

ABSTRACT

Steel sheets coated with zinc or zinc base alloys, such as Zn-Fe or Zn-Ni, are employed in the construction of automobile bodies with improved corrosion resistance. Among these coatings, the Zn-Ni alloys in the range 11-14% Ni provide superior corrosion resistance and excellent weldability, but are less used than other coatings due to cost factors and, from the technological viewpoint, because of some problems that commonly occur during drawing, such as detachment of hard powders that contaminate the tools and or dirty because of breakage or seizure phenomena arrays. Compared to the mechanical properties of the base steel material of the sheets, whose effects on the forming process are well known, the phenomena related to the tribological behaviour of these Zn-Ni coated have not received attention in the literature : lubricant-materials compatibility, effects of surface finishes, effects of local pressure and speed , etc.

The aim of this thesis is the analysis of the tribological behavior of Zn -Ni coated sheets under the operational conditions of the real drawing processes currently employed in the manufacture of automotive body components. The investigation analyzes the effects of variables that control the values of friction, including the effects of external variables : pressure , speed , viscosity and lubricant additives , and the intrinsic variables of the material, with special attention to the evolution of real surfaces under contact and the flattening process of the surface topography. The influence of nitriding surface treatments applied to the tools on the friction and wear has been also analyzed.

Experimental work was carried out in a plane contact test bench, specially designed for this research work. Multiple passes between tools reproduce the conditions of deterioration or cumulative surface damage characteristics of real processes. Due to the high contact pressure and the low viscosity of drawing lubricants, contact conditions occur in a boundary lubrication regime. The results of the plane contact multi-pass tests have been supplemented with additional microtribometer tests, in order to extend the test conditions to dry contacts and to full lubricated contacts.

Test results indicate that under these boundary lubrication condition, the friction coefficient values have a high dispersion from 0.10 to 0.40, close to the values obtained in dry lubrication conditions tests. The stability of the friction coefficients values in the range 0.10-0.15 depends primarily on the availability of lubricant in the contact zone and on the high speed conditions which favor the formation of boundary layers. The surface plastic deformation mechanisms surface of these coatings are different from those observed in pure zinc coated plates. Asperity flattening and growth of the real contact surface is produced by flattening the sub- surface steel asperities, whose hardness is considerably lower than the hardness of the Zn -Ni coating itself (HV = 315 HV).