Smooth Silent Ecological

Special Environmental Specifications of THK Linear Motion Systems

- Clean Rooms
- Vacuum
- Corrosion Resistance
- High Speed
- High Temperatures
- Low Temperatures
- Fine Movement

For details, visit THK at www.thk.com

#Product information is updated regularly on the THK website.
The linear motion systems used in special environments such as semiconductor production systems, liquid crystal production systems, health care equipment and food processing machinery are the product of roughly 30 years of technology and a vast amount of experience.

This brochure provides an introduction to the special environmental specifications products created by taking full advantage of THK’s proprietary Caged Ball Technology, materials technology, lubrication technology and surface treatment technology in order to effectively respond to the increasingly diversified needs of today.
In clean environments such as the environments found in clean rooms, it is necessary to reduce the generation of dust by linear motion systems as well as enhance rust preventive performance since rust preventive films cannot be used. In addition, depending on the degree of cleanliness of the clean room, it is also necessary to use a dust collector.

### Generation of Dust from Linear Motion Systems

| Measures against dust generation caused by splattering of grease: | **THK AFE-CA Grease and AFF Grease**  
Grease resulting in low generation of dust is used and is suitable for clean environments. |
| Measures against dust generation caused by production of metal wear fragments: | **LM Guide with Ball Cage**  
The use of the LM Guide with Ball Cage reduces the level of metal wear fragments produced by eliminating friction between the balls, thereby making it possible to suppress the generation of dust. |

### Rust Prevention

#### Material countermeasures:

| Stainless Steel LM Guide  
This LM Guide uses martensite stainless steel that is effective in prohibiting rust. |
| High Corrosion Resistance LM Guide  
The LM Rail uses austenite stainless steel resulting in a high degree of rust preventive effects. |

#### Surface treatment countermeasures:

| **THK AP-C Treatment, AP-CF Treatment and AP-HC Treatment**  
Surface treatment (plating) of linear motion systems results in improved rust prevention capabilities. |

In vacuum environments, it is necessary to select products having excellent rust prevention capabilities as countermeasures against dispersion of gases released from resins and splattering of grease since rust preventive oil cannot be used.

### Measures against gas released from resins:

| Stainless Steel LM Guide  
Stainless steel is used for the material of the end plates of the LM block (through which plastic balls circulate) to reduce the levels of released gas. |

### Measures against grease splattering:

| Vacuum Grease  
When general-purpose grease is used in a vacuum environment, the oil component of the grease ends up dispersing resulting in a loss of lubricity. Consequently, vacuum grease is used that uses a fluorine-based oil having a low vapor pressure for the base oil. |

### Rust preventative countermeasures:

| Stainless Steel LM Guide  
The stainless steel LM Guide is used in vacuum environments due to its excellent rust preventative effects. |
| **High-Temperature LM Guide**  
The high-temperature LM Guide is used in cases of being subjected to high temperatures such as during baking, etc. because of its excellent heat resistance and corrosion resistance. |
3 Corrosion Resistance

Similar to the case of use in clean rooms, corrosion resistance is enhanced by selecting appropriate materials and surface treatment.

**Material countermeasures:**

- **Stainless Steel LM Guide**
  This LM Guide uses martensite stainless steel that is effective in prohibiting rust.

- **High Corrosion Resistance LM Guide**
  The LM Rail uses austenite stainless steel resulting in a high degree of rust preventative effects.

**Surface treatment countermeasures:**

- **THK AP-C Treatment, AP-CF Treatment and AP-HC Treatment**
  Surface treatment (plating) of linear motion systems results in improved rust prevention capabilities.

4 High Speed

In high-speed environments, an optimum lubrication method is required that suppresses the generation of heat during high-speed motion and improves the retention capabilities of the grease.

**Measures against heat generation:**

- **LM Guide with Ball Cage**
  Heat generation is reduced as a result of the ball cage eliminating friction between the balls. Moreover, since the retention capabilities of the grease are improved, a long service life and outstanding high-speed performance are achieved.

- **High-Speed Ball Screw with Ball Cage (DN value up to 160,000)**
  The use of a ball cage realizes the ideal ball circulation structure, enabling high-speed feeding unable to be realized with conventional products.

