

# Effect of different additives in metal working fluids for tribological performance of stamping

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Different types of additives used added in two different base metal working fluids were tested in metal sheet-tool (WC-Co) contact. The results show that certain additives can significantly reduce coefficient of friction, while for others the effect is very limited or even negligible. In addition to additive type/group the important role plays also the presence of active sulfur as well as the base metal working fluid used. The AFM study further reveals differences in boundary film properties that prevail over base metal working fluid properties and govern friction performance. It is also shown that certain additives can reach the same friction performance as full-formulated straight oils.

**Keywords (from 3 to 5 max):** tribology, stamping, metal-working fluids, metal sheet, additives

## 1. Introduction

Industries in packaging sector, automobile sectors etc. are using increasingly stamping process as sheet-metal working to get high quality product with less cost. The tribological conditions during this process effect on quality of product and durability of process and tools and usage of different metal working fluids is commonly inevitable. However, residuals of lubricant after the process is un-desired for post-cleaning of the metal sheet [1]. Therefore, the selection of proper lubricant for specific metal sheet is of the great importance.

## 2. Methods

### 2.1. Tribological tests

Tribological tests were performed by using reciprocating sliding conditions in metal sheet to ball contact at normal load of 185 N and stroke length of 10 mm under ambient conditions. Material of ball was WC-Co that is conventional tool material. For lubrication two types of base lubricants were used, namely paraffinic and naphthenic and six types of different additives (friction modifier, poly-alkylene-glycol, phosphate esters, sulfurized esters with and without active sulfur and ester base lubricity additives).

### 2.2. Surface analyses

Metal sheets and balls (tool) were analyzed after the test under the SEM and with FT-IR. In addition AFM analysis were done on some samples.

### 2.3. Results

Results of tribological tests are presented in Figure 1. Results show that most of additives significantly improve friction performance of base vanishing paraffinic oil, while for naphthenic ones this effect is not so large, however still very significant. It is also shown that all ester based additives hinders difference in friction performance between paraffinic and naphthenic oils. In addition, similar friction performance to friction modifiers provide also sulfurized esters with active sulfur.

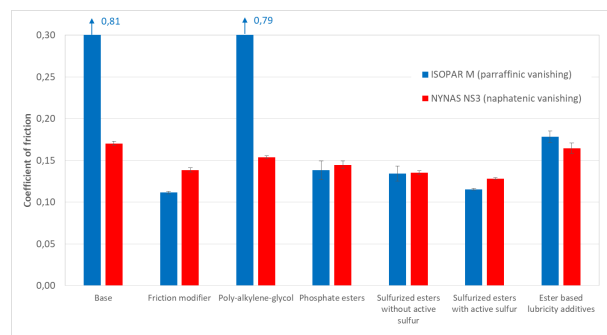


Figure 1: Coefficient of friction results.

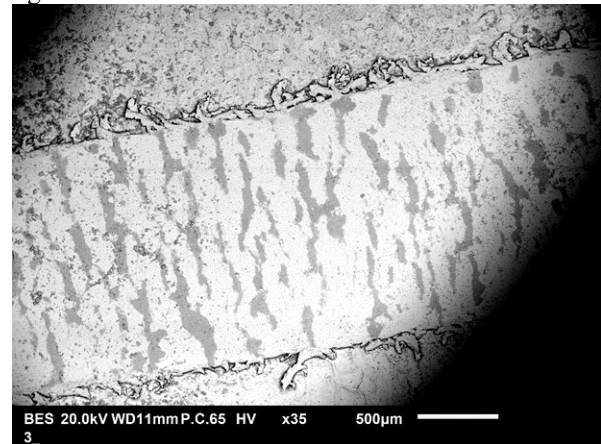


Figure 2: SEM figure of tribofilm formed on the metal sheet.

## 3. Discussion

The SEM analysis shown in Figure 2 show formation of tribofilm on metal sheet that is additionally confirmed with AFM analyses.

## 4. References

- [1] J. P. Byers, Metalworking fluids (2<sup>nd</sup> edition), CRC, Taylor and Francis Group, STLE, 2006.

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