Q. Tribology

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Contractor: U.S. Automotive Materials Partnership
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Objectives

- Conduct stamping simulation tests to study the effects of tribological conditions on the stamping performance of advanced high-strength steels (AHSSs). Stamping performance in this project is defined as minimizing die wear and identifying the optimum die materials and lubricants for AHSSs.
- Include these ultimate benefits:
  - Improve test procedure to simulate die wear.
  - Define a model for prediction of die wear.
  - Optimize lubricant/die combinations for AHSSs.
  - Maintain common lubricants among automotive companies and steel suppliers.

Approach

- Examine wear rates of different die materials, die surface treatments and lubricants with AHSSs.
- Comparison of wear rates with different lubricants and die materials.
- Evaluation of methods of improving die life.
- Optimized lubricants/die combinations for AHSSs.
- Project consisting of L16 (DOE) two material grades, two thickness, two sheet coatings, two bead radii, two lubricants and two bead coatings.

Accomplishments

- Completed Phase 1 report "Enhanced Stamping Performance of High Strength Steels with Tribology."
- Completed Phase 2 report "Effect of Stroke Length and Penetration on Die Wear."
- Obtained steel coils of galvannealed AKDQ, HSLA340, and DP600 supplied by partner companies. The materials are used in the wear tests for Phase 3.
- Collected data for the eight test conditions.
- Completed Phase 3 report "Enhanced Stamping Performance of High Strength Steels with Tribology – Report on Phase 3 Testing."

Future Direction

- Develop wear-rate model to predict die life.
- Gather wear test data to substantiate model.
- Correlate model with production data as AHSSs come into production.

Progress Report

October 1, 2004 to September 30, 2005:

A project was initiated to improve the understanding of the effects of lubricants on die wear and part dimensional variation (springback due to interfacial friction) associated with stamping of high-strength steels. Die material will also be studied. Advanced high-strength steels (AHSSs) may require different lubricant and/or die material to minimize die wear, achieve consistent friction, and reduce part variation.

This Phase will examine wear rates of different die materials; die surface treatments and lubricants with AHSSs. The TribSys wear test apparatus was used to evaluate wear tests under various conditions. The test simulates the forming of 48,000 parts. Changes in process conditions and physical wear of the die will be evaluated. The project also builds on and extends knowledge it gained in the previous studies. It established a baseline of die wear from three (3) sheet materials (AKDQ, HSLA, and DP600) and two (2) lubricants (prelube and mill oil) with one die material (flame-hardened G3500). This study will compare the baseline results to D2 die material with and without chromium nitride (CrN) coating. The performance of dry film lubricants will also be compared to mill oil on galvannealed and hot-dipped galvanized AHSS.

TribSys Inc. will conduct experiments to evaluate die wear on drawbeads under the following conditions.

1. A 2" wide steel strip will be pulled through a set of three (3) beads. The center bead will be used to evaluate die wear.
2. Coils will be coated with mill oil and dry film lubricant prior to testing.
3. For each test condition, 48,000 pulls of 2" length will be performed using the TribSys Wear Test Apparatus.
4. Results will be analyzed using statistical analysis and analytical methods (scanning electron microscope/surface roughness). Analysis of wear will be presented in a report.

The timing of the project fell behind due to delays in obtaining master steel coils of various grades and gauges from the steel suppliers. But, at this time the entire required master coils of the various steel grades and gauges have been received at the steel processor. The coils were processed into 2" widths, 50% bare and 50% with dry film lube coating to satisfy the test requirements. All of the coils were then shipped to TribSys Inc. for completion of the die wear tests. The testing shall begin in October 2005.