- **THK AFG Grease**
  The use of grease capable of suppressing heat generation during high-speed use while also offering excellent lubricity makes it possible to achieve high-speed feeding.

**Lubrication countermeasures:**

- **Lubricator QZ**
  Lubricator QZ makes it possible to significantly extend lubrication maintenance intervals by compensating for lost oil. Since only the minimal amount of lubricating oil is applied to the rolling surface, the surroundings are not soiled resulting in a lubrication system that is environmentally friendly.
Under low-temperature conditions, grease is used that results in minimal effects on plastic parts caused by low temperatures while also minimizing fluctuations in rust preventative countermeasures caused by temperature changes from normal to low temperatures as well as fluctuations in rolling resistance even at low temperatures.

**Heat resistance:**
- High-Temperature LM Guide
  - This LM Guide offers outstanding heat resistance and is subjected to only minimal dimensional changes following heating and cooling.

**Rust preventative countermeasures:**
- Surface treatment of the linear motion system results in enhanced rust preventative capabilities.

**Grease:**
- THK AFC Grease is used that exhibits only minor fluctuations in rolling resistance even at low temperatures.

In high-temperature environments, the effects of dimensional changes caused by heat can become a problem. The High-Temperature LM Guide and High-Temperature Grease are used because they offer outstanding heat resistance and are subjected to minimal dimensional changes following heating and cooling.

**Heat resistance:**
- High-Temperature LM Guide
  - This LM Guide offers outstanding heat resistance and is subjected to only minimal dimensional changes following heating and cooling.

**Grease:**
- High-Temperature Grease
  - High-temperature grease is used because it causes only minor fluctuations in rolling resistance even during temperature changes from normal temperature to high temperatures.

Under low-temperature conditions, grease is used that results in minimal effects on plastic parts caused by low temperatures while also minimizing fluctuations in rust preventative countermeasures caused by temperature changes from normal to low temperatures as well as fluctuations in rolling resistance even at low temperatures.

**Effects of low temperatures on plastic parts:**
- Stainless Steel LM Guide
  - Stainless steel is used for the material of the end plates of the LM block (through which plastic balls circulate).

**Rust preventative countermeasures:**
- Surface treatment of the linear motion system results in enhanced rust preventative capabilities.

**Grease:**
- THK AFC Grease is used that exhibits only minor fluctuations in rolling resistance even at low temperatures.

Extremely short strokes can cause oil films to be depleted and ineffective lubrication eventually leading to rapid wear. In cases such as this, a grease is selected that has excellent oil film strength and enables the oil film to be formed easily.

**Grease:**
- THK AFC Grease
  - This urea-based grease offers excellent oil film strength and wear resistance.
Clean Rooms

- Measures against dust generation
- Rust preventative countermeasures

LM Guide with Caged Ball Technology
- Applicable types: SHS, SNR/SNS, SSR, SHW, SRS

Stainless Steel LM Guide
- Applicable types: HSR, SR, SSR, SHW, SRS

High Corrosion Resistance LM Guide
- Applicable type: HSR-M2

Surface Treatment

Grease
Vacuum

- Measures against released gases
- Measures against grease splatter
- Rust preventative countermeasures

High-Temperature LM Guide

- Applicable types: 
  - HSR-M1
  - RSR-M1
  - SR-M1

High Corrosion Resistance LM Guide

- Applicable type: 
  - HSR-M2

Stainless Steel LM Guide

- Applicable types: 
  - HSR
  - SR
  - HR
  - RSR
  - HRW
  - RSH

Vacuum Grease

- Measures against released gases
- Measures against grease splatter
- Rust preventative countermeasures
Special Environmental Specifications of Linear Motion Systems

High Speed
- Measures against heat generation
- Grease retention

LM Guide with Caged Ball Technology
- Applicable types: SHS, SNR/SNS, SSR, SHW, SRS

High-Speed Ball Screw with Caged Ball Technology
- Applicable type: SBK, HBN, SBN

