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Material formulation, integrity of the brake pad and wear at high temperature

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The present work studies the friction and wear behavior of two types of brake pad formulations at high temperature. Two prototype formulations, a Non-Asbestos Organic (NAO) and a Low Steel (LS) were used in braking tests against cast iron discs. The NAO pads undergo a much larger wear than the LS pads, and their surface shows numerous macroscopic cracks. The evolution of the materials in the near surface, as well as thermal conditions are studied. SEM observations show different mechanisms and arrangement of the third body at the surface of both pads and discs.

Keywords (from 3 to 5 max): Brake pad, high temperature, wear, integrity

1. Introduction

The aim of this project is to elucidate the effect of different pad material formulations regarding wear and integrity at high temperature. Lapinus (Part of the ROCKWOOL Group) designed two prototype formulations aimed at representing two major families of formulations: Non Asbestos organic (NAO) and Low Steel (LS). An experimental study was conducted at LaMcube laboratory on a reduced scale tribometer, in order to understand the wear mechanisms, and the process of crack formations in the pad.

2. Methods

2.1. Friction parts

Two prototype pad formulations were designed, characteristic of a NAO (Non-Asbestos Organic) and a LS (Low-Steel) materials. The exact composition cannot be disclosed. They are rather similar, but a major difference between the two is that the LS pad contains steel fibers and the NAO contains Man-made vitreous (silicate) fibers (MMVF). The discs were made of usual grey cast iron.

2.2. Tribometer

The tribometer is an inertial bench which features a one-sided pad-disc contact, able to perform various braking situations: stopping, slowing down, holding, and metro type succession. It is controlled with normal applied force, initial speed and imposed inertia.

2.3. Test sequence

The braking test derives from a standard fading test, which has been modified to include only a burnishing sequence (100 brakings), a high speed braking and a so called “fade” sequence (20 brakings). With apparent contact pressure around 2 MPa and initial sliding speed above 20 m/s, this “fade” sequence enables temperature variations of several hundreds of degrees in a few seconds, for the near surface material of both pad and disc.

2.4. Results

NAO pads underwent a much larger wear than the LS pads, and their surface showed macroscopic cracks (Figure 1). Brakings with the LS pads produce a friction coefficient between 0.25 and 0.45. Brakings with NAO pads produce a lower coefficient of friction (0.1 to 0.35).

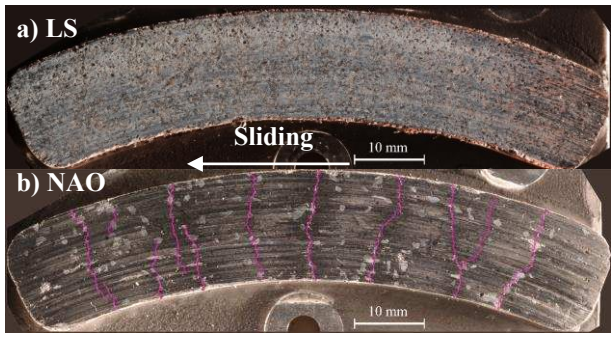

Figure 1: Pads after a braking test. a) LS pad, b) NAO pad. Purple lines show the paths of macroscopic cracks.

Surface observations (SEM) of discs and pads show differences in tribological mechanisms, with the arrangement of the third body, and linked to the initial pad formulation. Temperature measurement in the near surface of the pad showed larger gradients in the NAO pads than in the LS pads.

3. Discussion

The results highlight differences in friction and wear behavior when using the two different types of pad. In particular, the creation of numerous cracks at the surface of the NAO pad is investigated. At high temperature, the evolution of the material properties near the surface coupled with large temperature gradients seem to play a role in these creation mechanisms. Further work is currently being conducted to better characterize these two aspects (material toughness and thermal damage) of the question.