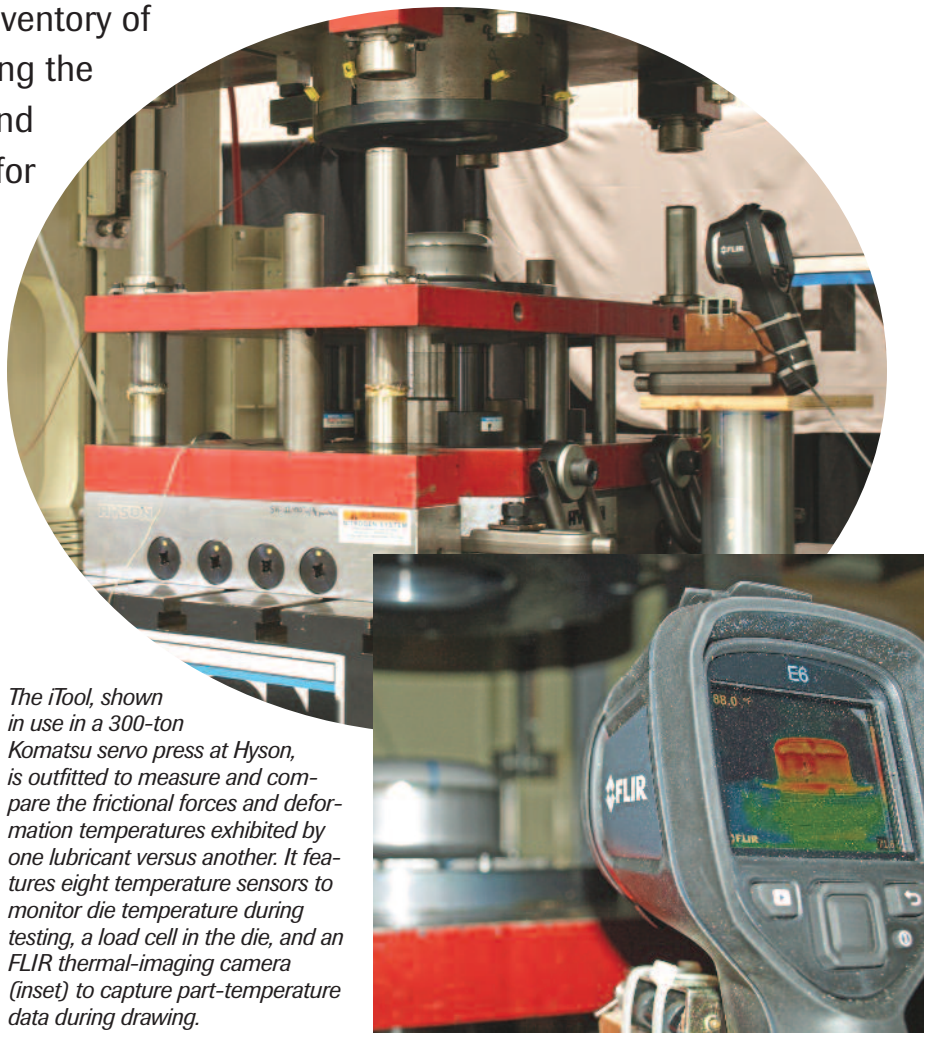
A Data-Driven Approach to Lubricant Selection

Automotive supplier Shiloh Industries has embarked on a rigorous lubricant-testing and evaluation process, with the goals of streamlining its inventory of stamping-lubricants; eliminating the use of chlorinated paraffins; and identifying the right lubricant for stamping advanced high-strength steels.

BY BRAD F. KUVIN, EDITOR



The iTool, shown in use in a 300-ton Komatsu servo press at Hyson, is outfitted to measure and compare the frictional forces and deformation temperatures exhibited by one lubricant versus another. It features eight temperature sensors to monitor die temperature during testing, a load cell in the die, and an FLIR thermal-imaging camera (inset) to capture part-temperature data during drawing.

Chlorinated paraffins (CPs) in lubricants soon will be banned by the Environmental Protection Agency, possibly as early as July 2017. Faced with that stark reality, technical specialist Cliff Hoschouer at Shiloh Industries, Valley City, OH, has embarked on a proactive and engineering-driven course to evaluate the company's stamping-lubricant options moving forward.

Hoschouer's mission is to identify the ideal lubricants to handle the firm's current projects—Shiloh employs CP-containing lubricants for difficult deep-drawing applications. At the same time, he's looking ahead at the influx of work requiring the forming of advanced high-strength steels (AHSS). For this work, a new lubricant strategy also is required.

"We're deep-drawing mild steels, for oil pans for example," shares Hoschouer. "We also form a lot of TRIP 780 and DP600 AHSS grades and blank DP980 steel, and we stamp some stainless steel and aluminum." That combination of work has led to the use of about 10 different lubricants throughout the company—Shiloh operates several stamping plants throughout North America, and also has two plants in Europe. Some 20 percent of its work requires the use of CP-containing lubricants.

"As we look ahead to more and more AHSS work coming in," continues Hoschouer, "and the banning of CPs, we felt it was time to reevaluate our

lubricant program and streamline. We'd like to settle on four or five lubricants that can handle our entire book of business, and that also will equip us for the future—maybe one lube for aluminum, one for stainless steel, and one or two for deep-drawing of mild steels and for stamping AHSS."

An Engineering Approach

Shiloh has been on a mission in recent years, focused on being a "lightweight solutions provider," Hoschouer says. "That's leading the company into more AHSS work, and we need to be ready to handle that. DP980 will be a workhorse."