Lubricator QZ

Grease
High Speed

Lubricator QZ for LM Guide

Lubricator QZ for Ball Screw

THK AFG Grease

SHS  SSR  SNR/SNS  SHW  SRS

SBK  HBN  SBN

P.15~  P.17~  P.18~  P.18~  P.25~
Special Environmental Specifications of Linear Motion Systems

High Temperatures

- Heat resistance
- Grease

High-Temperature LM Guide
- HSR-M1
- RSR-M1
- SR-M1

High-Temperature Grease

Stainless Steel LM Guide
- HSR
- SR
- HR
- RSR
- HRW
- RSH

Surface Treatment

Low Temperatures

- Effects on plastic parts
- Rust preventative countermeasures
- Grease

Grease

Fine Movement

- Grease retention

Grease
The LM Guide with Caged Ball is able to demonstrate outstanding low dust generation performance due to the low level of production of metal wear fragments as a result of the ball cage eliminating friction between the balls.

### Friction Between Balls

Conventional type (without ball cage)

New type (with ball cage)

Contact structure between balls and ball cage

- Ball cage
  - Contact between balls is eliminated for reduced ball wear

### Low Dust Generation Data

<table>
<thead>
<tr>
<th>Particle size (μm)</th>
<th>Amount of dust generated (particles/2 min-liter)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.3 – 0.5</td>
<td>Conventional products (without ball cage)</td>
</tr>
<tr>
<td></td>
<td>SSR20 (with ball cage)</td>
</tr>
<tr>
<td></td>
<td>0 – 50</td>
</tr>
<tr>
<td></td>
<td>50 – 200</td>
</tr>
<tr>
<td></td>
<td>200 – 300</td>
</tr>
<tr>
<td></td>
<td>300 – 0</td>
</tr>
</tbody>
</table>

- Conventional type (without ball cage)
  - Low dust generation
  - Friction between balls

- New type (with ball cage)
  - High speed
  - Clean rooms
  - Contact structure between balls and ball cage
  - Ball cage
  - Contact between balls is eliminated for reduced ball wear

- Conventional products (without ball cage)
  - 0 – 50
  - 50 – 200
  - 200 – 300
  - 300 – 0

- SSR20 (with ball cage)
  - Low dust generation
  - High speed
  - Clean rooms
  - Contact structure between balls and ball cage
  - Ball cage
The use of ball cages reduces the generation of heat caused by friction between the balls, thereby improving grease retention capabilities and resulting in outstanding high-speed performance.

Grease retention status after travel (SHS45LV: load durability test)

### High-Speed Durability Test Results

- **Sample**: SHS65LVSS
- **Speed**: 200 m/min
- **Stroke**: 2,500 mm
- **Lubrication**: Initial sealing of grease only
- **Acting load**: 34.5 kN
- **Acceleration**: 1.5 G

Distance traveled (km)

Calculated service life: 19,718 km

Distance traveled: 30,000 km

Grease remains on the balls and there are no abnormalities observed in the balls or grease.

Detailed illustration of ball cage
With High-Speed Ball Screw with Ball Cage model SBK, balls are evenly spaced by a ball cage to eliminate collision and friction between the balls and ensure a high level of grease retention. As a result, low noise, low torque fluctuation and long-term maintenance-free operation are achieved.

**Stress-free, ideal circulation structure**

Balls circulate toward the tangential direction  
Balls circulate toward the lead-angle direction

In addition, this model has an ideal circulation structure where balls are picked up in the tangential direction, thus to achieve a DN value* of 160,000 (* DN value = ball center diameter × rotation speed per minute) in high-speed operation.

### Structural Drawing of Model SBK

In addition, this model has an ideal circulation structure where balls are picked up in the tangential direction, thus to achieve a DN value* of 160,000 (* DN value = ball center diameter × rotation speed per minute) in high-speed operation.

