Evaluating lubricants for stamping galvannealed steels, Part I

The strip drawing test

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Editor's Note: This article is Part I of a two-part article that discusses the evaluation of lubricants for stamping galvannealed steels. Part I describes the strip drawing test. Part II, which will appear in the September/October issue, will discuss the deep-drawing test.

Lubrication is one of the important parameters that can improve part quality in stamping. This is very evident when stamping galvannealed (GA) steels; GA steel is difficult to deep draw because of its hard iron coating. Better lubrication can increase the forming process window (see **Figure 1**) and reduce the scrap rate.

The Center for Precision Forming at The Ohio State University, in cooperation with Honda of America Manufacturing Inc., conducted a detailed study and evaluation of 21 different types of lubricants, some already in use at Honda's North American and international plants (see **Figure 2**).

Chemical Stability, Corrosion Testing

Quaker Chemicals and IRMCO conducted chemical stability and corrosion tests on the selected lubricants. They tested the mixture of lubricant, washer oil, and mill oil over a period of time at different temperatures for precipitation, haziness, and corrosion on galvannealed steels.

Lubricants that were successful in these tests also underwent a cleanability test, conducted by Henkel Corp., to determine their characteristics for such postprocessing applications as welding and painting. Seven lubricants were eliminated after the chemical stability, corrosion, and cleanability tests.

Realistic Testing Conditions

Several tests can be used to evaluate stamping lubricants, but only a handful of them can emulate the relevant process conditions that exist in the industrial stamping environment. Important parameters such as stamping speed, contact pressure at sheet-die interface, die surface, and sheet metal deformation need to be similar to the conditions existing in stamping plants.

These realistic conditions are used in the deep-draw test (DDT), which involves deep drawing of a cup. Since the strip draw test (SDT) works on the same principle as the DDT, except that a strip is formed instead of a cup, it was used as a preliminary test in this study because a large number of lubricants were tested. Lubricants that performed well in the SDT were later tested using DDT.

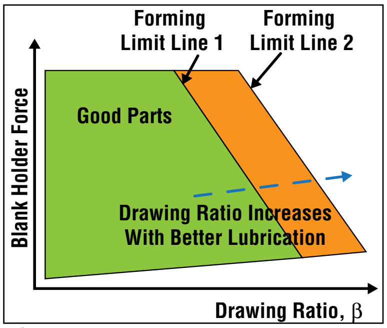

Figure 1

Good lubrication can increase the forming process window and reduce the scrap rate.[1]

Synthetic lubricant	L1, L11, L12, L13
Semisynthetic lubricant	L10
Water-based lubricant	L6, L15
Petroleum-based lubricant	L7, L8, L9, L14
Washer oils	W2, W3

Figure 2

Several types of lubricants were evaluated for the study.

Strip Drawing Test

Strips measuring 14 by 1 by 0.03 in. were drawn on a 160-ton hydraulic press using an uncoated graphite cast

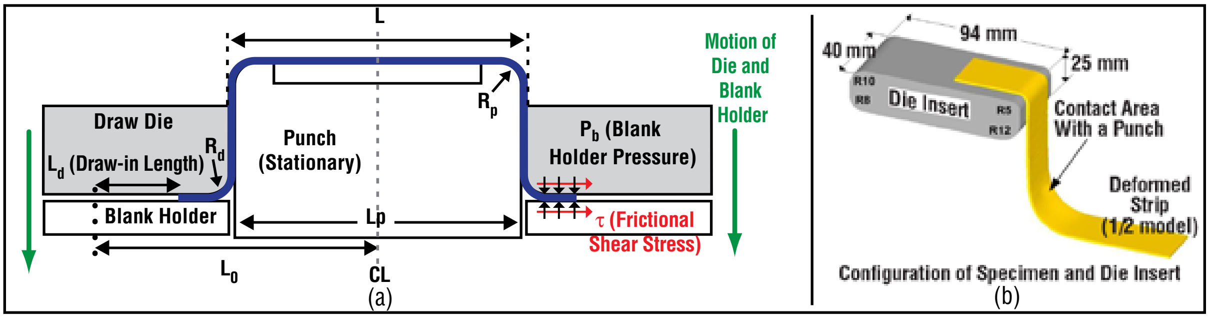

Figure 3

The strip draw test (a) evaluates lubricants based on strip length after drawing (b).

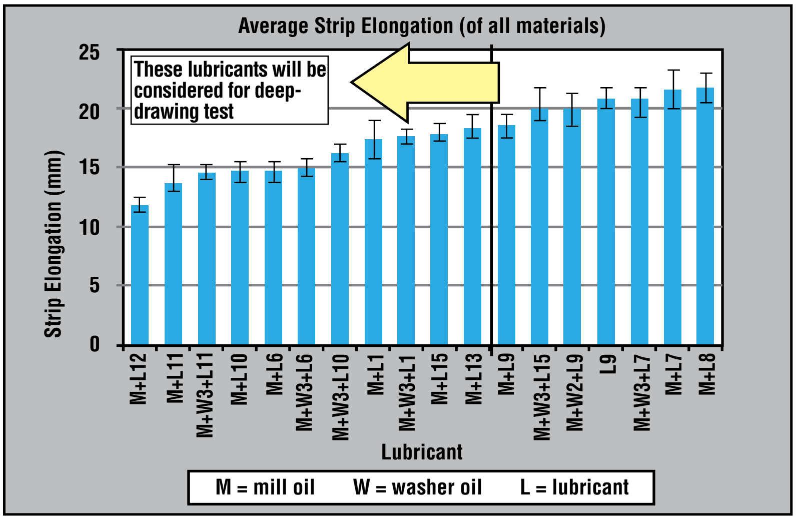

Figure 4

The average elongations of strips of four different sheet materials, formed under different lubrication conditions, are shown here.

iron die (see **Figure 3**) with a corner radius of 5 mm. This radius was chosen to achieve a severe condition at the contact area. Press speed was about 10 mm/sec., based on experimental trials, and blank holder force was set to 3 tons, based on results of finite element simulations, which revealed thinning of the sheet after drawing.

Eighteen lubrication conditions were tested on four varieties of draw-quality GA steel. The lubricants were applied using a draw down bar and pipette to 1.5 (±0.3) gm/m^2, emulating the lubrication conditions in stamping plants that use 0.6 to 0.8 gm/m^2 of lubricant on the sheet blanks.

Lubricant performance was judged based on the strip length after drawing. The lengths of the strips before drawing were the same; their lengths after drawing depended on the coefficient of friction at the tool-strip interface. The better the lubricant, the lower the coefficient of friction and lower the strip elongation.

The strips that showed less elongation had better material flow during forming and less thinning (see **Figure 4**). Thus, they were considered to be formed with better lubricants. Strip elongations varied from 12 to 23 mm, showing a large difference in the behaviors of the tested lubricants.

The lubricants were tested on four different sheet materials, and there was no significant difference in the performance of lubricants on the different materials. Lubricants that performed best were tested further using the DDT. ST

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Notes

1. M. Meiler, M. Pfestorf, M. Merklein, and M. Geiger, "Tribological Properties of Dry Film Lubricants in Aluminum Sheet Metal Forming," in proceedings from the 2nd ICTMP, Nyborg, Denmark, June 15-18, 2004, pp.489-500.