MOLYKOTE®

FROM DOW CORNING

Lubrication Solutions for Threaded Connections

Molykote® Anti-Seize Pastes and Anti-Friction Coatings from Dow Corning

MOLYKOTE®
LUBRICANTS FROM DOW CORNING

More than 60 years of *trust*, around the globe.

For more than 60 years, OEM designers, maintenance and materials engineers around the world have trusted the *Molykote*® brand for performance and expertise to prevent or solve many diverse lubrication problems.

Formulated for extreme loads and environments, *Molykote* lubricants are also ideal for normal service lubrication. They deliver extended benefits as compared to conventional lubricants, such as:

- Long component life
- Extended lubricant durability
- Long maintenance intervals
- Savings of time and money

With technical centers all over the world, our expanded product choices can reach you wherever you are to provide **Smart Lubrication**™.

Harsh environments, heavy loads and extreme speeds can challenge your productivity. *Molykote*® brand Anti-Seize Pastes and Anti-Friction Coatings (AFCs) help keep your equipment and processes moving smoothly.

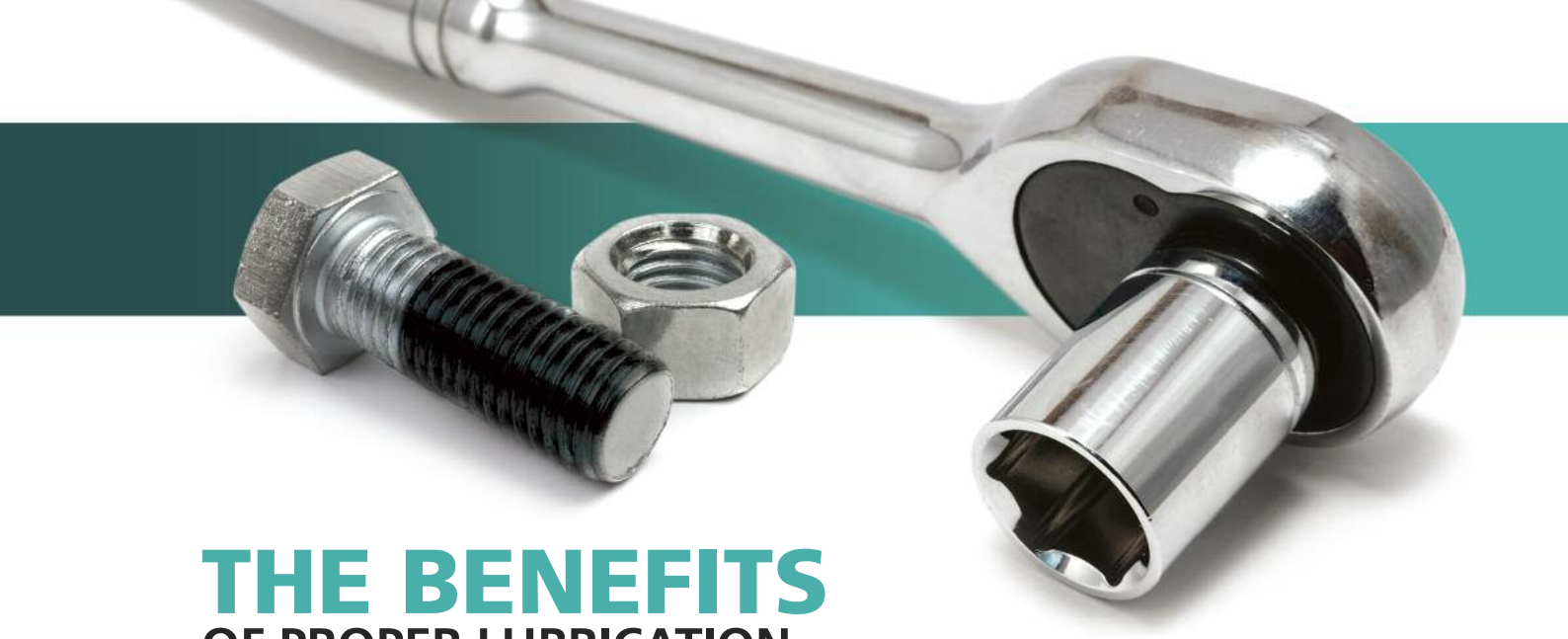
IMPROVE PERFORMANCE
OF THREADED CONNECTIONS

Threaded connections offer several advantages, including, but not limited to, convenient disassembly, repeated use of a fastener and accurate reassembly. However, without proper lubrication, those advantages can be lost, giving rise to significant equipment challenges and reliability concerns.