### High-Speed Durability Test

<table>
<thead>
<tr>
<th>Conditions</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample</td>
<td>SBK4030-7.6</td>
<td></td>
</tr>
<tr>
<td>Speed</td>
<td>3800 (min⁻¹) (DN value: 160,000)</td>
<td></td>
</tr>
<tr>
<td>Stroke</td>
<td>700 mm</td>
<td></td>
</tr>
<tr>
<td>Lubricant</td>
<td>Multemp HRL grease</td>
<td></td>
</tr>
<tr>
<td>Amount applied</td>
<td>12 cm³ (applied every 500 km)</td>
<td></td>
</tr>
<tr>
<td>Load</td>
<td>2.28 kN (0.038Ca)</td>
<td></td>
</tr>
<tr>
<td>Acceleration</td>
<td>1 G</td>
<td></td>
</tr>
</tbody>
</table>

**Results**

No abnormalities after 10,000 km of travel

### Load Durability Test

<table>
<thead>
<tr>
<th>Conditions</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample</td>
<td>SBK5530-7.6</td>
<td></td>
</tr>
<tr>
<td>Speed</td>
<td>1500 (min⁻¹) (DN value: 160,000)</td>
<td></td>
</tr>
<tr>
<td>Stroke</td>
<td>300 mm</td>
<td></td>
</tr>
<tr>
<td>Lubricant</td>
<td>Multemp HRL grease</td>
<td></td>
</tr>
<tr>
<td>Amount applied</td>
<td>16 cm³ (applied every 500 km)</td>
<td></td>
</tr>
<tr>
<td>Load</td>
<td>22.5 kN (0.38Ca)</td>
<td></td>
</tr>
<tr>
<td>Acceleration</td>
<td>0.5 G</td>
<td></td>
</tr>
</tbody>
</table>

**Results**

Traveled 3.3 times the estimated service life
The LM Guide and Ball Screw lose a small amount of grease during the course of travel. The Lubricator QZ is a revolutionary new lubrication system that supplies an appropriate amount of lubricating oil at the appropriate locations, thereby enabling it to compensate for any oil lost over a long period of time. Installation of the Lubricator QZ on the LM Guide with Ball Cage or High-Speed Ball Screw with Ball Cage, demonstrating excellent grease retention capabilities, results in even further enhanced lubrication performance.

Since the Lubricator QZ supplies an optimal amount of lubricating oil at appropriate locations, lubricating oil can be used without waste.

Comparison of Amount of Lubricating Oil Used After Travelling 5,000 km

<table>
<thead>
<tr>
<th>Lubricator QZ oil content: 0.166 cm³/sheet × 2 sheets = 0.332 cm³</th>
<th>Forced lubrication: 0.03 cm³/6 min × 16667 min = 83.3 cm³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount of lubricating oil used is 1/250 that of forced lubrication.</td>
<td></td>
</tr>
</tbody>
</table>

Significant Extension of Maintenance Intervals

Since lubricating oil continues to be supplied for a long time, maintenance intervals can be extended considerably.

| Rotational speed | 2500m/min⁻¹ |
| Max. speed | 25m/min⁻¹ |
| Stroke | 500 mm |
| Load | Internal preload only |
Stainless Steel LM Guide delivers outstanding corrosion resistance as a result of using martensite stainless steel. In addition, heat treatment to a level of HRC58 or higher results in a long service life, enabling it to withstand high loads.

Although plastic end plates are used in ordinary environments, when used in a vacuum environment, SUS304 (austenite stainless steel) is used for the end plates to reduce the level of released gases. SUS304 materials are characterized by low oxidation and low levels of released gases.

High Corrosion Resistance LM Guide

Austenite stainless steel SUS304, offering excellent corrosion resistance, is used for the LM rail, while SUS431, offering the highest level of corrosion resistance among martensite stainless steel materials, is used for the LM block and balls. The result is a significant improvement in corrosion resistance over conventional stainless steel.
The LM block and LM rail are made of THK-EX50 martensite stainless steel additionally treated for dimensional stability to minimize the effects of heat on dimensional changes. SUS304 austenite stainless steel is used for the end plates for enhanced heat resistance.

**Dimensional Stability Data**

Dimension stabilization treatment makes it possible to reduce dimensional changes following heating and cooling to extremely low levels.

- Total length and curvature data indicate the amount of change when from normal temperature to 150°C for 100 hours followed by cooling to normal temperature.
- HSR25 + 580L high-temperature, standard and stainless steel products were used for the samples.

