SMOOTH SLIDING

Consulting company providing engineering services on issues related to sliding bearings

Molybdenum Disulfide as Solid Lubricant

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Molybdenum disulfide (**MoS_2**) is a crystalline lamellar structure material contained in the natural mineral Molybdenite.

Molybdenum disulfide is a solid lubricant relating to the class of inorganic lubricants with lamellar structure, which also includes molybdenum, graphite, boron nitride (BN) and some other sulfides, selenides and tellurides (chalcogenides) of molybdenum, tungsten, niobium, tantalum and titanium.
The crystal lattice of molybdenum disulfide is similar to that of graphite. It consists of hexagonal molybdenum planes sandwiched between two hexagonal sulfur planes. The atoms in the planes are strongly covalently bonded to each other.
The planes are bonded by weak Van der Waals forces.

The layered structure allows sliding movement of the parallel plates. Weak bonding between the planes provides low shear strength in the direction of the sliding movement but high compression strength in the direction perpendicular to the sliding movement.

Friction forces cause the particles of molybdenum disulfide to orient in the direction, in which the hexagonal layers are parallel to the sliding movement. The anisotropy of the mechanical properties imparts the combination of low coefficient of friction and high carrying load capacity to molybdenum disulfide.

The sulfur layers of molybdenum disulfide have an affinity for tenacious adherence to the metal substrate atoms therefore a strong lubrication film is formed on the substrate surface. The lubrication film provides good wear resistance and seizure resistance (compatibility).

In contrast to graphite, moist atmosphere is not required for lubrication by molybdenum disulfide. Therefore, it demonstrates low friction in dry atmosphere and in vacuum where its coefficient of friction is even lower than in the presence of water vapor.

Coefficient of friction of molybdenum disulfide is lower than that of graphite and it decreases with increasing load.
At high loads in vacuum it may be as low as 0.03.

Application of molybdenum disulfide in open air at elevated temperatures is limited to 700°F (371°C). Higher temperatures cause oxidation of **MoS_2** into the molybdenum trioxide **MoO_3** and sulfur dioxide **SO_2**. The oxides attract moisture resulting in increase of the coefficient of friction. In non-oxidizing environment and in vacuum molybdenum disulfide is stable up to 2100°F (1150°C).

Some applications of molybdenum disulfide:

- Additives in lubricating oils
- Components of polymer based composite anti-friction coatings
- Second phase particles of metal based composite anti-friction coatings
- Solid lubricant in metal forming
- Release coatings and non-sticking refractory linings in foundry