BY PREVENTING:

- Inconsistent coefficients of friction, resulting in inconsistent bolt tension
- Stick-slip
- Stress corrosion cracking
- Fretting
- Galling
- Seizing

Molykote® brand lubricants can help your threaded connections perform well in service, from initial assembly through repeated disassemblies. They are specially formulated to withstand harsh conditions, perform in a wide range of service temperatures and resist the effects of heavy loads, salt-spray or other contaminants.



THE BENEFITS
OF PROPER LUBRICATION

Lubricants serve to reduce friction and wear, protect against corrosion and dissipate heat.

The use of carefully selected lubricants can help circumvent some of the common failure mechanisms associated with threaded connections. Some key functions of proper lubrication are:

- Providing a consistent coefficient of friction (μ)
  - On mating surfaces, this enables designers and applicators to minimize the complexity of obtaining proper connector preload forces and torque specifications
  - Limits the effects of temperature and load variations, reducing fatigue failure rates
- Forming barriers between substrates and oxygen gas layer
  - Prevents undesirable scale formation on thread surfaces
- Providing protective layers to mating surfaces
  - Reduces the effects of oxide layer depletion, reducing the occurrence of fretting, galling, seizing and shearing
  - Decreases exposure to corrosive, hydrogen-rich and low-melting metal environments, reducing stress corrosion cracking as well as hydrogen and solder embrittlement

MOLYKOTE® ANTI-SEIZE PASTES PROVIDE CONSISTENT COEFFICIENT OF FRICTION

PRODUCT NAME	μ_t	μ_c	K*
MOLYKOTE® G-n METAL ASSEMBLY PASTE/SPRAY*	0.078	0.085	0.15
MOLYKOTE® G-n PLUS PASTE**	0.12	0.06	0.14
MOLYKOTE® HSC PLUS PASTE	0.10	0.10	0.15
MOLYKOTE® G-RAPID PLUS PASTE/SPRAY	0.10	0.06	0.13
MOLYKOTE® 1000 PASTE	0.13	0.08	0.17
MOLYKOTE® M-77 PASTE	0.12	0.12	0.20
MOLYKOTE® P-37 PASTE	0.142	0.091	0.18
MOLYKOTE® P-40 PASTE	0.16	0.08	0.18
MOLYKOTE® P-74 PASTE	0.117	0.078	0.16
MOLYKOTE® P-1900 PASTE	0.10	0.10	0.17
MOLYKOTE® U-n PASTE	0.11	0.11	0.18

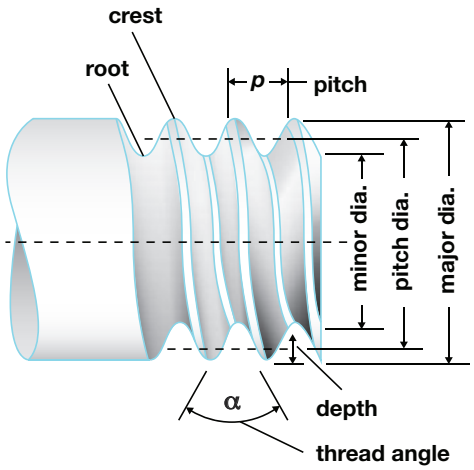
All values and calculations in this table were determined by using the K-Factor formula and are based on a standard, 5/8 inch UNF fastener.
* Product not available in Europe
** Product not available in North America

Torque

Proper bolt torque is required to achieve appropriate bolt tension and elongation. Torque must overcome all sources of friction before elongation can occur. Thread and bolt-head friction can be reduced and made consistent by adding a lubricant.

Required torque calculations for proper bolt elongation are made based on threaded fastener geometry and friction of thread and load-bearing surfaces. The friction factor applied to torque calculations is referred to as **K-Factor**. Both thread and bolt-head friction coefficients are used to calculate K-Factor, so it is through lubrication that friction and K-Factor can be controlled to ensure proper bolt tension and elongation are achieved for a derived torque value.