**Grease-Induced Rolling Resistance Data**

High-temperature grease is used that minimizes changes and fluctuations (catching) in rolling resistance caused by the grease even when the temperature changes from normal temperature to high temperature.

HSR25M1R1C1 is used as the sample for the above data.

**Thermal Characteristics of LM Rail and LM Block Materials**

- Specific heat capacity: 0.481 J/(g·K)
- Coefficient of thermal conductivity: 20.67 W/(m·K)
- Mean coefficient of linear expansion: 11.8 × 10^{-6}/°C

*Structure and Materials of High-Temperature LM Guide (Type HSR)*
■ **THK AP-HC Treatment**

THK AP-HC treatment is equivalent to hard chrome plating, and allows for corrosion resistance nearly equivalent to that of martensite stainless steel. In addition, since surface treatment is performed that results in the formation of a film having a hardness of 700 HV or more, dust generation is reduced while offering outstanding wear resistance.

### Characteristics of **THK** AP-HC Treatment

![Graph showing dust count over time for AP-CF (with and without seal), AP-HC (with seal)].

**Test Conditions**

- **LM guide model numbers:**
  - SSR20WF + 280LF (AP-CF without seal)
  - SSR20UUF + 280LF (AP-CF with seal)
  - SSR20UUF + 280LF (AP-HC with seal)
- **Injected grease:** THK AFE-CA Grease
- **Amount applied:** 1 cc (1LM block)
- **Speed:** 30 m/min (max)
- **Stroke:** 200 mm
- **Measurement flow rate:** 1 liter/min
- **Clean room volume:** 1.7 liters (acrylic case)
- **Measuring instrument:** Dust counter
- **Measured particle size:** 0.3 µm and above

**THK** AP-HC treatment results in high surface hardness and offers excellent wear resistance. The large amount of wear occurring in the initial portion of the graph is considered to be attributed to initial wear of the end seals.

**Note:**
- THK AP-HC treatment (equivalent to hard chrome plating)
- THK AP-CF treatment (equivalent to black chrome plating + fluororesin coating)
THK AP-C Treatment

THK AP-C treatment consists of black film treatment for the purpose of improving corrosion resistance. It is used in applications requiring rust prevention since it is priced lower than stainless steel LM guides.

THK AP-CF Treatment

THK AP-CF treatment consists of compound surface treatment in which a special fluororesin is coated into a black film. Since this treatment results in complete coverage of metal surfaces, it offers a high degree of rust prevention and is suitable in cases requiring a high level of corrosion resistance. Moreover, since the fluororesin constitutes a chemically stable film, it also offers outstanding contamination resistance.

<table>
<thead>
<tr>
<th>Surface treatment</th>
<th>Rust prevention capabilities</th>
<th>Wear resistance</th>
<th>Surface hardness</th>
<th>Sealing</th>
<th>Appearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>AP-HC</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>Metallic gloss</td>
</tr>
<tr>
<td>AP-C</td>
<td>○</td>
<td>△</td>
<td>△</td>
<td>△</td>
<td>Black gloss</td>
</tr>
<tr>
<td>AP-CF</td>
<td>○</td>
<td>○</td>
<td>△</td>
<td>○</td>
<td>Black gloss</td>
</tr>
</tbody>
</table>

(○) (Superior)

Cycled saltwater spraying test
Sprayed solution: 1% NaCl solution
Cycle: Spraying for 6 hours followed by drying for 6 hours
Temperature conditions:
- During spraying: 35°C
- During drying: 60°C

Before testing

After 6 hours

After 24 hours

After 96 hours
AFF Grease is a high-grade synthetic oil that uses a lithium-based thickener and special additives to realize the perfect balance of stable rolling resistance, low dust generation and flaking resistance not possible with conventional vacuum grease and low dust generation grease. The use of THK AFF Grease results in improved uniform velocity characteristics of the precision positioning units used in semiconductor and liquid crystal production systems as well as improved response during micro-step feeding. Moreover, due to its excellent flaking resistance to minute vibrations (fine movement wear performance), the intervals between lubrication times can be extended resulting in a reduction in maintenance costs.

