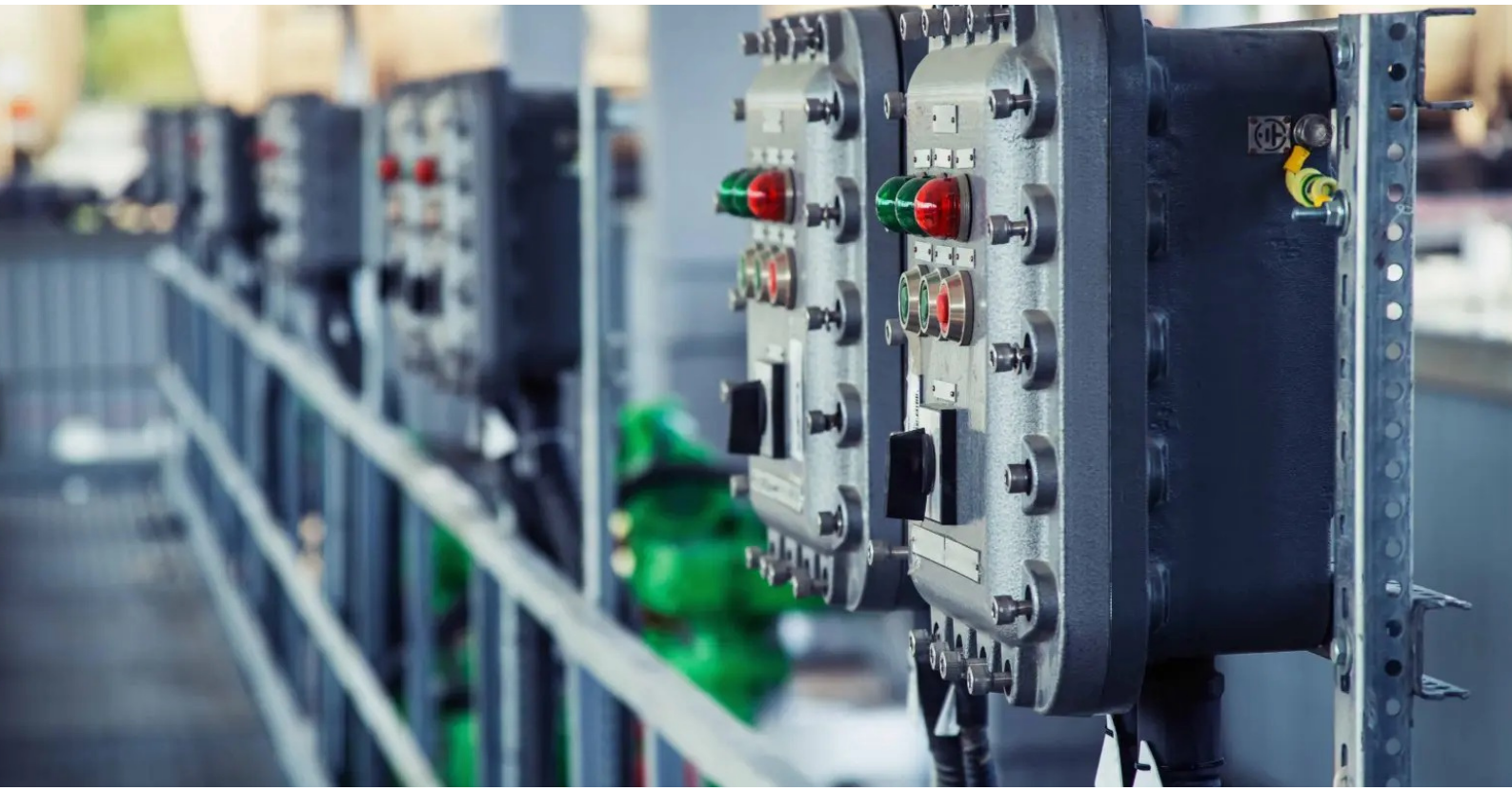
Lubrication and Protection of Switches, Connectors, and Sensors

Wallimore lubricant for electrical switches and contacts



Contact lubricant

- EXTEND CONTACT LIFESPAN
- IMPROVE SIGNAL QUALITY
- ENHANCE OPERATIONAL STABILITY
- REFINE SWITCH FEEL
- PREVENT SWITCH CONTAMINATION
- SILICONE-FREE

1. Wallimore Contact Lubricant, ensuring electrical performance and enhancing operational experience.

In the usage of electrical contacts and connectors, there are often several misconceptions:

- Grease attracts dust and particles.
- Lubricants affect conductivity.
- Gold-plated contacts do not require grease.
- Controlling grease on contacts can control costs.....