In assembly, the torque energy is first consumed by overcoming friction. The remaining energy is consumed by bolt elongation (which provides the clamping force). Without proper lubrication, too much torque is used to overcome friction, resulting in insufficient bolt elongation.



K-FACTOR FORMULA

$$K = \left[\frac{\left[\frac{(0.5d_p)(\tan\lambda + \mu_t \sec\beta)}{(1 - \mu_t \tan\lambda \sec\beta)} \right]}{D} \right] + [0.625\mu_c]$$

Where

D = nominal bolt shank diameter
β = thread half-angle = 60°/2 = 30°
λ = thread helix angle = tan-1 ($p/\pi d_p$)
ρ = pitch
d_p = bolt pitch diameter
μ_t = coefficient of thread friction
μ_c = coefficient of collar (head) friction

Failure Mechanisms Defined

Unequal coefficients of friction (μ)

- High μ of mating surfaces (head, nuts, shank and threads) can result in increased twisting of the fastener and reduced clamping force.
- Low μ of mating surfaces can result in excessive bolt elongation.

Stick-slip

The difference between static friction and kinetic friction when two surfaces are in contact.

Stress corrosion cracking

At high temperatures, sulfur diffuses into grain boundaries, producing high stress points. The sulfur then combines with nickel (of alloy steels) to form sulfide crystals. These crystals grow, increasing the stress and creating larger cracks.

Fretting

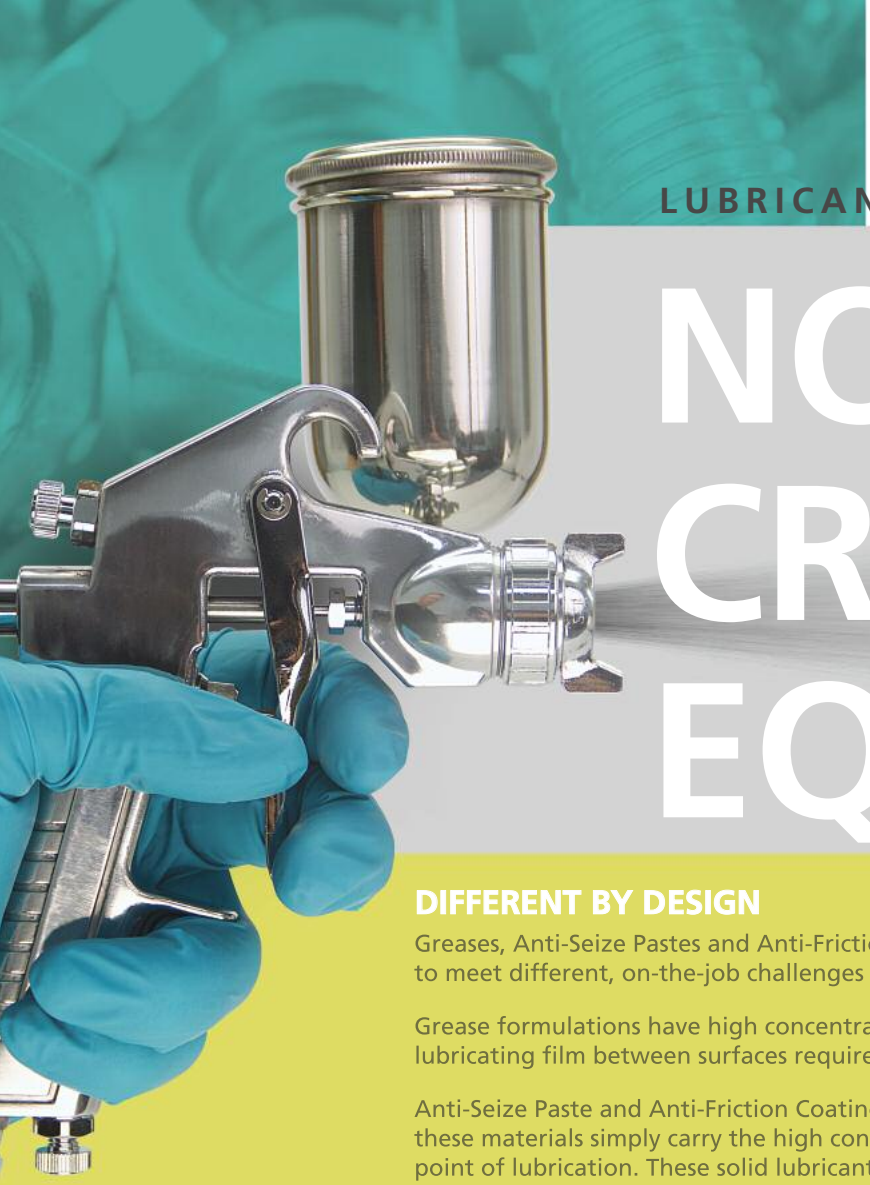
When vibration induces wear of oxide layers, the oxide particles clog internal clearances, leading to seizure.

