remove the finished workpiece from the tooling.

In cases of a less accurate internal profile but a complex outside shape, a fixed plug can redirect the material flow to ensure correct coverage. This type of mandrel can be made from a tool steel with a highly polished surface or carbide coating to reduce wear caused by workpiece removal. The contact area is smaller than that of an expanding mandrel, and only a small surface will remain in contact at the end of cycle. Material springback is also a factor in decreasing friction.

In both cases–whether using a fixed plug or an expanding mandrel–the outside dimensions that define the type of fit in the tube can be changed easily because segmented tooling is suitable for a small range of sizes around the nominal value that it was designed for.

Segmented tooling does present some drawbacks, however, such as tool marks made on the wall of the tube at the edges of the forming dies.

Segmented tooling generally is designed for universal drop-in, inside-outside (I/O) tooling in both standard and large-barrel configurations. It can accommodate tube sizes ranging from 1 by ¼ in. to 4 by 4 in. The standard angle is 14 degrees on the cone and outside of the dies. Designing tooling around industry standards allows the use of standard tool components for new applications.

When more reduction is necessary, a larger angle can be used. This allows for a larger opening to fit the new part into the forming dies. However, dies with a custom angle require a custom cone with the same angle.

Based on the close tolerances of profiled dimensions, stringent requirements–part straightness, equal step-down from the original tube to profile on all sides (common centerlines), minimal taper condition on the formed area–create new challenges in the forming process.

Segmented tooling does present some drawbacks, however, such as tool marks made on the wall of the tube at the edges of the forming dies. Also, the amount of reduction that can be achieved is limited.

Die Design for Welded Tube. Another challenge is in the use of

welded tube. One side of the rectangle contains the welded seam. Compared to the rest of the tube circumference, the weld seam has significant differences in strength, hardness, flow characteristics, and springback. The welded side and the opposite side resist the forming forces with different values, resulting in slightly different dimensions.

A die design that allows the dies some degree of axial rotation is beneficial for self-alignment for forming round parts. However, this is a drawback with nonround parts. The small gap between the dies, and their ability to rotate axially, allows the dies to close more on the side opposite the weld seam. Square and rectangular parts formed with this type of die are not symmetrical.

Another die design–one that is specifically intended for rectangular tube–has a guiding system that restricts axial rotation, helping to ensure a proper approach of all four dies at 45 degrees. The guiding system prevents axial pivoting of the dies, resulting in symmetrically formed parts.

As parts are fed manually into the machine, the dies contact the forming length while the rest of the tube is free. This condition leads to parts with deviation of the formed end toward the weld, as stress in the tube is concentrated in a pattern dependent on the weld. Assembling two or three of these sections together accentuates this deficiency. A set of dies that contact both the end formed area and some length of the unformed area help to decrease or eliminate these deviations.

Ram Forming or Segmented Tooling?

Although ram forming continues to be a viable end-forming method, use of segmented tooling is growing. In applications that have more stringent forming requirements, segmented tooling can be a suitable alternative.

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