Selective choice of high temperature wear resistant materials

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1. Abstract

Under high temperature environments only a few metallic materials can withstand severe wear conditions and provide required wear resistance. High temperature (HT) abrasion occurs in many applications, e.g. crusher systems or transportation of hot abrasive materials. HT impact/abrasion is the main loading demand in applications where large abrasives hitting and sliding over surfaces. In addition, solid particle erosion is a common wear mechanism in several high temperature applications at the presence of fine abrasives.

The aim of this work was the screening of high temperature materials under various abrasive wear regimes at elevated temperatures. Hence the following wear tests were performed: (i) three-body abrasion tests, (ii) cyclic impact/abrasion tests, (iii) erosion test and (iv) hot hardness tests for detailed study of critical temperatures. In order to create a material selection map for severe wear demands at high temperatures, a widespread material matrix was tested.

2. Experimental

Hot Hardness Tests (HHT) describing hardness dependence on testing temperature were conducted from room temperature (RT) up to 800°C. Hot hardness is a good indicator for material degradation mechanisms, while critical temperature ranges can be determined simultaneously [1]. HT abrasive tests were performed from RT-550°C, representing a typical application range for Fe-based hardfacings. To model high stress three-body abrasion, a heated sample is pressed against a turning steel wheel with abrasive material flowing in between (Fig. 1) [1].

For experimentally simulation of HT impact/ abrasion from RT-700°C a test is realised by a cyclic free falling plunger hitting a specimen at certain angle with an abrasive fed in between. In this case the plunger is able to slide a certain distance after the impact, leading to abrasion [1]. Solid particle erosion was performed from RT-650°C at high impact velocities (80 m/s) at oblique (30°) and normal impact (90°) [2].

Different Fe- and Co-based PTA hardfacings and two high temperature cast alloys (Fe- and Ni-based) were investigated. While Fe-based hardfacings were hard phase rich alloys with a hypereutectic matrix entailing high macro hardness, Co-alloys proved to be more ductile.

3. Results

Results point out that complex Fe-based alloys feature the highest hardness, which typically drops in the range of 500-600°C. Co- and Ni-based alloys on the other side show lower hardness level at steadier hardness profiles in the investigated temperature range.

During HT high stress abrasion the Fe-based hard-facings show less beneficial performance due to matrix degradation and carbide fracture, while the more ductile materials show mechanically mixed layer (MML) formation, i.e. a self protective layer is established. Although similar effects are present in the impact/ abrasion environment, high hardness is still necessary to withstand against wear. Under solid particle impacting at high angle, the hard, carbide rich materials show carbide breaking and sign of fatigue, while the cast and Co-based alloys experience much lower wear rates.

It can be concluded, that, depending on the HT-wear regime, certain materials can significantly reduce wear and enhance lifetime of components under specific loading conditions in application.

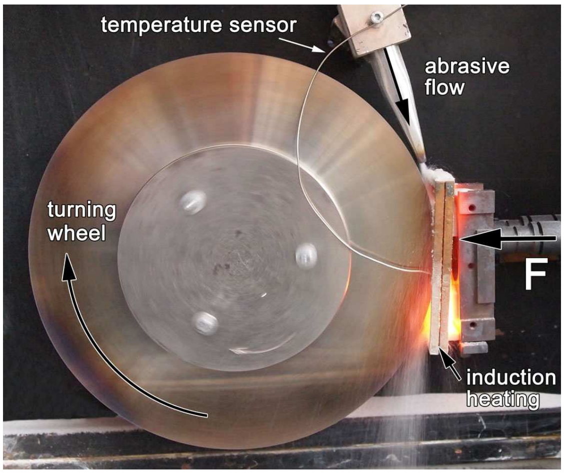

Fig.1 High temperature continuous abrasion test

References

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