However, in reality, Wallimore's contact lubricant has demonstrated the inaccuracy of these misconceptions through practical applications:

1. Establishment of an Environment Shield

- Wallimore's contact lubricant creates a protective barrier isolating dust, particles, oxygen, moisture, corrosive gases, and other harmful substances from the contact surface. This effectively prevents metal oxidation and corrosion.

- The use of Wallimore's contact lubricant increases the stability and lifespan of various current-carrying metal contact surfaces (including contact points, connectors, and busbars), extending their lifespan by over 300%.

2. Stable Electrical Contact Assurance

- The use of Wallimore's contact lubricant does not affect the impedance values of connectors. The use of contact grease effectively reduces insertion and extraction forces by up to 80%, improving the connection and assembly efficiency of complex devices such as multi-pin connectors.

- Additionally, Wallimore lubricant's thick film provides insulation, preventing leakage current. The extremely thin film layer (between closed metal contacts) conducts electricity due to the quantum tunneling effect, and the neutral pH value avoids surface corrosion.

3. Protection of Precious Metals

- The thin film formed by Wallimore lubricant complements and seals porous gold-plated layers, reducing scratches and wear on precious metals, preventing the emergence of oxides, and ensuring electrical performance.

- Using contact lubricant can bridge the design shortcomings of switches, significantly reducing costs compared to thick gold plating.

4. Economic Benefits and Extended Lifespan

- Wallimore's contact lubricant not only provides arc protection and corrosion resistance but, more importantly, effectively prevents "micro-motion corrosion." This phenomenon occurs due to low-frequency vibrations caused by movement or temperature fluctuations, leading to wear and metal accumulation that can result in circuit failure. Lubricants minimize metal wear, preventing micro-motion corrosion at the contact points.

- Additionally, it is recommended to fill internal spaces with grease, acting as protective encapsulation.

The Application of Quantum Tunneling Effect

The quantum tunneling effect refers to the phenomenon at the microscopic scale where particles can pass through energy barriers that are considered impassable in classical physics.

In the operation of contact lubricants, the quantum tunneling effect plays a crucial role. On a microscopic level, the surface of the contact points is not perfectly smooth but consists of alternating peaks and valleys. Electrical current flows only from the tips of the protruding peaks, while the contact lubricant fills the valleys. The lubricant on the tips is pushed aside, allowing the current to pass through. This phenomenon can be explained by the quantum tunneling effect, where electrons overcome energy barriers, enabling conduction on the uneven surface.

2. Why lubricate switches and contacts?

Maintaining low levels of contact resistance and insertion/extraction force is crucial, especially under frequent operational demands. Therefore, the use of lubricants on electrical contacts becomes imperative.

- Enhancing Effectiveness: Even with plated or chemically coated contacts, achieving the desired effectiveness can be challenging without lubrication. This is particularly true when a thicker coating is required, which may become more costly.

- Reducing Wear: In scenarios involving frequent insertion and extraction operations, minimizing wear is a primary method for extending the lifespan of contacts.

- Minimizing Friction: For applications requiring low insertion/extraction force, reducing friction is a critical factor.
- Extending Lifespan: In the face of vibrations and frequent temperature cycles, such as in automotive and automation technologies, prolonged lifespan and reliable contact are necessary. The role of lubricants is to reduce micro-motion corrosion.

- Resisting Arc Erosion: Even relatively thick corrosion-resistant metal layers struggle to resist contact erosion caused by switch arcs.

- Adapting to Environmental Changes: Harsh environments and operating conditions often lead to the deposition of foreign substances or chemical changes on contact surfaces. The use of lubricants helps address these challenges.

3. The working principle of contact lubricants

Although new alloys and plastics are continuously being adopted, and the manufacturing processes of contacts are continually improving, it is still challenging to produce completely smooth metal contact surfaces, which is a major cause of switch failures.

The working principle of contact lubricants lies in compensating for metal surface defects, filling the gaps between contacts, effectively increasing the contact surface area, preventing the formation of arcs, temperature rise, and oxidation. Additionally, the lubricant provides an isolation barrier to prevent the contamination of harmful substances such as air, reducing the impact of friction generated during component operation.

The working principle of contact lubricants also involves the "quantum tunneling effect." Contact lubricants form a thin film where the lubricant molecules can utilize the quantum tunneling effect to transmit current through tiny defects on the metal surface. The quantum tunneling effect ensures smooth conduction of current on the contact surface at the microscopic level, improving electrical performance, reducing friction and corrosion, and achieving more stable and efficient current transmission.