### Typical Properties of AFF Grease

<table>
<thead>
<tr>
<th>Test Item</th>
<th>Representative Value</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worked penetration (25°C, 60W)</td>
<td>315</td>
<td>JIS K 2220 7</td>
</tr>
<tr>
<td>Dropping point: °C</td>
<td>216</td>
<td>JIS K 2220 8</td>
</tr>
<tr>
<td>Copper plate corrosion (100°C, 24h)</td>
<td>Accepted</td>
<td>JIS K 2220 9</td>
</tr>
<tr>
<td>Evaporation amount : mass% (99°C, 22h)</td>
<td>0.43</td>
<td>JIS K 2220 10</td>
</tr>
<tr>
<td>Oil separation rate : mass% (100°C, 24h)</td>
<td>2.6</td>
<td>JIS K 2220 11</td>
</tr>
<tr>
<td>Stability of oxidation : kPa (99°C, 100h)</td>
<td>39</td>
<td>JIS K 2220 12</td>
</tr>
<tr>
<td>No. of contaminants : pieces/cm² 25 μm or more</td>
<td>0</td>
<td>JIS K 2220 13</td>
</tr>
<tr>
<td>75 μm or more</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>125 μm or more</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Mixing stability (100,000 W)</td>
<td>329</td>
<td>JIS K 2220 15</td>
</tr>
<tr>
<td>Low temperature torque : mN⋅m (–20°C)</td>
<td>Start 220</td>
<td>JIS K 2220 18</td>
</tr>
<tr>
<td>Revolutions</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Apparent viscosity : Pa⋅s (–10°C, 10s⁻¹)</td>
<td>340</td>
<td>JIS K 2220 19</td>
</tr>
<tr>
<td>Timken load capacity : kg</td>
<td>5.44</td>
<td>JIS K 2220 20</td>
</tr>
<tr>
<td>4-ball testing (burn-in load) : N</td>
<td>3089</td>
<td>ASTM D2596</td>
</tr>
<tr>
<td>Fretting resistance : mg</td>
<td>3.8</td>
<td>ASTM D4170</td>
</tr>
<tr>
<td>Bearing rust prevention : (52°C, 48h)</td>
<td>Accepted</td>
<td>—</td>
</tr>
<tr>
<td>Service Temperature Range (°C)</td>
<td>– 40 to 120</td>
<td>—</td>
</tr>
</tbody>
</table>

### Low Dust Generation Characteristics

#### Test Conditions

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model used</td>
<td>SR20W + 280LP</td>
</tr>
<tr>
<td>Amount of grease injected</td>
<td>1 cm³/L block (initial injection only)</td>
</tr>
<tr>
<td>Air supply volume</td>
<td>500 cm³/min</td>
</tr>
<tr>
<td>Measuring instrument</td>
<td>Particle counter</td>
</tr>
<tr>
<td>Measured particle size</td>
<td>0.3 μm and above</td>
</tr>
<tr>
<td>Speed</td>
<td>30 m/min</td>
</tr>
<tr>
<td>Stroke</td>
<td>200 mm</td>
</tr>
</tbody>
</table>

#### Operating Time and Dust Generation

- AFF Grease
- AFE-CA Grease
- Typical low dust generation grease
- General purpose grease

### Stable Rolling Resistance Values

#### Test Conditions

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model used</td>
<td>HSR25A1C1 + 580LP</td>
</tr>
<tr>
<td>Amount of grease injected</td>
<td>3 cm³/L block (initial injection only)</td>
</tr>
<tr>
<td>Speed</td>
<td>10 mm/s</td>
</tr>
</tbody>
</table>

(23°C)

### Grease Viscous Resistance Values

- AFF Grease
- AFB-LF Grease
- Competitor’s low dust generation grease A
- Competitor’s low dust generation grease B

### Low-Speed Rolling Resistance Values

- AFF Grease
- AFB-LF Grease
- Typical low dust generation grease A
- Typical low dust generation grease B
AFE-CA Grease uses for its base oil a high-grade synthetic oil along with a urea-based thickener for outstanding low dust generation characteristics. Since THK AFE-CA Grease is able to accommodate a wide temperature range from low temperatures to high temperatures, and generates lower levels of dust than vacuum grease and typical low dust generation grease conventionally used for low dust generation, it is optimal for the LM guide, ball screws and various other units of semiconductor and liquid display production systems. In addition, it also contributes to reduced maintenance costs by being able to significantly extend the service life of LM systems.