Galling

During sliding contact, the oxide layer of threaded materials peels away. Asperities transfer from one part to the other, then break away, destroying the surface and preventing disassembly.

Seizing

Caused by fretting, oxide-free surfaces cold weld under extreme pressure, preventing disassembly.



LUBRICANTS ARE

NOT CREATED EQUAL

DIFFERENT BY DESIGN

Greases, Anti-Seize Pastes and Anti-Friction Coatings are each uniquely formulated to meet different, on-the-job challenges and keep equipment running strong.

Grease formulations have high concentrations of base oils, which create the lubricating film between surfaces required to reduce friction and prevent wear.

Anti-Seize Paste and Anti-Friction Coating formulations are different. The base oil in these materials simply carry the high concentration of solid lubricants directly to the point of lubrication. These solid lubricants are not subject to evaporation, and as temperature or pressure increases, the lubricating films maintain their thickness – providing effective, reliable and long-term lubrication of the threaded surface.

To ensure assembly and disassembly of threaded connections over time, the lubricant must stay in place, even under harsh environments. *Molykote*® brand Anti-Seize Pastes and Anti-Friction Coatings offer long-term, effective solutions. These lubrication solutions form a protective layer between threaded surfaces, easing assembly and disassembly, while protecting against wear and corrosion that can lead to connection failure.

Greases are designed to bleed base oils, which provide lubrication. But in threaded connections, the lubricant may not carry high load and the base oil will evaporate, reducing grease life.

Anti-Seize Pastes contain a high concentration of solid lubricants for protecting industrial components from galling, fretting corrosion, stick slip, seizure or damage. They provide corrosion protection, water washout resistance and a consistent coefficient of friction. These solid lubricants remain in place – even at high temperatures and under heavy loads – to help with long-term lubrication. To ensure optimal performance of threaded connections, the appropriate *Molykote* Anti-Seize Paste needs to be selected for the application conditions.

Anti-Friction Coatings are paint-like products that form a slippery film that covers and smoothes surface roughness. This optimizes friction control, even under extreme loads and working conditions. However, the effectiveness and surface life of an AFC is greatly affected by the surface pretreatment of the component, such as degreasing, phosphating, sandblasting and anodizing.

TYPICAL PROPERTIES OF SOLID LUBRICANTS USED IN ANTI-SEIZE PASTE AND ANTI-FRICTION COATING FORMULATIONS

By combining different types of solid lubricants in paste formulations, we get increased protection from fretting corrosion, increased load-carrying and wear prevention. ***The sum of what they can do together is superior to what they offer separately.***

Graphite
High temperature stability
Good lubricant under humidity
Low coefficient of friction at high loads
Protects against fretting corrosion
Molybdenum Disulfide (MoS_2)
High load carrying capacity
Wide temperature range
Excellent adhesion
Protects against fretting corrosion
Friction decreases with increasing load
Prevents stick-slip
Not for use in humid environments
Polytetrafluoroethylene (PTFE)
Colorless
Low load carrying capacity
Low coefficient of friction at low loads
Good chemical resistance
Good at reducing sliding friction
Copper
High load carrying capacity
High temperature stability
Should not be used with stainless steel above temperatures of 1000° C (1832° F)
May promote galvanic corrosion
White Solids
Protects against fretting corrosion
Suitable for high temperatures
Excellent adhesion

Anti-Seize Pastes

Molykote® brand Anti-Seize Pastes are high-performance products specially formulated for harsh conditions. Unlike conventional greases or compounds, *Molykote* Anti-Seize Pastes create and maintain a lubricating layer, despite extreme loads and temperatures.

