Wear behavior of corrosion resistant cold work steel X30CrMoN15-1 at constant frictional energy by varying lubricants

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Comparative wear tests with different lubricants have been intensively studied and published in literature. In these tests, the accumulated frictional energy is mostly given as a result of the tests while the energy consumption is considered as one of the most important input parameters of a technical system. In this study, a different approach is taken. Sliding wear tests using three different lubricants are conducted using otherwise the same test conditions. The only other variable parameter was the number of sliding cycles – this was set so that all tests achieve the same accumulated friction energy [μm^3 / J]. The aim of this study is to clarify a possible correlation of energy input, wear mechanisms and amount of wear for a given steel.

A corrosion resistant cold work steel (X30CrMoN15-1, 1.4108) with 70% retained austenite is tested against standard bearing balls from 100Cr6 (1.3505). Reciprocating sliding wear tests are conducted at constant normal force of 30 N and an average sliding speed of 0.06 m/s at room temperature. Three different lubricants including silicone oil, commercial gear oil and polyalphaolefin (PAO) without additives are applied. Tests are continued until a predetermined amount of accumulated friction energy (367 ± 35 J) is reached. Sliding wear tests with each lubricant are repeated four times. After the experiments, wear volumes and wear appearances of base and counter bodies are analyzed by the means of confocal and scanning electron microscopy. Additionally, the friction coefficients and energy-based wear rates are evaluated.

Wear mechanisms on all samples are dominated by abrasion, with few delaminations by surface fatigue on the hard steel balls and local regions covered by tribochemical reaction products. Experiments conducted with silicone oil display highest amount of wear by frictional energy, leading to the highest energy-based wear rate. PAO without additives show intermediate wear volume, thus energy-based wear rate ranges between other two oils. Lubrication with commercial gear oil leads to the lowest wear of all experiments, resulting lowest energy-based wear rate. This study shows that for the investigated steel, a significant part of the frictional energy is consumed by deformation and phase transformations, which explains why the wear rate does not correlate with the introduced friction energy.

Keywords: reciprocating sliding wear, friction energy, cold work steel, lubrication.

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