Sliding wear behavior of non-ferrous metals against chromium alloy steel under dry and lubricated conditions

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Sliding wear behavior of 6026 aluminum and standard bronze against chromium alloy steel was evaluated using a linearly reciprocating sliding tester. Coefficients of friction (COFs) were obtained using a load cell, a DAQ interface, and LabView software. Mechanical profilometry and SEM microscopy were used to evaluate the wear volume, additionally XPS and EDS techniques were used to characterize the tribofilms generated. According to the results, the bronze specimens in the dry condition showed high plastic deformation and material transferred to the steel ball by adhesion, while the aluminum specimens in the lubricated condition showed a greater wear volume.

Keywords: Sliding wear, Ball-on-flat reciprocating tribometer, Wear mechanisms, Coefficient of friction.

1. Introduction

Currently, the mechanical demands on machines and cutting tools are vital to determine its useful life because of the mechanical elements operating in critical conditions as heavy loads, high working speeds, and severe environmental conditions. Ball-on-flat linearly reciprocating sliding wear is one of the most common laboratories wear testing methods to determine the wear behavior of engineering materials. The volume of the material removed is one of the meaningful parameters for wear characterization materials.

Non-ferrous metals have found application in the manufacture of various automotive engine components where adhesive wear or dry sliding wear is a predominant process. Moreover, materials with high wear resistance under dry conditions are associated with the formation of a tribolayer on the worn surface.

This study aimed to evaluate the sliding wear behavior of 6026 aluminum and standard bronze against chromium alloy steel using a linearly reciprocating sliding tester with a ball-on-flat configuration either in dry or lubricated condition, using glycerol as a lubricant.

2. Methods

The sliding wear action was evaluated by recording the friction forces, their data were recorded by a DAQ interface. While the COFs were computed through the LabView software. The experimental tests were carried out using the values given in table 1, according to some parameters of the ASTM G133 standard.

Table 1: Test conditions of sliding wear tests.

Temperature	Room temperature (20-25 ºC)
Load	5 N, 10 N and 15 N
Test duration	60 min
Frequency	4 Hz
Stroke length	4 mm
Counterface	7.93 mm AISI 52100 chromium alloy steel

2.1. Results

In dry conditions, COFs did not show significant changes in the aluminum and bronze samples because of the applied load. Bronze specimens in dry conditions showed high plastic deformation and material transferred to the counterface by adhesion phenomenon. The lubricated samples of 6026 aluminum showed a greater wear volume but exhibited seizure in the dry condition at the contact surface against the steel sphere at 15 N load. On the other hand, the wear scars were analyzed using scanning electron microscopy, and some wear mechanisms were identified, as plastic deformation, plowing, cracks, fractures, and pitting on aluminum specimens in dry condition. Moreover, in lubricated conditions, it was possible to find plastic deformation, fractures, and cracks.

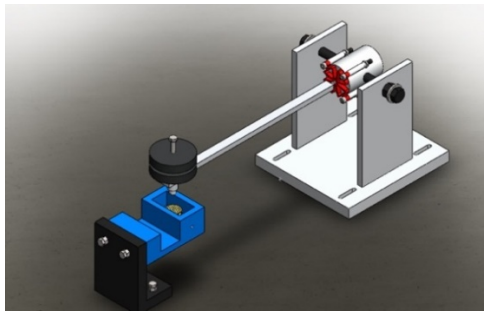

Figure 1: Schematic diagram of linearly reciprocating tester.

3. Discussion

Tests on 6026 aluminums at lubricated condition showed a high wear volume and deep wear scars, attributable to the tribochemical reactions at the contact surface and the glycerol used as a lubricant. Moreover, seizure on the contact surface of the steel sphere at 15 N load was observed at dry condition and mainly due to the low hardness of aluminum samples, which promotes that the real area of contact approaches to the apparent contact area.