ABRASION WEAR RESISTANCE OF MODIFIED HADFIELD STEELS

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Hadfield austenitic manganese steel are widely used in industrial applications that include rock crushing and railroad crossing due to their high toughness, excellent wear resistance and high work hardening ability. The traditional chemical composition of Hadfield steel alloys containing approximately 1.0–1.4% C and 10–14% Mn. It is known that increase in carbon content results in an improvement of abrasion wear resistance [1,2]. Nevertheless, the addition of this element compromises the toughness caused by grain boundary carbide precipitation [3]. Moreover, avoid the carbides precitate phases is achieved by dissolution of carbides by a suitable heat treatment, addition of elements that delay carbide formation such as Mo, or reduction of carbide-forming elements such as C [3]. Additionally, adding nitrogen (includes nitrogen in solid-solution and in precipitate form) has received a lot of interest to steel because improves its mechanical strength without change in ductility [4].

In this study, the abrasive wear behavior and mechanism of a standard Hadfield steel (1.1%C, 13%Mn, 1.5%Cr) and a modified austenitic manganese steel with lower carbon content and nitrogen addition (1.05%C, 13%Mn, 2.5%Cr and 0.05%N) were investigated. Abrasive wear tests, using a rubber wheel abrasion tester, were carried out applying normal loads up to 200 N with abrasive size of 0.2 mm for 600 s. The steels were: (i) standard Hadfield steel, (ii) Class C Hadfield steel with 2.5%Cr and (iii) modified Hadfield steel with nitrogen. The microstructure of these modified austenitic manganese steel alloys was studied thoroughly using optical microscopy (OM), scanning electron microscopy (SEM) and X-ray diffraction (XRD) and was compared to the standard Hadfield steel. The worn surface and the wear debris were analyzed by SEM and XRD. Macro and microhardness were measured before and after the wear tests in order to analyze the strain-hardening effects beneath the abraded surfaces. The surface topography of the wear scars was examined by a non-contact 3D profiler in order to measure the depth of the abrasive penetrations. Microstructural results showed that varying the carbon content in the Hadfield alloys can affect the abrasive wear resistance which leads to considerable changes of the mechanical properties. The wear results showed that the traditional Hadfield steel had a higher wear resistance than modified Hadfield steel, as shown in Fig. 1. This is associated with a higher hardness of the traditional alloy, as observed in the hardness profile realized below the worn surface, where the traditional steel presented a hardened layer with a hardness value higher than 100 HV. The deformed layer below the abraded surface was also analyzed by EBSD. Some regions close to the top of abraded surface was not fully identified due to high deformation, but for the traditional alloy was possible to observed high density of twin formation in comparison to the modified alloys which explains the higher hardness for this alloy, as shown in Fig. 2.

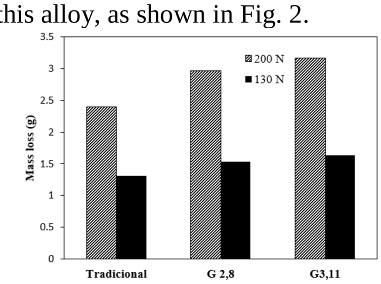

Fig.1 Mass loss as function of normal load

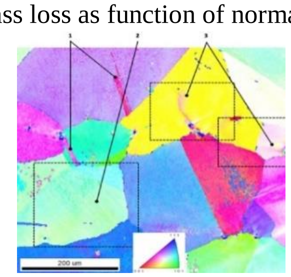

Fig.1 EBSD-IPF of deformed layer.

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