Tribology of Thermal Spray Coatings under varying Lubricant Quality

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On the way to a CO_2-neutral mobility, regenerative fuels can be a measure to decrease the footprint of combustion engines. The incomplete combustion of regenerative fuels can yield acidic byproducts. Here, we analyze the impact of peracetic acid and water on the tribological performance of iron-based thermal spray coatings, that are state of the art in modern combustion engines. Two thermal spray coatings with varying chromium content are compared with respect to their tribological performance under varying lubrication conditions.

Keywords (from 3 to 5 max): thermal spray coatings, regenerative fuels, peracetic acid

1. Introduction

Under appropriate conditions along the product chain, regenerative fuels can contribute to the reduction of the carbon dioxide footprint of internal combustion engines. During the incomplete combustion of ethanol, peracetic and acetic acid and hydrogen peroxide are products that are potentially harmful to liner bore surfaces. Here, we analyze the tribological behavior of two thermal spray coatings with varying lubricants. Hypothesis to be examined is that an increase in chromium content improves the corrosion resistance and consequently the wear behavior of the thermal spray coatings.

2. Methods

Thermal spray coated AlSi-disks with different chemical compositions but comparable topographies and comparable forces during grinding are tested against Cr-plated pins on a pin-on-disk tribometer. Two different commercially available lubricants are used with and without dilution with peracetic acid. Besides ex-situ analysis of surfaces with X-ray photoelectron spectroscopy, scanning electron microscopy, focused ion beam cross sections and topography analysis, we measure the wear of the systems in situ to access the wear rates in the ultra-low wear regime. This is important to analyze the running-in behavior of the systems.

3. Results and discussion

Besides friction and wear, another important criterion to describe tribological systems is the sensitivity of a system to external triggers like e.g. vibrations, relative humidity or oil chemistry. All variations show a pronounced running-in behavior, i.e. a decrease in the coefficient of friction over time.

The variation of the coating material has an overall lower impact on friction behavior after running-in than the variation of the additives in the engine oils. The X20Cr13 alloy has a lower sensitivity to the changes of the chemical environment compared to the 13Mn6 alloy when changing the lubricant, see Fig. 1.

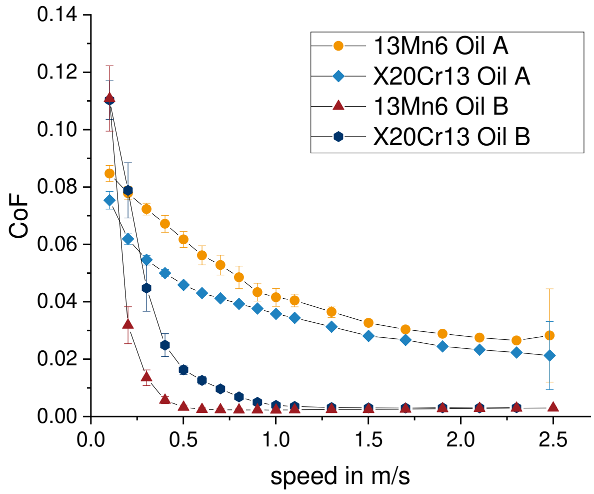

Fig. 1: Stribeck curves after running-in of different disk materials and different engine oils.

This does interestingly not hold true for the friction of the systems after the dilution of the oil B with peracetic acid: Here, the X20Cr13 shows a higher sensitivity to the acid addition than the 13Mn6, i.e the friction increases in the course of the experiment slightly stronger for the X20Cr13 than for the 13Mn6.

Considering the wear behavior, wear increases through the addition of peracetic acid for the 13Mn6 system. In contrast, X20Cr13 shows a lower sensitivity to the change in the chemical environment: the wear rate shows a minor increase under peracetic acid addition.