7th World Tribology Congress, WTC 2022
July 10-15, 2022, Lyon, France

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: tribology, stamping, metal-working fluids, metal sheet, additives

1. Introduction

Stamping is one of the most important mass-production manufacturing processes in the automotive, home-appliances, electrical sectors, etc., and it is vital to many steps in the forming of metal pieces. It requires a very efficient and highly customized lubrication technology [1] for its heavy-duty operations. This is due to the fact that contact conditions are in the boundary-lubrication regime, where direct contacts between the surface asperities of the punching tool, die and metal-sheet workpiece are dominating. Successful stamping therefore depends on the specific properties of the interacting surfaces and their ability to form wear-protective and low-friction boundary films.

Methods

1.1. 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).

1.2. 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.

1.3. 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 hot 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.

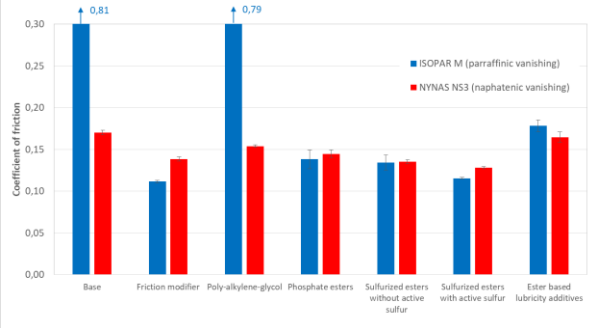

Figure 1: Coefficient of friction results.

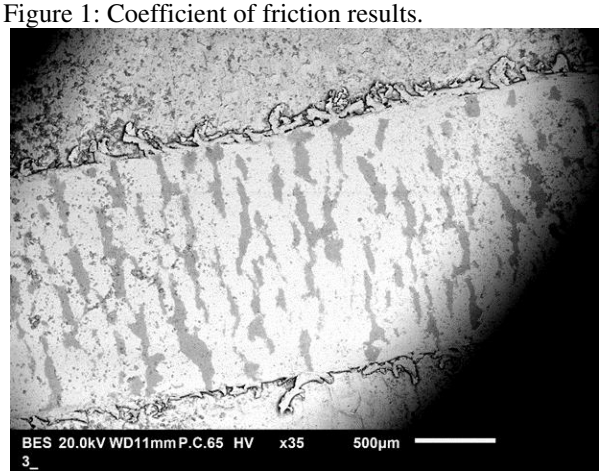

Figure 2: SEM figure of tribofilm formed on the metal sheet.

2. Discussion

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

3. References

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

Acknowledgment

The authors acknowledge the financial support from the Slovenian Research Agency, ARRS (re-search core funding No. L2-9244).