Tribocorrosion of abrasion-resistant steel grades in marine environments

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Hardness is frequently taken as a crucial indicator of the abrasion resistance of materials. However, in the recently developed wear-resistant steels grades, a tailored microstructure with lower hardness has exhibited similar wear performance as that of a well-known abrasion-resistant steel grade, having a fully martensitic microstructure. The present article characterizes the abrasive wear resistance of two different wear-resistant steel grades, martensitic and complex phase steel, using pin abrasion tester (ASTM G132) in dry and wet environments. Both the materials behave differently in the presence of an electrolytic medium whereas similar specific wear rates are observed in dry conditions.

Keywords: abrasive wear, two-body wear, pin abrasion tester, ASTM G132, tribocorrosion

1. Introduction

Abrasive wear in both dry and wet conditions is often encountered in various applications, e.g. mining, dredging, biomedical applications etc. Material hardness is often taken as a crucial indicator of the wear resistance of materials [1]. However, in the recently developed grades of abrasion-resistant steels, a tailored microstructure consisting of a complex phase structure of bainite, retained austenite and dispersed carbides has shown quite a comparable abrasion resistance to the commonly used steel grade essentially consisting of a fully martensitic microstructure. In the present paper, the specific wear resistance of both the steel grades is compared in the presence and absence of an electrolytic medium.

2. Methods

Two steel grades were tested using a pin abrasion tester (ASTM G132) in dry and wet environments. The latter tests were conducted using a newly developed tribocorrosion tester at Soete laboratory [2]. Tests were done in the presence of three different electrolytes, namely, Distilled Water (DW), Aqueous Salt Solution (ASS) and Sea Water (SW) from the North Sea.
The material properties are given in Table 1.

Table 1: Mechanical properties of Martensitic (MS) and Complex Phase (CP) steels

Property	Unit	MS	CP
Hardness	HV	433	357
Elastic modulus	GPa	209	193
Yield strength*	MPa	1380	987
Tensile strength	MPa	1601	1340

2.1. Results

The specific wear rates in dry conditions determined for martensitic and complex phase steel are compared in Figure 1 (a) at a normal load of 15 N and a sliding speed of 150 mm/s for five different abrasive grades. The specific wear rates in wet conditions at 6.5 N load at 10 mm/s sliding speed using P180 SiC abrasive paper for both the materials are shown in Figure 1 (b).

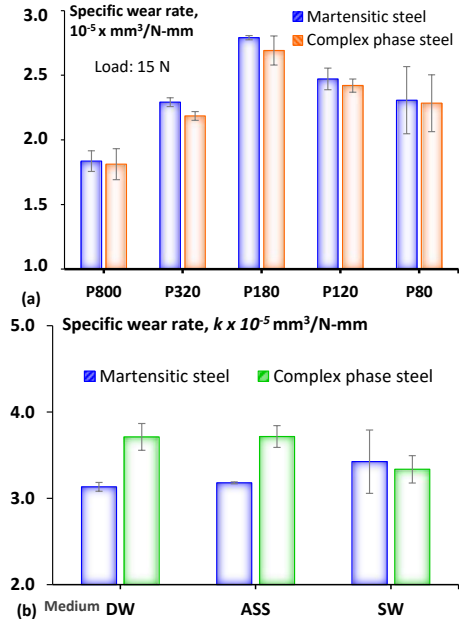

Figure 1: Specific wear rates of martensitic steel and complex phase steel in dry (a) and wet conditions (b).

3. Discussion

In dry conditions, the specific wear rates in both the steels appear equivalent; the mean specific wear rate in martensitic steel is slightly higher than that of complex phase steel at all the abrasive grades. Thus, the abrasion resistance of both the steels is quite close to each other in multiple asperity abrasion despite the difference in hardness. In the presence of an electrolyte, complex phase steel shows higher specific wear rate in DW and ASS. However, similar specific wear rate is observed in seawater.

4. References

[1] J. F. Archard, "Contact and rubbing of flat surfaces," *Journal of Applied Physics,* vol. 24, pp. 981-988, 1953.

[2] K. Pondicherry, J. Vancoillie, J. De Pauw, J. Sukumaran, D. Fauconnier, and P. De Baets, "Design and development of a novel electrochemical abrasion-corrosion tester," *Tribology International,* vol. 131, pp. 652-660, 2019