"Feel" has become an important quality indicator for lubricants, and lubricants optimize the contact performance between metal-to-metal or plastic-to-plastic. With the action of lubricants, contacts can operate with a longer lifespan and higher efficiency, providing reliable electrical connections for various application scenarios.

4. Confusion about the use of contact grease

1. Heat Collection

For surfaces with insufficient contact, the current loads only on a small portion of the designed surface area, leading to the accumulation of heat concentrated on these contact points. This can result in a high-resistance oxide layer and hotspots, eventually causing the two surfaces to weld together and fail completely. In such cases, the overall efficiency of the switch is reduced.

2. Arcing (Micro Light Impact)

Arcing can occur on unlubricated contact points. Due to ionization of the air and temperature rise, metal migration occurs on the contact surface, forming new "peaks and valleys." This may lead to contact failure, affecting the normal operation of the equipment.

3. Mechanical Wear

Mechanical wear occurs on metal contact surfaces, whether static or dynamic, with static contacts referred to as microvibration wear. As the contacts wear, metal particles generated from friction penetrate through the plating layer, exposing the surface and underlying metal, causing oxidation and wear. This eventually leads to contact failure or may affect the continuity of signal transmission.

4. Silicon Contamination

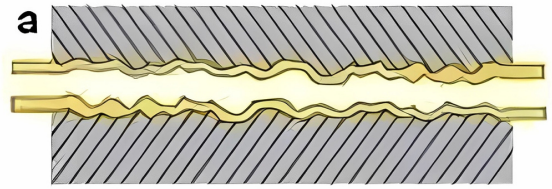
Silicon migration can result in silicon contamination, which is not suitable for the switch field. In dynamic and vibrating switches, silicon reacts under the action of the arc to form silicon carbide (carborundum), these crystals wear the contact surface and cause electrical breakdown. Therefore, introducing Wallimore lubricants during the design phase ensures the selection of the right products and appropriate processes. Factors to consider when choosing lubricants include voltage, current, operating temperature range, contact resistance, cycle count, and related plastic materials.

5. Switch Control

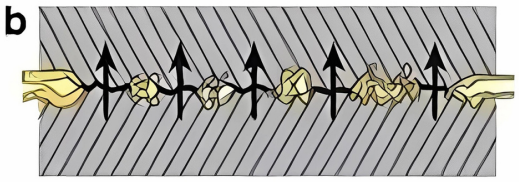
"Feel" is becoming an important indicator of switch quality, especially in the automotive industry. In addition to the technical benefits, contact lubricants also determine the feel of the switch. On the dashboard of commercial vehicles, contact lubricants exhibit a strong and decisive performance, while in luxury cars, they perform smoothly and quietly.

5. How is contact resistance generated?

Even though the contact surface may appear very smooth to the naked eye, there is a certain level of roughness visible under a microscope. Depending on the applied contact force, the electrically effective surface is only 0.01% - 1% of the apparent contact surface. This minuscule actual contact area determines the magnitude of contact resistance.



Common foreign layers on the contact surface, such as metal oxide layers or plastic deposits, increase resistance. Penetrating these layers requires a sufficiently high contact force or the generation of heat due to power loss. Excessive heat can lead to micro-welding, forming the so-called "point stick." The remaining electrically effective contact surface is referred to as "point A."



The frequent repetition of these processes, possibly caused by insertion and removal cycles, vibrations, or temperature fluctuations, results in changes to the contact surface. This makes the penetration of foreign layers more challenging, and the electrical contacts quickly lose their continuously decreasing transitional resistance, leading to unstable contacts.

6. How does lubricant function on electrical contacts?

Lubricants are essentially insulators, but they impact electrical contacts in the following ways:

1. Protective Coating During Storage:
    - Lubricant covers open contacts, effectively preventing the formation of harmful foreign layers (such as oxides) on their surfaces.
    - This protective coating acts as a barrier, preventing dust, oxygen in the air, and other potentially corrosive substances from causing metal oxidation and corrosion.

2. Separation Film When Contacts Close:
    - When electrical contacts close, the lubricant forms a separation film due to the relative movement of the two contacts.
    - The separation film significantly reduces the coefficient of friction and wear, making the metal contact between electrical contacts smoother.
    - The separation film acts as an insulator in the closed state, effectively reducing electrical contact resistance.

3. Effect During Contact Opening:
    - When contacts open, the arc can stop more quickly, benefiting from the lubricant's dielectric strength higher than that of air.
    - The rapid cessation of the arc means a reduction in contact erosion, effectively extending the lifespan of the electrical contacts.