In 2015 Shiloh experienced a record year for new business, according to reports, adding new customers and new products at a rapid rate. It's transforming itself from a blanking company into a product-development company, becoming more integrated with customers and vehicle designs. That means a lot of new-product development—it launched 527 new products in 2015, three times as many as in 2014, and 60 percent of its new sales represent the sale of lightweighting technology. That, and previously noted factors, have Hoschouer and others at Shiloh thinking ahead.

Such forward thinking led Hoschouer, in mid-2015, to spearhead Shiloh's lubricant-evaluation program, which concludes later this year. The company formed a team of people across multiple disciplines to devise a plan that would take into consideration how a shift to new lubricants would impact the company, as well as its Tier One and OEM automotive-industry customers. The plan of action: Take a scientific approach to testing a variety of lubricants on multiple workpiece materials on the most challenging of applications.

Hoschouer's team began by identifying the CP-containing lubricants where the company was at risk, and then invited four suppliers to submit potential replacements to handle its most difficult mild-steel deep-drawing work, and its challenging AHSS parts. To conduct its trials, the team enlisted the help of a new tool and test method developed by lubricant manufacturer Irmco, Evanston, IL, in partnership with Bennett Tool & Die, Nashville, TN, and the GE Advanced Mfg. Development Group, Louisville, KY. The tool, dubbed the Irmco iTool, performs controlled and monitored cup-draw testing. Testing follows a methodology based on research conducted by Dr. Taylan Altan at the Ohio State University and the Center for Precision Forming, in Columbus, OH. The tool is outfitted to measure and compare the frictional forces and deformation temperatures exhibited by one lubricant versus another.

Over two days of testing, nearly 400 12-in. blanks were deep-drawn; materials tested were 2-mm-thick mild, HSLA, and stainless steels, and 1.4-mm DP1180 (an AHSS grade), shown here.

iTool in Action

We caught up with Hoschouer and a team from Irmco at Hyson headquarters near Cleveland, OH, earlier this year. Hyson's 300-ton Komatsu servo press was enlisted to put the iTool through its paces on behalf of Shiloh.

The Irmco iTool Consortium

Ten years ago, Dr. Taylan Altan invited lubricant supplier Irmco to participate in his metalforming research at The Ohio State University's Center for Precision Forming, and then later when he joined the Edison Welding Institute Forming Center. Dr. Altan's team was conducting cup-draw tests (CDT) on advanced high-strength steels (AHSS). The CDT is a practical friction test, and Irmco had experienced good correlation of its lubricant performance on difficult draws in the real world. Unlike benchtop friction equipment, the CDT utilizes an actual press and die.

Irmco envisioned a need for stampers to evaluate lubricants in a controlled, unbiased manner—without using their own, valuable production-press time. It also recognized the industry's need to better understand the capabilities of servo presses, and to gauge how forming in a servo press impacts tooling and part temperature.

After presenting these concepts at Great Designs in Steel, in May 2015, the Irmco iTool Consortium was born. The consortium: GE Louisville's Advanced Mfg. Development Team, Bennet Tool, Unist and Hyson. Shiloh and other metal stampers also have come on board.

Hoschouer used the setup, which included 16 tons of nitrogen blankholder force built into the tool, complemented by a Hyson 50-ton servo-controlled hydraulic cushion, to blind-test 24 different lubricants—synthetics and oil-based products from several suppliers. Over two days of testing, nearly 400 12-in. blanks were deep-drawn; materials tested were 2-mm-thick mild, HSLA and stainless steels, and 1.4-mm DP1180 (a duplex AHSS grade).

Bennett Tool built the ASTM-design iTool, which features eight temperature sensors to monitor die temperature during testing, a load cell in the die, and an FLIR thermal-imaging camera to capture part-temperature data during drawing.

"The test setup performed perfectly for deep-drawing of mild, HSLA and stainless steels," says Hoschouer, "providing a wide spread of data for the various lubricants. The extra tonnage from the servo-hydraulic cushion played a critical role in ensuring we developed sufficient blankholder force.

"However, with the AHSS material, the data is too clumped together to make complete evaluations," he adds, "so we'll be conducting further studies on AHSS, as well as on aluminum, using our inhouse 600-ton hydraulic press. It allows us to apply tonnage throughout the entire stroke."

In addition to tracking tool and part temperature during drawing, the test procedure also called for automated circle-grid analysis of test samples, using the Argus system, to evaluate strain and thinning; and manual measurement of the perimeter of each blank.

"Ideally, we want the blanks to draw into the die, rather than stretch and thin," Hoschouer says. "With this setup, we can correlate material movement to temperature while capturing strain and workpiece-temperature data. The better the lubricant the less thinning we get."

Drum Roll, Please

The preliminary results are in, and Hoschouer and his team have successfully narrowed the list of candidate lubricants down to five. In early summer, Hoschouer expects to enroll those five lubricants in a full-scale testing program at one of Shiloh's stamping plants, on production parts (parts will be washed prior to shipping to the customer).

"We'll test the five lubricants on an array of materials and parts," Hoschouer says, "and get a better idea of which of the five lubricants actually makes a positive impact on our processes. We hope to narrow the list of finalists down to two or three lubricants that we eventually will move into widespread production.

"In fact," Hoschouer continues, "some of the finalists actually performed very well on all of the materials we've tested—maybe not the best on all materials, but in the top five on all materials. If that holds up in full-scale testing, we might be able to get down to one or two lubricants." **MF**