### Low Dust Generation Characteristics

#### Test Conditions

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model used</td>
<td>Type KR4610</td>
</tr>
<tr>
<td>Ball screw rotating speed</td>
<td>1000min⁻¹</td>
</tr>
<tr>
<td>Stroke</td>
<td>210mm</td>
</tr>
<tr>
<td>Amount of grease injected</td>
<td>Ball screw, LM guide: 2 cc</td>
</tr>
<tr>
<td>Measurement flow rate</td>
<td>1 l./min</td>
</tr>
<tr>
<td>Measuring instrument</td>
<td>Dust counter</td>
</tr>
<tr>
<td>Particle size</td>
<td>0.5 μm</td>
</tr>
</tbody>
</table>

#### LM System Operating Time and Dust Generation

- **AFE-CA Grease**: High-grade synthetic oil along with a urea-based thickener for low dust generation characteristics.
- **General-purpose grease**: Standard grease for general use.
- **Vacuum grease**: Vacuum grease for low dust generation.
- **Competitor’s low dust generation grease**: Low dust generation grease from competitors.

#### Long Service Life Characteristics

**Surface Status of Balls After Traveling**

- **Name**: THK AFE-CA Grease
- **Distance traveled**: 290km
  - **Condition**: Hardly any color change or damage
- **Distance traveled**: 440km
  - **Condition**: Hardly any color change or damage
THK AFG Grease uses its base oil a high-grade synthetic oil along with a urea-based thickener for outstanding low dust generation characteristics. It also reduces heat generation during high-speed use while offering excellent oxidation stability.

<table>
<thead>
<tr>
<th>Test item</th>
<th>Representative value</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worked penetration (25°C, 60W)</td>
<td>285</td>
<td>JIS K 2220 7</td>
</tr>
<tr>
<td>Dropping point : °C</td>
<td>261</td>
<td>JIS K 2220 8</td>
</tr>
<tr>
<td>Copper plate corrosion (100°C, 24h)</td>
<td>Accepted</td>
<td>JIS K 2220 9</td>
</tr>
<tr>
<td>Evaporation amount : mass% (99°C, 22h)</td>
<td>0.2</td>
<td>JIS K 2220 10</td>
</tr>
<tr>
<td>Oil separation rate : mass% (100°C, 24h)</td>
<td>0.5</td>
<td>JIS K 2220 11</td>
</tr>
<tr>
<td>Stability of oxidation : kPa (99°C, 100h)</td>
<td>80</td>
<td>JIS K 2220 12</td>
</tr>
<tr>
<td>Mixing stability (100,000 W)</td>
<td>329</td>
<td>JIS K 2220 15</td>
</tr>
<tr>
<td>Grease removal resistance during water rinse : mass% (38°C, 1h)</td>
<td>0.6</td>
<td>JIS K 2220 16</td>
</tr>
<tr>
<td>Low temperature torque : mN·m (~20°C)</td>
<td>Start 170</td>
<td>JIS K 2220 18</td>
</tr>
<tr>
<td>Bearing Corrosion prevention : (52°C, 48h)</td>
<td>Accepted</td>
<td>ASTM D1743-73</td>
</tr>
<tr>
<td>Service Temperature Limit (°C)</td>
<td>–45 to 160</td>
<td></td>
</tr>
</tbody>
</table>

**Low Heat Generation Characteristics**

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shaft diameter/lead</td>
<td>32/10mm</td>
</tr>
<tr>
<td>Speed</td>
<td>67 - 500mm/s</td>
</tr>
<tr>
<td>Shaft rotating speed</td>
<td>400 - 3000min⁻¹</td>
</tr>
<tr>
<td>Stroke</td>
<td>400mm</td>
</tr>
<tr>
<td>Amount of grease injected</td>
<td>12cm³</td>
</tr>
<tr>
<td>Temperature measurement</td>
<td>Nut exterior</td>
</tr>
</tbody>
</table>

