WHAT THE HECK IS MOLY?

Pick up a container of any “industrial strength” lubricant and it is likely to say that it is “fortified with moly.” Some may say “advanced formula with moly”, or perhaps “high performance moly lubricant.” Moly moly moly. What the heck is moly, what exactly does it do, and why do I want it in my lubricants?

molybdenum disulfide powder

When I was in high school, Molly was the cute red-haired girl in math class, but the moly being referred to here is molybdenum disulfide powder. Pronounced m*uh*-**lib**-de*h*-n*uhm* di-**suhl**-fide (which is why we just say “moly”), the dictionary describes it as “a black crystalline powder, MoS_2, insoluble in water, used as a lubricant”. That’s nice, but it doesn’t explain how or why it is used.

Moly is a crystal with a lamellar structure, which is a technical way of saying that it is flat. The best (albeit over simplified) way to describe how these flat moly plates work is to think of a deck of playing cards. Whether stacked on top of each other or singly, the playing cards can withstand an enormous amount of weight relative to their own weight and size. Imagine a pickup truck with a deck of cards under each wheel. Each card would remain relatively unaffected, even if you fill the pickup with a ton of bricks.

Now imagine a room with a floor full of loose playing cards, several cards deep throughout. Try running on the cards and you’ll begin to see how the moly works as a lubricant.

More technically speaking, the moly has weak bonds between the sulfur layers while having strong bonds in the “flat” plane. Much like the playing cards, the flat moly shape naturally tends to lay flat, especially when burnished into a metal surface or allowed to dry from a liquid coating. In fact, moly particles have a natural affinity for metal surfaces and will “stay put” more than other dry lubricants.

Further, moly is relatively inert and can withstand a wide range of temperatures, from –300^{o} to 750^{o} F in oxygen atmospheres (even higher in a vacuum). It can withstand pressures of 250,000 to 500,000 p.s.i., and has a low coefficient of friction (about 0.03 to 0.04), which is similar to PTFE (Teflon^{TM}) and tungsten disulfide (moly’s higher temperature cousin).

It is the combination of metal-friendly particles, toughness in many environments, and slipperiness that make moly a popular choice for metal-related lubricants.

There are a number of ways moly is used as a lubricant. Pure molybdenum disulfide powder is often burnished into metal parts. High-speed tools (such as a Dremel tool or cordless drill) with cotton, leather, or other soft wheels are used to repeatedly build-up these rubbed-in coatings. Repeated hand rubbing, with a soft cloth, works as well. Another simple do-it-yourself way to apply a moly coating is to mix it with isopropyl (rubbing) alcohol (I prefer the 91% IPA, available at most pharmacies). Many very sophisticated companies use nothing more than a pie tin, some moly, and alcohol to coat small quantities of bearings, pins, chains, gears, slides, hinges, and other parts.

The alcohol penetrates hard to reach areas, quickly evaporates, and leaves a chalky film of moly behind (to later be self-burnished from the friction).

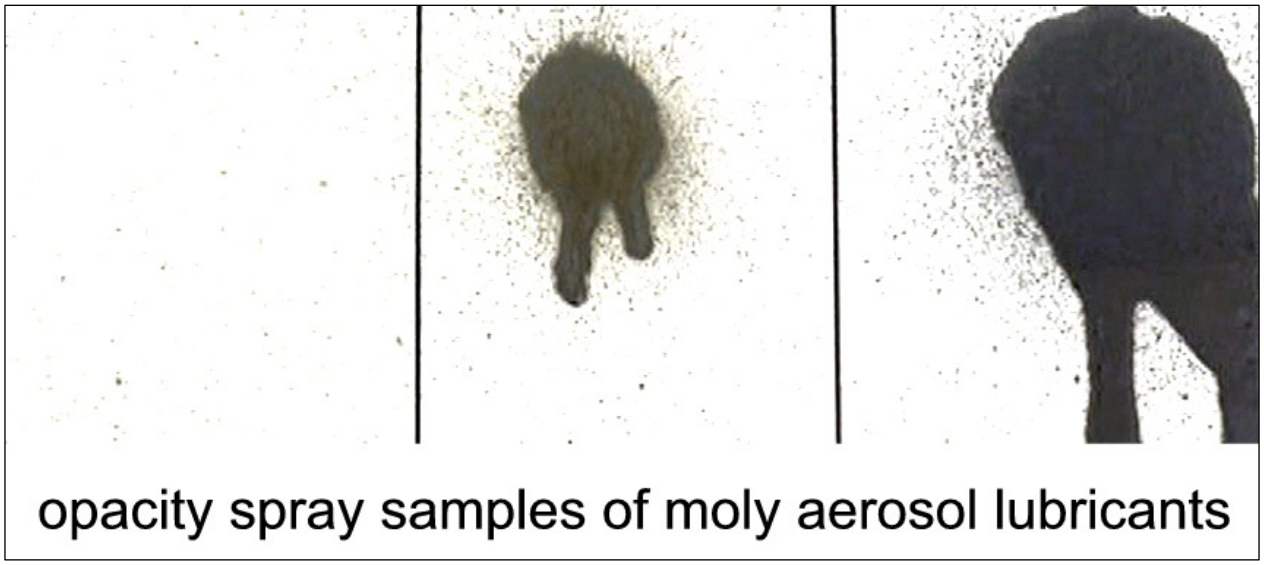
More commonly, moly powder is used as an additive to boost the performance of other lubricants. Moly, when added to grease or oil, extends the ability to provide lubrication to wider range of temperatures and/or pressures. For example, many greases are lithium based, with an effective upper operating range of about 350^{o} F. Adding moly to a lithium grease will result in added lubrication as the grease approaches or surpasses maximum temperatures. As the grease "melts" and begins to leave the boundary area between the friction surfaces, some moly (which withstands much higher temperatures) remains to help maintain that boundary.