Through these three mechanisms, lubricants play a crucial role on electrical contacts, optimizing the performance of electrical connections, extending the equipment's lifespan, and enhancing system reliability.

7. What should be considered when choosing contact lubricants?

1. Compatibility with Other Materials

- The lubricant used should be compatible with the contact and surrounding materials.
- Consider factors such as voltage, current, operating temperature, external environment, contact metal material, cycle count, and relevant plastics.
- Conduct product usage discussions during the design phase to ensure the selection and use of appropriate products.
- Plastic test strips coated with Wallimore lubricant were subjected to critical parameter testing after being placed at 40°C for 7 days.

2. Chlorine Resistance

- Test the antioxidant performance of contact lubricant products by applying different varieties of contact lubricants or mechanical lubricants to copper plates. Place the samples in chlorine-containing air at 35°C for 2 months. The results indicate that some products have inadequate protective performance.

3. Protection in Wet/Corrosive Environments

- Develop a testing process to ensure that the product exhibits a high level of protection in high humidity and corrosive environments.
- Coat the surfaces of steel and copper plates with different varieties of lubricant products, maintain at 35°C and 90% humidity for 3 weeks, and then continue placing them in a salt spray chamber containing a 5% salt solution for 1 week at 35°C. Conduct visual inspections and record corrosion/oxidation data.

4. Primary Selection Criteria

The selection criteria for lubricants depend on the parameters that need the most optimization, which could include:

- Reducing insertion and removal forces
- Resisting micro-motion corrosion
- Increasing insertion and removal cycle counts
- Transitional resistance, dielectric resistance
- Alternating changes in high and low-temperature environments

Application Method

- The selection of lubricants should consider factors such as the metal surface, the forces involved in mutual movement, etc. The adhesion of the lubricant depends on its chemical composition and viscosity, and also on the contact material, surface roughness, and orientation of roughness.
- Lubricants used for charged contacts should have a low evaporation tendency and high resistance to oxidation.
- At high temperatures, lubricants should evaporate or burn without leaving residues to avoid the accumulation of foreign materials (coking) that may affect the contact's functionality.
- Under these requirements, perfluoropolyether (PFPE) performs superiorly compared to hydrocarbon-based lubricants

8. How is lubricant applied to the contacts?

The application of contact lubricants involves various manufacturing processes to ensure the formation of a thin and uniform lubricating layer on the contact surface, thereby enhancing contact performance. Here are some common coating methods:

1. Spray Method

- In the manufacturing process, an economical and common method involves spraying a dissolved or dispersed lubricant onto the contact surface at an appropriate concentration. After solvent evaporation, a very thin lubricant layer is formed, highly effective in friction studies.

2. Micro-Metering Systems

- Advanced micro-metering systems can directly apply undiluted lubricants to the contacts at a set production rate, ensuring precise coating.

3. Transfer Printing

- For larger or rotating contacts, lubricant can be applied using transfer printing technology. This technique allows achieving the desired layer thickness, such as 2-5μm.

4. Brush Coating

- For high-pressure contacts, especially in cases where fiber lubricants are needed to prevent arc discharges, brushing or metering devices (such as spraying) can be used to apply a thicker lubricant layer.

5. UV Color Indicators

- To better control the application process, lubricants can incorporate integrated UV color indicators for online application monitoring through an appropriate optical system, ensuring the quality of the lubricating layer.

The choice of these methods depends on the characteristics and requirements of the contacts. The selection of lubricants should also consider factors such as voltage, current, operating temperature range, and contact resistance.

9. Switch Contact Protection

1. High-Current Arc Switches or Contacts

- In high-current arc switches or contacts, unlubricated contacts are prone to arc formation. The ionization of air due to high currents leads to temperature rise, causing metal migration, protrusions, and the formation of craters on the contact surface. This exacerbates the "make-and-break" process of the switch, resulting in repetitive current fluctuations, generating noise, and reducing signal quality.

- Lubricants fill the gaps on the contact surface, preventing the formation of arcs and temperature rise, avoiding the generation of corrosive chemicals. The lubricant also acts as a shock absorber, reducing contact bounce.

Application Examples

- Starter/Ignition: ECG 80 Electric Contact Grease
- Heater/Ventilator: ECG 81 Electric Contact Grease

2. Intermediate Current Switches or Contacts

- This type of switch is designed with sensitive plastics and elastic materials, and lubricants should have compatibility to meet usage requirements.

- Contact lubricants significantly increase the contact surface area, eliminate hotspots, improve operational efficiency, and ensure low and stable contact resistance.

