Evaluating lubricant performance for stamping

Part I: Analysis factors and testing methods

BY ADAM GROSECLOSE

Editor's Note: This article is Part I of a two-part series that reviews practical testing techniques used to evaluate lubricant performance at the Center for Precision Forming (CPF) of The Ohio State University. Part II, which will appear in the April issue, will cover additional lubricant and stamping research, as well as the evaluation of lubricants for a major OEM.

In response to changing market conditions and consumer expectations, the automotive industry continues to introduce new materials for stamping. These materials—galvanized advanced high-strength steel (AHSS) and new grades of aluminum alloys and stainless steels—may require advanced lubrication systems to enhance formability and reduce scrap rates.

In September 2008 the Center for Precision Forming (CPF) at The Ohio State University sponsored a seminar, Lubrication in Stamping Workshop, to bring together stampers, lubricant suppliers, and lubricant application system manufacturers to discuss issues of common interest related to the practice and advancement of lubrication in stamping operations. The workshop included presentations and panel discussions on:

- The stamping process as a system—blank material and coating, lubrication, press characteristics, tool material and coating, deformation mechanics, interface conditions, and product properties.
- Methods for evaluating the performance of various lubricants in deep drawing and stamping.
- Application of various tests (twist-compression, draw bead, strip draw, cup draw) to evaluate lubricants under realistic, near-production conditions.
- Fundamentals of friction and lubrication in stamping and the effects of blank and die material, surface finish, die/blank interface pressure and temperature, press speed, and die temperature.

Analysis Factors

Many factors need to be considered in the analysis of a lubricant's applicability to a certain process. It is not sufficient to select a lubricant with low coefficient of friction for the stamped part. It is necessary to consider the workpiece material, the tooling, the tool/workpiece interface, the deformation zone, the equipment, the finished part, and the environment (which includes the handling and pre- and poststamping processing).

Figure 1 shows a typical deep-drawing system which shows an automotive case with wet lubrication. The schematic indicates material handling, lubricant application, stamping processes, and lubricant removal for such postprocessing as painting and welding.

Consideration of the system approach is important. If a lubricant gives a low coefficient of friction but causes corrosion of the workpiece or tooling, causes degradation of the environment, or cannot be cleaned off, then the lubricant cannot be considered effective for application. Therefore, the laboratory tests should emulate the practical stamping conditions and processes so they can be taken into consideration when choosing a lubricant for a given stamping operation.

Lubricant Evaluation Tests

Two tests were conducted evaluating the lubricity and coefficient of friction of lubricants related to galling, tool materials, and coatings:

- **Cup drawing test**—A round blank is drawn into a round cup (see **Figure 2**). The performance criteria are the maximum drawing load, the maximum applicable blank holding force (BHF) without fracture, measurement of draw-in length or flange perimeter of the drawn cup, and visual inspection of buildup on dies during use of dry lubricants. After cup drawing, the flange is removed and the part is ironed.
- **Strip drawing test**—This test is similar to the cup drawing test, except a 14-inch by 1-inch strip of material is used instead of a round piece. The strip is drawn into a hat shape, and maximum drawing load and measured draw-in length are used for evaluation (see **Figure 3**). The test was developed to evaluate AHSS, which is difficult to use with the cup drawing test. It also is cheaper and faster to run than the cup test, so it is practical for evaluating a

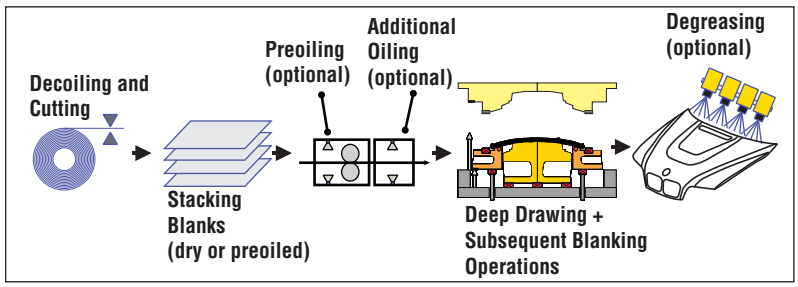

Figure 1

This stamping system is designed for an automotive stamping process with oil-based (wet) lubrication (courtesy of M. Pfestorf, 2005, BMW).

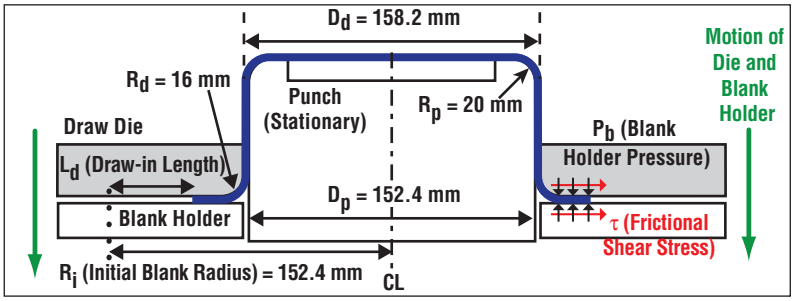

Figure 2

The cup drawing test is used to evaluate the performance of lubricants in stamping of low-alloy steels and aluminum alloys.

large number of lubrication conditions quickly.

In the cup ironing test, the galling of the tool is observed along with maximum ironing load and cup thinning. For the strip ironing test, the clearance between the punch and die inserts is reduced to create an ironing situation, but otherwise the test is run in the same way as the strip drawing test. ST

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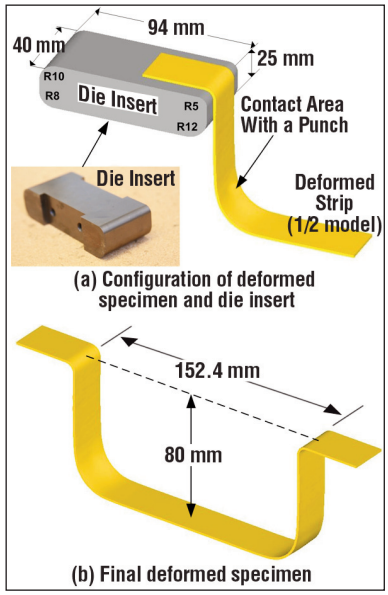

Figure 3

The strip drawing test is used to evaluate the performance of lubricants in stamping of AHSS.