Commentary

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Characteristics of Carbon Containing Steels and Carbide Ceramics with Low Friction Coefficients

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Description

Experiments of reciprocating friction in the air were carried out in order to investigate the frictional properties of carbon containing steels and carbide ceramics. Carbide materials included SiC, TiC for these tests. As non-carbides, Al_2O_3, Si_3N_4 were also utilized. Additionally, three kinds of steel were used as plate materials in experiments: JIS SKH4 has a carbon content of 0.74–0.82%, JIS SUS430 has a carbon content of less than 0.12% and JIS 312L has a carbon content of less than 0.02%. All combinations of identical carbides exhibited a low coefficient of friction as a result of the experiment. Raman spectroscopy was used to look at the wear that was stuck to the wear scar after the friction test. Consequently, it was discovered that a material resembling graphite was present in the wear debris of all carbide ceramics with low coefficients of friction. As is the case with carbon based materials like diamond these findings demonstrated that friction between identical carbide ceramics results in the formation of a material resembling graphite.

Coefficient of Friction

The SKH4 plate had a coefficient of friction that was similar to that of ceramic balls and steels when they were rubbing against each other. Raman spectroscopy revealed that the SUS430 plate wear debris, which had a high coefficient of friction, contained only a small amount of graphite like materials, while the SKH4 plate wear contained a large quantity. In addition, SUS430 adhered more strongly to the friction surface than SKH4, possibly due to the reduced metal adhesion caused by the graphite like material produced by friction. These findings demonstrated that carbon in steel also lowers the friction coefficient by reducing the shear force and suppressing adhesion, producing graphite like material through friction. Parts, cutting tools, and dies made of ceramics and hard steels are frequently used in machinery applications as bulk and thin films. These materials mechanical properties have been used in mechanical design after being summarized from numerous measured data. There is still a lack of understanding of the tribological properties that are required for the design of friction devices from several existing reports. The weight of carbon in carbon steels that can withstand heat treatment is between 0.30 and 1.70%. The quality of the resulting steel can be significantly impacted by trace impurities of various other elements. Steel is particularly brittle and crumbly at working temperatures due to trace amounts of sulfur. Manganese is frequently added to low carbon steels in order to enhance their hardenability, and low alloy carbon steels, like the A36 grade, have a melting point of between 1,430 and 1,540 °C. By some definitions, these additions make the material low alloy steel, but the AISI definition of carbon steel allows up to 1.65% manganese by weight. High carbon steel and ultra-high carbon steel is the two types of higher carbon steel.

Treatment Process

The extent to which a material is hardened following a heat treatment process determines its hardenability as a metal alloy. It should not be confused with hardness, which is a measure of a samples resistance to being scratched. Because it is inversely proportional to weldability the ease with which a material can be welded it is an important property for welding. When a hot steel workpiece is quenched, the water contact area immediately cools and reaches an equilibrium temperature with the quenching medium. However, the inner depths of the material cool slower, and in large workpieces, the cooling rate may be slow enough to allow austenite to fully transform into a structure other than bainite. As a result, the workpiece has a different crystal structure throughout its entire depth; with a harder shell and a softer core. The softer core is usually a mixture of ferrite and cementite, like pearlite. Sulfur is the fifth most abundant element on earth and the tenth most abundant by mass in the universe. Sulfur typically occurs as sulfide and sulfate minerals on earth, despite being occasionally found in its pure, native form. Sulfur was known to be used due to its abundance in its native form. Sulfur has also been referred to as brimstone. Today, almost all elemental sulfur is produced when sulfur containing contaminants are removed from natural gas and petroleum. The production of sulfuric acid for sulfate and phosphate fertilizers and other chemical processes is the most common commercial use of the element. Matches, insecticides, and fungicides contain sulfur. Organosulfur compounds are to blame for the odors of skunk scent, grapefruit, garlic, odorized natural gas, and many other sulfur compounds that are odoriferous. The distinctive odor of rotting eggs and other biological processes is caused by hydrogen sulfide.

Presents sliding cycle dependent coefficients of friction for two types of steel plates and ceramic balls made of carbide and non-carbide. The non-carbide Si_3N_4 and Al_2O_3 had friction coefficients between the ceramic ball and the SKH4 plate, while the carbides SiC and friction coefficients. The non-carbide was found to have a friction coefficient of when it came to friction between the ceramic ball and the SUS430 plate. It was discovered that the value of carbide was slightly lower. Carbide demonstrated a low coefficient of friction in all instances of friction between ceramics that were identical. A material resembling graphite was found in the wear debris observed around the wear scar, as determined by raman spectroscopy. These findings demonstrate that even carbides generate the graphite like substance through heat generated by friction. The flash temperature was assumed to be sufficiently high in the friction of carbides and to reach the temperature at which carbon is precipitated by the oxidation of carbides because graphite like material was confirmed.