Application Examples

- Windshield Wiper: ECG 81 Electric Contact Grease
- Central Locking Switch: ECG 60 Electric Contact Grease / ECG 81 Electric Contact Grease
- Power Seat Switch: ECG 60 Electric Contact Grease
- Dashboard Controller: ECG 65 Electric Contact Grease
- Power Window Switch: ECG 65 Electric Contact Grease
- Micro Switch: ECG 65 Electric Contact Grease

3. Low to Intermediate Current Switches or Contacts

- Low to intermediate current switches or contacts typically utilize sensitive plastics and elastic materials. Wallimore contact lubricants are widely used in high-quality audio and ergonomic controller applications, ensuring devices have low current loads and excellent electrical performance. They also prevent metal interface corrosion, avoid switch noise interference, and maintain signal stability.

Application Examples

- Steering Wheel Switch: ECG 81 Electric Contact Grease
- Light Switch: ECG 50 Electric Contact Grease
- Low Contact Pressure Switch: ECG 50 Electric Contact Grease
- Audio Switch: ECG 81 Electric Contact Grease

10. Connector Protection

1. Contact Point Protection

- Contact lubricants in connectors are used to prevent wear, environmental corrosion, and "micro-motion corrosion." Minor movements within the connector's housing cause vibrations and thermal fluctuations. By reducing the formation of metal oxides at the contact interface, synthetic lubricants can extend contact lifespan and maintain low contact impedance.

2. Gold-Plated Contact Points

- While most automotive connectors use silver- or tin-plated contact points, some connectors, such as those used in airbags, opt for gold plating. Due to the softness of gold, adhesion during contact is easy, which can lead to abrasion and scratches, sometimes even exposing the underlying copper metal and causing corrosion. The use of appropriate synthetic lubricants effectively reduces adhesion, preventing abrasion, scratches, and deformation.

3. Insertion and Removal Forces

- Reducing insertion and removal forces has become a primary challenge for OEMs. The mating contacts of multi-pin connectors are sometimes challenging to align, often requiring significant force, which can lead to poor assembly and repetitive motion injuries for assembly personnel. Fluorinated ether-based synthetic lubricants have been proven to effectively reduce insertion and removal forces without increasing impedance.

Application Examples

- ECG 60 Electric Contact Grease
- ECO 62 Electric Contact Lubricating Oil

11. Sensor Protection (Non-Electrical)

1. Sensors and Potentiometers

- In electromechanical sensors or potentiometers, ensuring continuous contact is crucial for signal transmission. Therefore, selecting a low-viscosity fluorosilicone oil is essential to prevent the hydraulic plane phenomenon caused by high-viscosity grease, which can impact contact performance. Sensor lubricating oil should have good viscosity-temperature characteristics to ensure it does not harden in low-temperature environments, such as -70°C.

- Potentiometers require low contact force while maintaining good contact with resistance. The most suitable product is a lubricant composed of low-viscosity base oil and a non-carbonizing thickener to ensure excellent contact performance.

- In high-temperature operating conditions, an ideal lubricant for fuel level sensors needs to coat a thin and durable layer. Fluorinated lubricants possess special plastic compatibility and solvent resistance, making them suitable for such environments.

Application Examples

- Fuel Hydraulic Sensor: ECO 66F Electric Contact Lubricating Oil
- Seat: ECG 90F Electric Contact Grease
- Electronic Valve: ECG 90F Electric Contact Grease

2. Interior Components - Non-Electrical

Interior components require a variety of lubricants to ensure the smooth operation of devices:

- Metal contact points, such as seat tracks, sunroof tracks, etc., require lubricants suitable for metals.
- Plastic contact points, such as wiper gears, window sunshades, cup holders, grab handles, etc., need lubricants suitable for plastics.
- Plastic-metal contact points, cables, glove box locks, etc., require lubricants with specific characteristics to avoid jumping phenomena and noise interference, ensuring device quality and safety.

Wallimore lubricants provide engineers with safe and reliable products suitable for various interior components, ensuring their optimal performance.

Application Examples

- Dashboard Pointer: PLT 30 Plastic Lubricating Grease
- Window Sunshade: PLT 32 Plastic Lubricating Grease
- Window Track: ECG 50 Electric Contact Grease

> "LUBRICATION PROTECTION UNDER HARSH CONDITIONS"

WALLIMORE®
威力摩

JIUTING INDUSTRIAL PARK, SONGJIANG DISTRICT, SHANGHAI
WWW.WALLIMORE.COM
TECH@RUNSUNSH.COM
+86 400 920 5357