Molykote® pastes provide:

- Wear protection
- Reliable performance across wide temperature ranges
- Consistent coefficient of friction (μ)
- Water washout resistance
- Corrosion protection
- Immediate lubrication once applied
- Long-term lubrication

Easy, quick and accurate application of Anti-Seize Pastes can be achieved by brushing or dispensed pumping. Some Anti-Seize Pastes are also available in spray form.

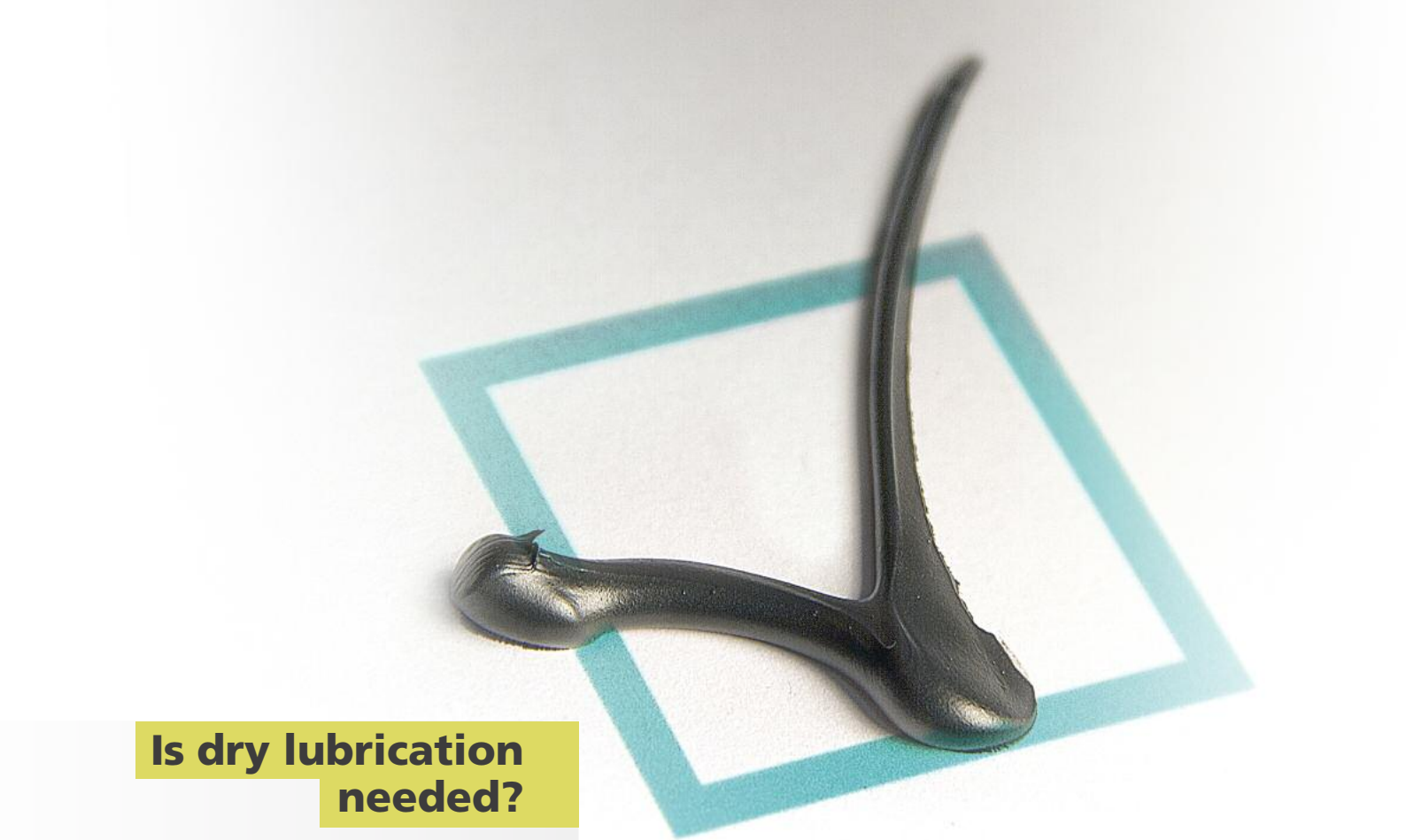
Anti-Friction Coatings

Molykote® brand Anti-Friction Coatings are very useful for parts exposed to dusty environments or inaccessible areas where long-term lubrication is desired. The parts can be pre-lubricated in a clean environment to reduce handling during field assembly operations.

Molykote® brand AFCs are formulated to offer these benefits after curing:

- Dry lubrication
- Coating that is nonflammable
- Film that does not attract dirt and dust
- Additional corrosion protection
- Long-term lubrication without evaporation
- Effective lubrication even after prolonged service life

Application methods include hand or drum spraying, dipping, centrifuging, brushing, roll coating or printing. The best application method is at the discretion of the end user and depends on the geometry of the part being coated.



Is dry lubrication needed?

YES, my application is exposed to dust, dirt and debris and would benefit from dry lubrication.

Choose *Molykote*® brand Anti-Friction Coatings.

NO:

Choose *Molykote*® brand Anti-Seize Pastes.

Can your part be thoroughly cleaned and dried?

YES:

Choose *Molykote*® Anti-Friction Coatings.

NO:

Consider *Molykote*® Anti-Seize Pastes.

SELECT
THE RIGHT LUBRICANT

The *Molykote* Anti Seize Pastes and *Molykote* Anti Friction Coatings (AFCs) presented in this brochure are specially formulated for use on threaded connections, helping deliver long term protection, reliability and productivity.

While *Molykote* Anti Seize Pastes and *Molykote* AFCs offer many similar benefits, they perform best in specific applications:

- The performance of *Molykote* Anti Seize Pastes does not require extensive surface preparation, so they are especially useful in the field.
- *Molykote* AFCs must be applied to surfaces that can be thoroughly cleaned and dried, and are often prepared in a clean environment as an engineered solution to help improve maintainability.

When used together, *Molykote*® Anti Seize Pastes and AFCs can deliver synergistic performance.

