Comparison between different test methods for evaluation of galling properties of tool steel

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Surface finish concerns are critical for the tolerances of many components made of metal sheet. Major obstacles to the generation of acceptably smooth surfaces are smudge, orange peel and galling, with galling also being one of the major causes for tool failure in metal forming processes. Galling develops gradually as an accumulation of material pick-ups on the tool surface during the forming operation, causing aesthetic problems with the work-peace and establishing unstable friction conditions for the proceeded forming process. Generally, lubricants are used in order to decrease friction and adhesion in the contact between work material and tool. However, the very high stresses and high degree of plastic deformation experienced in forming will inevitably lead to metal-to-metal contact and galling initiation.

In recant years the main focus on improving tribological properties of forming tools has been on modifying the surface of the tool, including new forming tool steels, improved surface finish, and application of surface treatments and coatings. In order to evaluate, compare and select suitable materials and/or surface treatments for forming tools proper test methods for galling evaluation are needed.

The aim of the present investigation was to compare and evaluate three different test methods in terms of galling properties assessment of a coated and un-coated forming tool steel. The Pin-on-Disc configuration was included as the most simple and generally used model test in tribology research. However, it has its limitations in testing flexibility. The second method was a modified Block-on-Cylinder test, where, it is possible to scan the contact load during each test run tthrough a spring loading system. Finally, a new load-scanning test method was included, which involves two crossed cylinders, forced to slide reciprocally against each other under a constant speed. The normal load increases gradually during forward strokes and decreases correspondingly during reversed strokes. Thus, each point along the contact path of both specimens will experience a unique load and display a unique tribological history after test completion.

Results of this investigation reveal the load-scanning test rig as the most suitable method to evaluate galling properties of tool steels. It gives the capability to compare different tool steels, surface finishes and treatments, and hard coatings in terms of friction increase, material transfer intensity and critical load for galling initiation. Besides being very simple it also provides results representing a whole range of loads during one single test run. While a modified Block-on-Cylinder test also gives the possibility to scan the contact load, it is limited to a single wear track, thus making the analysis of the history of the contact surface impossible. Pin-on-Disc configuration may be the simplest one. However, limited to a fixed load and a single wear track it is very restricted in galling evaluation, at the same time being very time consuming.