Moly-based paint-like coatings are becoming increasingly popular with manufacturers. These anti-friction coatings can be solvent-based based liquids that are sprayed, dipped, or centrifugally spun onto parts and are applied as part of the manufacturing process by companies such as Boeing, GM, and other large manufacturers and parts suppliers. These coatings usually require further heat or ultra-violet curing that activates a chemical adhesive binder. A number of specialty coating contractors perform these services on a job-shop basis.
High-speed impingement is another way of applying a moly-based coating. Certain specialty coating businesses are equipped to "sand-blast" moly particles onto a prepared metal surface. The surface is usually cleaned and etched to a specific surface profile prior to application. This process essentially forces the moly particles into the nooks and crannies of metal surfaces.

A few companies now manufacture water-based and air-curing moly coatings, which are fast growing in popularity. These paint-like coatings are more user friendly because they don't require professional application, or professional heat or UV curing. They offer much of the performance characteristics of the professionally applied coatings mentioned above without the environmental or regulatory headaches. More importantly, they can be applied by the non-professional, such as a serious hobbyist, home mechanic, or shop maintenance foreman.

Piston skirts, slides, hinges, gears, cams, shafts, ball bearings, bearing races, worm gears, pinions, spring clips, and many other parts are being moly coated. Moly powder is increasingly being added to plastic and rubber parts. For example, moly-fortified rubber is now used to make automotive suspension bushings because the reduced friction prolongs the life of the bushing (and makes your ride a little less squeaky).
But, all is not rosy in the world of moly lubricants (Rosey was the cute girl in biology). Lubricant manufacturers add varying amounts of moly to their formulas, and not all of these amounts are adequate. Many "off the shelf" products at large retailers and industrial distributors are formulated to keep costs low, and may not be the best choice for your application. When choosing a moly-based lubricant, content is king.

Why? Imagine that room full of playing cards again, except that now there are so few cards that you can see large areas of the floor. This illustrates how inadequate moly coverage will result in unnecessary metal-to-metal friction and wear, particularly as the friction environment starts to approach the limits of the host lubricant. The amount of moly used in any lubricant is roughly proportional to the amount of added protection you will get as the friction environment approaches the limitations of the base lubricant. More simply, the tougher your application, the more moly required to meet these demands.
My advice is to compare the moly content of the products you buy. Contact the manufacturer if the content is not displayed on the product label or MSDS, or at least do an old fashioned eyeball test by comparing the opacity and/or color of various lubricants. Aerosol moly lubricants (such as chain and wire spray oils and dry-film coatings) and paint-like moly dry-film coatings should appear as black and as opaque as possible.



opacity spray samples of moly aerosol lubricants

When choosing a lubricant or anti-friction coating, you need to answer a few basic questions about the lubricant's service environment. What operating and temperatures will the lubricant need to withstand? What is the pressure between the friction planes? Is it slow moving and heavy pressure, or fast moving and lower pressure? Will a greasy or oily lubricant attract unwanted dust, dirt, or debris? Will solvents be present? The service environment will determine the basic type of moly lubricant to be used. For example, the presence of strong solvents will likely require a professionally applied, cured or impinged coating. An outdoor or field application may require a water-based coating for environmental reasons. Mechanics, maintenance workers, and other do-it-yourselfers will want one of the easy to apply, air-curing aerosols or paint-like coatings.

There are many moly fortified lubricants in the marketplace, some are excellent, some are good and some are simply not sufficient for your needs. Take the time to do a bit of research. Contact manufacturers and read labels, because a little knowledge can help you find the perfect product for your application. And if you come across Molly, give her my best.

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