Evaluating lubricant performance for stamping

Part II: Determining the best lubrication conditions for tryout

BY ADAM GROSECLOSE

Editor's Note: This article is Part II of a two-part series that reviews practical testing techniques used to evaluate lubricant performance. Part I, appeared in the March issue.

One of the main topics discussed at a Lubrication in Stamping Workshop was a project being conducted by the Center for Precision Forming (CPF) for a major original equipment manufacturer (OEM). In this project, CPF has started to analyze 19 different lubricants and their performance with different materials. The materials include two grades of Galvaneal® draw-quality steel, which are to be studied with and without prephosphating, and one grade of aluminum-alloy sheet. Six different companies submitted their lubricants for testing.

Lubricants were tested individually and in various combinations. Thirty-four different lubrication combinations of mill oil, wash oil, and stamping lubricant go through a battery of preliminary screening tests. The objective is to identify the two or three best lubrication conditions that should be tried out in production.

Evaluation Tests

Lubricants were evaluated using the following procedures:

•**Stability test**—This test was performed by mixing the lubricants into their respective combinations and letting the mixtures sit for four weeks. Observations were made periodically to see how the mixture was reacting (such as soluble or separated).

•**Cleanability/paintability test**—In this test, lubricant combinations are applied to the tested sheet materials and are allowed to sit for a couple of weeks to simulate being in the company's storage. This is sometimes referred to as the stack stain test. After the waiting period, the lubricants are removed. The difficulty of removal is noted and the appearance of the sheet surface is observed.

•**Strip draw test (SDT)**—The lubricant was used to draw a 14-in. by 1-in. piece of material into a hat shape. The draw-in length of the sample and the punch force were recorded (see **Figure 1**).

•**Cup drawing test (CDT)**—A round cup was drawn, with a larger draw-in length and smaller punch force indicating better lubricant performance (see **Figure 2**).

Testing Results

The stability test, cleanability test, and preliminary SDTs have been run for this particular project and the results summarized. The stability and cleanability/paintability tests were performed by lubricant suppliers in cooperation with the OEM and CPF and included suppliers' experience and advice in testing and results analysis. From these two tests, CPF was able to eliminate 11 lubricant conditions from the study.

The preliminary SDTs were run to fine-tune the test for the OEM's process. To ensure ideal conditions, the press speed in the test was similar to the press speed in production. The blank holder force (BHF) was maximized and the tool radius minimized to give the greatest forming pressures and largest variation between lubricants.

The smallest available die corner radius was chosen, since it gave the largest pressures and the most severe

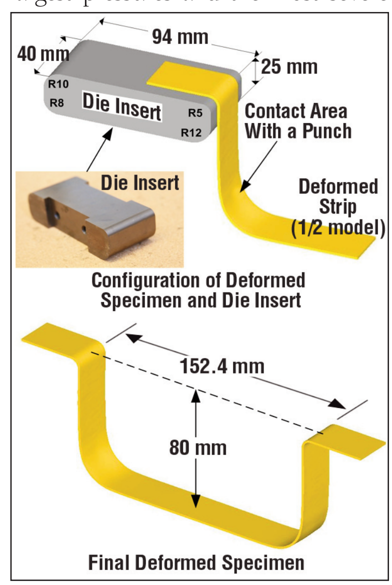

Figure 1

In the strip draw test, the lubricant was used to draw a 14-in. by 1-in. piece of material into a hat shape.

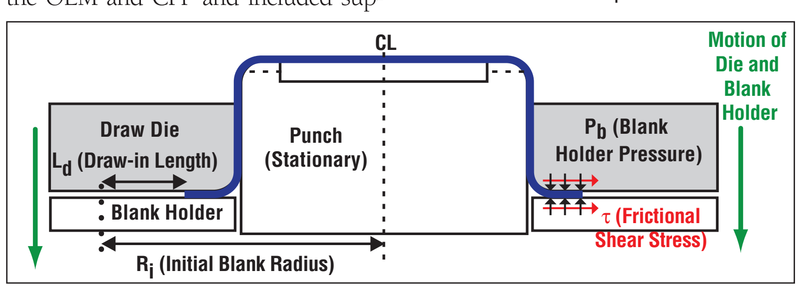

Figure 2

In the cup drawing test, a round cup was drawn, with a larger draw-in length and smaller punch force indicating better lubricant performance. This test determines the maximum applicable BHF.

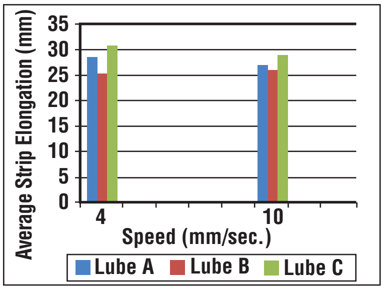

Figure 3

This is the average strip elongation for the 4-ton BHF.

lubrication conditions at the tool/material interface. The BHF was chosen based on finite element method (FEM) simulations and experiments. The samples fractured under 5 tons, and there was very little variation between strip elongation under 3 tons, so a 4-ton BHF was chosen (see **Figure 3**).

Press speed played an important role in the strip elongation, which was

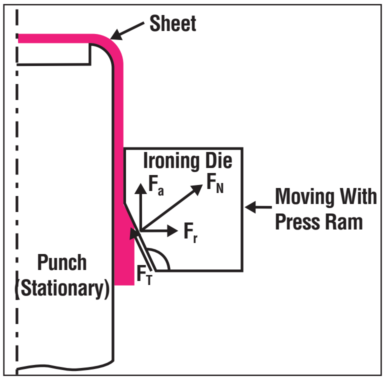

Figure 4

An ironing test determined lubricant performance under high-surface-pressure conditions.

expected, but not to the extent that was found.

The ideal speed was estimated to be 40 millimeters (mm) per second, but this speed caused fracture for all BHFs; 20 mm per second caused fracture for the 4-ton and 5-ton BHFs and little variation in 3-ton BHFs. The other press speeds of 4 and 10 mm per second were tested and produced no fractured samples. Thus, the speed of 10 mm per second was chosen because it was closer to the production speeds.

With the test parameters (die corner radius, BHF, and press speed) chosen, the SDTs currently are under way to analyze the 23 remaining lubrication conditions. The best lubrication conditions, determined by SDT, will be tested further by cup drawing and ironing (see **Figure 4**) to determine the performance of the lubricants under high-surface-pressure conditions. ST

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