

Tribological behavior of ceramics at high sliding speeds in steam

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Three sets of tests were conducted using a pin-on-disk tribometer to determine the tribological behavior of ceramics at high sliding speeds in steam. In the first set, the speed was increased from 4000 rpm to 10,000 rpm in 1000 rpm increments. Constant rotational speeds of 4000 rpm, 6000 rpm, 8000 rpm and 10,000 rpm were used in the second test series. In the third series of tests, the rotational speed was slowly increased to 10,000 rpm and allowed to coast down to zero. While the coefficient of friction for silicon nitride/YTZP pair varied between 0.2 and 0.4 without a clear pattern as the speed was increased in the first two test series, it decreased from about 0.6 to 0.2 when the speed was raised to 10,000 rpm in the third test series. This behavior is attributed to the general phenomena of powder lubrication as the wear debris provides an interfacial layer leading to reduced friction at high speeds. The coefficient of friction for silicon nitride/silicon carbide pair was substantially reduced to about 0.02 as the speed was raised. The low coefficient of friction, however, increased to a high level as the speed was further increased. The drop in friction is explained based on analysis of elasto-hydrodynamic lubrication assuming that a water film containing solid particles exists at the interface. Several possible mechanisms are suggested for the transition to a higher friction as the speed is raised: thermal effects at high flash temperatures, low residence times (for water adsorption on surface), collapse of the lubricant film and starvation effects.

KEY WORDS: friction, wear, ceramics, high speed, steam lubrication, silicon nitride, silicon carbide, zirconia