You can use the following tables to select the *Molykote* lubricant that best satisfies your needs. For more information and technical specifications or to contact a lubrication expert, visit *molykote.com*.

Molykote® Brand Anti-Seize Pastes Selection Table

Using Anti-Seize Pastes is one of the best ways to reduce and control friction in threaded connections, ensuring long-term performance and easy disassembly and reassembly. To determine the appropriate Anti-Seize Paste, consider the load, environment, temperature and speed of your application. Below is a general description of *Molykote* Anti-Seize Pastes that Dow Corning identifies as best suited for threaded connections.

PRODUCT NAME	KEY FEATURES	TEMPERATURE RANGE °C	SOLID LUBRICANTS	Strong Adhesion Capacity	Metal-Free Composition	Galling Prevention	Fretting Corrosion Protection	Water Resistance	High Load Carrying Capability	Suitable for Low to Moderate Loads
MOLYKOTE® G-n METAL ASSEMBLY PASTE/SPRAY*	• Suitable for general assembly and running-in	Up to 400	MoS_2, white solids	✓			✓		✓	
MOLYKOTE® G-n PLUS PASTE**	• Copper-free	Up to 400	MoS_2, graphite, white solids			✓	✓		✓	
MOLYKOTE® HSC PLUS PASTE	• Wide service temperature range • High load carrying capacity • Good electrical conductivity • Good corrosion protection	-30 to 1100[1]	MoS_2, copper, white solids			✓		✓	✓	
MOLYKOTE® G-RAPID PLUS PASTE/SPRAY	• Provides consistently low coefficient of friction	Up to 400	MoS_2, graphite, white solids				✓		✓	✓
MOLYKOTE® 1000 PASTE	• Good for high load and vibration applications where there is a need to establish consistent torque	-30 to 650	Copper and graphite, white solids	✓			✓		✓	
MOLYKOTE® M-77 PASTE	• Silicone base oil provides higher stability • Stays paste-like at higher temperatures • Compatible with many elastomers and plastics	Up to 350[1]	MoS_2					✓	✓	
MOLYKOTE® P-37 PASTE	• High purity • Suitable for stainless, austenite and high nickel chromium steel • Prevents stress corrosion cracking and solder embrittlement	-30 to 1400[1]	Zirconium dioxide		✓	✓			✓	
MOLYKOTE® P-40 PASTE	• Metal-free • Suitable for water contact	-40 to 1200[1]	White solids and PTFE	✓	✓	✓	✓	✓		✓
MOLYKOTE® P-74 PASTE	• Synthetic base oil carrier • Remains grease-like for longer period of time	-40 to 200	Graphite and white solids			✓		✓		
MOLYKOTE® P-1900 PASTE	• Suitable for food processing machinery • FDA 21 CFR 178.3570 • NSF H1 Classification	-30 to 300	White solids			✓	✓	✓	✓	
MOLYKOTE® U-n PASTE	• Polyalkylene glycol (PAG) base oil • Extremely tacky • Compatible with natural rubber	Up to 400[1]	MoS_2 and white solids	✓					✓	

