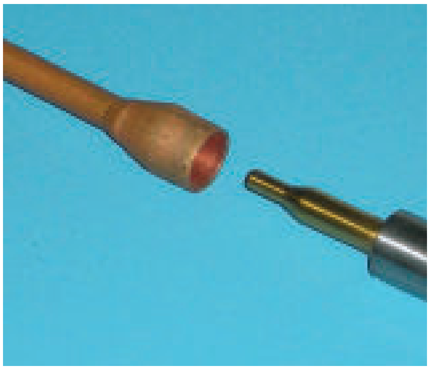

Figure 3

This easily visible coating (gold color) is merely 0.0002 in. thick. It protects the tooling and, when coupled with an appropriate lubricant, helps the process to expand the size of the copper tube from 3⁄16 in. to 3⁄8 in.

or mean, of the high and low points—peaks and valleys—on the surface. For example, a mirror typically has a smoothness of 4 RMS; a magazine cover is around 16 RMS; a business card about 32 RMS.

For this job, a finish of 32 RMS is too rough. The outcome would be considered a serrated finish and most likely would produce inconsistent results.

Surface finish isn't the only consideration. In fact, even if the tool's surface finish is acceptable, it can quickly come to an early demise if it isn't properly lubricated. As the ram tool necks down the tube, the process develops an enormous amount of friction between the tube and the tool's bore. If the lubricant is applied inconsistently, the process and results will be inconsistent.

A coating can extend the tool's life. Typically applied to heat-treated steels, the coating extends the tool's life by increasing its surface hardness (see **Figure 3**). TPJ

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