**Ball Screw High-Speed Durability Test**

Combining with a ball screw with ball cage enabled use at ultra-high speeds at a DN value of 130,000.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shaft diameter/lead</td>
<td>32/10mm</td>
</tr>
<tr>
<td>Max. rotating speed</td>
<td>3900 min⁻¹ (DN value: 130,000)</td>
</tr>
<tr>
<td>Stroke</td>
<td>400 mm</td>
</tr>
<tr>
<td>Acceleration</td>
<td>9.8 m/s²</td>
</tr>
</tbody>
</table>

[**Lubrication Conditions**]

- **Lubricant**: THK AFG Grease
- **Injection volume**: 12 cm³ (initial injection only)

There are no abnormalities observed.
AFC Grease uses a high-grade synthetic oil for its base oil along with a urea-based thickener and special additives to realize extremely outstanding flaking and corrosion resistance.

Since AFC Grease also offers excellent oxidation stability, the intervals between lubrication times can be extended resulting in a reduction in maintenance costs as compared with typical metallic soap-based grease.

### Flaking and Corrosion Resistance Test Data

**Test Conditions**

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stroke</td>
<td>3 mm</td>
</tr>
<tr>
<td>Strokes/min</td>
<td>200 min⁻¹</td>
</tr>
<tr>
<td>Total strokes</td>
<td>$2.88 \times 10^6$ (24 hours)</td>
</tr>
<tr>
<td>Bearing pressure</td>
<td>1118 MPa</td>
</tr>
<tr>
<td>Amount of grease injected</td>
<td>12 g/unit (supplied every 8 hours)</td>
</tr>
</tbody>
</table>

**AFC Grease**

- **Before travel**
- **After travel**

**General-purpose grease**

- **Before travel**
- **After travel**

### Typical Properties of AFC Grease

<table>
<thead>
<tr>
<th>Test item</th>
<th>Representative value</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worked penetration (25°C, 60W)</td>
<td>288</td>
<td>JIS K 2220 7</td>
</tr>
<tr>
<td>Dropping point : °C</td>
<td>269</td>
<td>JIS K 2220 9</td>
</tr>
<tr>
<td>Copper plate corrosion (100°C, 24h)</td>
<td>Accepted</td>
<td>JIS K 2220 8</td>
</tr>
<tr>
<td>Evaporation amount : mass% (177°C, 22h)</td>
<td>7.9</td>
<td>JIS K 2220 10</td>
</tr>
<tr>
<td>Oil separation rate : mass% (177°C, 24h)</td>
<td>2</td>
<td>JIS K 2220 11</td>
</tr>
<tr>
<td>Stability of oxidation : kPa (99°C, 100h)</td>
<td>50</td>
<td>JIS K 2220 12</td>
</tr>
<tr>
<td>No. of contaminants : pieces/cm²</td>
<td>370</td>
<td>JIS K 2220 13</td>
</tr>
<tr>
<td>Mixing stability (100,000 W)</td>
<td>341</td>
<td>JIS K 2220 15</td>
</tr>
<tr>
<td>Grease removal resistance during</td>
<td>0.6</td>
<td>JIS K 2220 16</td>
</tr>
<tr>
<td>water rinse : mass% (38°C, 1h)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low temperature torque : mN·m (- 54°C)</td>
<td>Start</td>
<td>JIS K 2220 18</td>
</tr>
<tr>
<td></td>
<td>Revolutions</td>
<td></td>
</tr>
<tr>
<td>Bearing Corrosion prevention : (52°C, 48h)</td>
<td>Accepted</td>
<td>ASTM D1743-73</td>
</tr>
<tr>
<td>Vibration test (200h)</td>
<td>Accepted</td>
<td></td>
</tr>
<tr>
<td>Service Temperature Limit (°C)</td>
<td>– 54 to 177</td>
<td></td>
</tr>
</tbody>
</table>