[1] Temperature range of solid lubricants
* Product not available in Europe
** Product not available in North America

Molykote® Brand Anti-Friction Coatings (AFCs) Selection Table

Using an AFC is one of the best ways to reduce and control friction in threaded connections, ensure long-term performance, and easy disassembly and reassembly. To determine the appropriate AFC, remember to consider service requirements, the desired coating method and the specific advantages for different applications. Below are general descriptions of *Molykote* AFCs that Dow Corning identifies as best suited for threaded connections.

PRODUCT NAME	KEY FEATURES	TEMPERATURE RANGE °C	SOLID LUBRICANT/ BINDER	High Load Carrying	Chemical Resistance	Fuel & Oil Resistance	Fretting Corrosion	Corrosion Resistance
MOLYKOTE® 3402-C LF ANTI-FRICTION COATING	• Room temperature curing • High pressure and wear resistance	-200 to 310	Solids: MoS_2 Binder: proprietary	✓	✓		✓	✓
MOLYKOTE® D-708 ANTI-FRICTION COATING	• Heat curing • Black glossy finish	-64 to 240	Solids: PTFE Binder: epoxy		✓			
MOLYKOTE® D-7409 ANTI-FRICTION COATING	• Heat curing • Suitable for high temperatures	-70 to 300	Solids: MoS_2 Binder: polyamide-imide	✓	✓	✓	✓	✓
MOLYKOTE® 3400A ANTI-FRICTION COATING LF	• Heat curing • Excellent adhesion	-200 to 260	Solids: MoS_2 Binder: epoxy	✓	✓		✓	✓
MOLYKOTE® D-321 R ANTI-FRICTION COATING	• Room temperature curing • Available as an aerosol spray	-200 to 260	Solids: MoS_2, graphite Binder: titanate	✓			✓	
MOLYKOTE® 106 ANTI-FRICTION COATING	• Heat curing • Easy to apply	-70 to 250	Solids: MoS_2 Binder: epoxy	✓			✓	

Need more information?
Visit ***molykote.com*** or contact your Dow Corning *Molykote*® lubricants distributor to get expert advice.

molykote.com

Learn More

Molykote lubricants are available through a distributor network of more than 3,000 distributors worldwide. And, Dow Corning has Lubricant Expertise Centers strategically located globally to provide you with expert technical service and support.

In addition to *Molykote* Anti-Seize Pastes and Anti-Friction Coatings, our other **Smart Lubrication**™ solutions include multipurpose oils, synthetic and ultra-high-purity mineral oil fluids, specialty compounds, greases and more. Learn more now about our extensive product and service offering by visiting ***molykote.com*** or email ***industrial@dowcorning.com***.

Images: Page 1, AV20593, AV20600; Page 2, AV19522; Page 3, AV19512, AV19520, AV17005; Page 4, AV19519, AV19516; Page 5, AV19513; Page 6, AV19514, AV19524; Page 8, AV19521; Page 10, AV19523; Page 11, AV19515

AMPM184-14 Form No. 80-3927-01

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