Study of the tribological behavior of thermal spray coatings with an interesting potential to substitute to hard chrome plating under different abrasion conditions

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A contribution is proposed by comparing the tribological performances of EHCP with interesting candidates such as thermal spray coatings by using different abrasion wear conditions (under a two-body abrasion test (ASTM G-132) and a three-body abrasion test (ASTM G-65)). More particularly, generated by three suppliers, a large range of different thermal spraying coatings (Cr2O3, T800, WC-10Co-4Cr, WC-12Co, Cr3C2/25(Ni-20Cr, etc.) with different hardness are tribological tested. This study enables to underline that thermal spray coatings (more particularly WC-12Co, WC-10Co-4Cr followed by Cr3C2/25(Ni-20cr)) represent a good alternative to the use of EHCP to enhance the wear resistance and decrease the friction coefficient.

Keywords: Coating; friction; wear; replacement of hexavalent chromium

1. Introduction

Electrolytic hard chrome plate (EHCP) coatings are widely used for their good tribological performances. Confronted to more restrictive safety and environmental requirements, manufacturers need to find alternative solutions. Therefore, a contribution in this field is proposed by comparing the tribological performances of EHCP with interesting candidates such as thermal spray coatings by using different abrasion wear conditions. Indeed, in agricultural operations, oil & gas drilling, mines and quarries, abrasion tests are often used to assess the life of wearing parts, which are very important for estimating the cost of operation.

2. Methods

Tribological results of various thermal spray coatings compared to EHCP coating are presented Figure 1. These results are obtained from tribological tests carried out under a two-body abrasion test (ASTM G-132 - Figure 1 (a)) and a three-body abrasion test (ASTM G-65 - Figure 1 (b)). More particularly, generated by three suppliers, a large range of different thermal spraying coatings (Cr2O3, T800, WC-10Co-4Cr, WC-12Co, Cr3C2/25(Ni-20Cr, etc.) with different hardness are tribological tested.

3. Results

For both abrasion wear tests, it is shown that the coatings composed by WC-12Co, WC-10Co-4Cr followed by Cr3C2/25(Ni-20cr) improve the wear resistance compared to the hard chromium coating. In addition, in the test performed under the ASTM G132, it is highlighted that these similar previous coatings present also a lower friction coefficient compared to the EHCP coating.

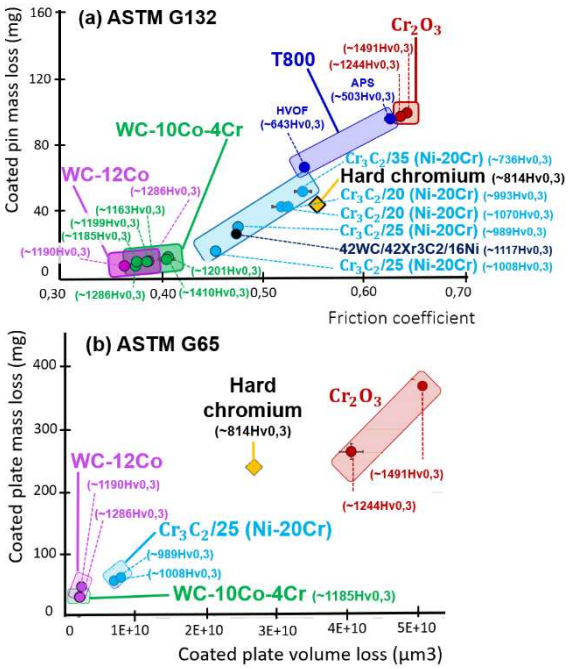

Figure 1: a) Evolution of the coated specimen mass loss as function of the friction coefficient in the case of tribological test under the ASTM G132 standard and (b) evolution of the coated specimen mass loss as function of the coated specimen volume loss for in the case of tribological test under the ASTM G65 standard.

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4. Discussion

This study enables to underline that thermal spray coatings represent a good alternative to the use of EHCP in order to enhance the wear resistance and decrease the friction coefficient. Moreover, despite a cost generally higher, thermal spraying has some advantages in terms of productivity and can use a wide range of materials. Therefore, efforts are currently devoted to testing more optimised thermal spray coatings by comparing different initial wear conditions.