Service Life

The life of Oriental Motor products is an important factor in determining the maintenance and inspection timing of your equipment. This section explains the definition of life for each of our products. Since life is not a guaranteed value, please use it only as a reference for proper maintenance and inspection.

Service Life of a Motor

The service life of a bearing greatly affects the service life of a motor. The service life of a bearing can be expressed in 2 ways:

1. Grease life is affected by grease deterioration due to heat.
2. Mechanical life is affected by grease deterioration due to heat generation than the load applied to the bearing.

In most cases, the motor life is estimated based on the grease life, since the bearing life is more affected by grease deterioration due to heat generation than the load applied to the bearing. Temperature is the primary determinant of grease life, meaning that grease life is significantly affected by temperature. A simple representation of this is shown in the graph below.

This graph shows that the life of bearing grease is halved with every 15°C temperature rise in the bearing.

![Graph showing the relationship between temperature and grease life](image)

Taking measures to lower the motor temperature is effective for extending the motor’s life.

The table below shows the average bearing grease life for each motor as reference.

<table>
<thead>
<tr>
<th>Product</th>
<th>Operating Condition</th>
<th>Estimated Average Life of Bearing Grease [h]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Induction Motors</td>
<td>Operation: Continuous, unidirectional, Torque: Rated torque</td>
<td>30,000</td>
</tr>
<tr>
<td>Brushless Motors</td>
<td>Type of Load: Uniform load, Speed: Rated speed, Ambient Temperature: 30°C</td>
<td>40,000</td>
</tr>
<tr>
<td>Servo Motors</td>
<td>Surface Temperature of Motor Case</td>
<td>50,000</td>
</tr>
<tr>
<td>Stepper Motors</td>
<td>Operation at 80°C</td>
<td></td>
</tr>
</tbody>
</table>

*Note that the life of bearing grease is greatly affected by operating conditions, such as method of use and environmental conditions.*

Standard AC Motors, Brushless Motors and Servo Motors

Use the motor in conditions where the surface temperature of the motor case is 90°C max.

Stepper Motors

Use the motor in conditions where the surface temperature of the motor case is 100°C max.

For the AZ Series, use the motor in conditions where the surface temperature of motor case is 80°C max.)

Because of the effects of operating ambient temperature and operating duty, the lower the motor surface temperature, the longer the motor life becomes.

In rare occasions such as when the motor is subjected to a large radial load, the mechanical life may become shorter than the grease life.

Service Life of a Gearhead

The gearhead life is reached when power can no longer be transmitted because the bearing mechanical life has ended. Therefore, the actual life of a gearhead varies depending on the load, how the load is applied, and the operating speed. Oriental Motor defines life under certain conditions as rated life, based on which the life under actual operation is calculated according to load conditions and other factors. The tooth surface of Oriental Motor’s gearheads is lubricated by a grease lubrication mechanism. Separate lubrication is not required.

Rated Life

Oriental Motor defines the rated life as the life of a gearhead under the following operating conditions:

**Conditions**

- **Torque**: Permissible torque
- **Load Type**: Uniform load
- **Input Speed**: Reference input speed
- **Radial Load**: Permissible radial load
- **Axial Load**: Permissible axial load

*The rated life of the PS geared, PN geared, or HPG geared type motors is the value when either a radial or axial load is applied.*

Table 1: Rated Life of Each Gearhead Type

<table>
<thead>
<tr>
<th>Motor Type</th>
<th>Series</th>
<th>Gearhead Type</th>
<th>Reference Input Speed [r/min]</th>
<th>Rated Life [h]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard AC Motors</td>
<td>KZ5 Series</td>
<td>Right-Angle Gearhead Type</td>
<td>1500</td>
<td>5000</td>
</tr>
<tr>
<td></td>
<td>KZ Series</td>
<td>Parallel Shaft Gearhead</td>
<td>1500</td>
<td>10000</td>
</tr>
<tr>
<td></td>
<td>FPW Series</td>
<td>Parallel Shaft Gearhead</td>
<td>1500</td>
<td>5000</td>
</tr>
<tr>
<td>Speed Control Motors</td>
<td>BMU Series</td>
<td>Parallel Shaft Gearhead</td>
<td>3000</td>
<td>10000</td>
</tr>
<tr>
<td></td>
<td>BLE2 Series</td>
<td>Parallel Shaft Gearhead</td>
<td>3000</td>
<td>10000</td>
</tr>
<tr>
<td></td>
<td>BXII Series</td>
<td>Parallel Shaft Gearhead</td>
<td>3000</td>
<td>10000</td>
</tr>
<tr>
<td></td>
<td>BLH Series</td>
<td>Hollow Shaft Flat Gearhead</td>
<td>20000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DSC Series</td>
<td>Parallel Shaft Gearhead</td>
<td>1500</td>
<td>10000</td>
</tr>
<tr>
<td>Stepper Motors</td>
<td>A Series</td>
<td>TS Geared Type</td>
<td>1500</td>
<td>10000</td>
</tr>
<tr>
<td></td>
<td>PS Geared Type</td>
<td>20000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>HPG Geared Type</td>
<td>20000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Harmonic Geared Type [42 mm]</td>
<td>7000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Harmonic Geared Type [30 mm, 30 mm]</td>
<td>10000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CRK Series</td>
<td>TH Geared Type</td>
<td>1500</td>
<td>5000</td>
</tr>
<tr>
<td></td>
<td>PS Geared Type</td>
<td>20000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PN Geared Type</td>
<td>20000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Harmonic Geared Type</td>
<td>5000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>RKII Series</td>
<td>TS Geared Type</td>
<td>1500</td>
<td>10000</td>
</tr>
<tr>
<td></td>
<td>PS Geared Type</td>
<td>20000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Harmonic Geared Type [42 mm]</td>
<td>7000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Harmonic Geared Type [30 mm, 30 mm]</td>
<td>10000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CVK Series</td>
<td>SH Geared Type</td>
<td>1500</td>
<td>10000</td>
</tr>
<tr>
<td></td>
<td>1.8°/0.9°</td>
<td>SHGeared Type</td>
<td>1500</td>
<td>5000</td>
</tr>
<tr>
<td></td>
<td>PK Series</td>
<td>SH Geared Type</td>
<td>1500</td>
<td>10000</td>
</tr>
<tr>
<td></td>
<td>PKP Series</td>
<td>SH Geared Type</td>
<td>1500</td>
<td>7000</td>
</tr>
<tr>
<td></td>
<td>NX Series</td>
<td>PS Geared Type</td>
<td>3000</td>
<td>10000</td>
</tr>
</tbody>
</table>

*1 The rated life of motors with an output power of 15 W is 5000 [h].
*2 The rated life of hollow shaft flat gearhead, 200 W and 400 W are 5000 [h].
Estimating Lifetime
Lifetime under actual conditions of use is calculated based on the operating speed, load and load type, using the following formula. The calculated lifetime represents the actual driven hours.

\[ L \ (\text{Lifetime}) = \frac{L_1 \times K_1 \times f_1}{(K_2)^2 \times f_2} \times [h] \]

- \( L_1 \): Rated lifetime (hours)
- \( K_1 \): Load factor
- \( K_2 \): Speed coefficient
- \( f_1 \): Load-type factor
- \( f_2 \): Frictional load factor

Refer to Table 1 above to find the applicable rated lifetime for the gearhead.

\( K_1 \): Load factor
The load factor \( K_1 \) is calculated based on the following formula:

\[ K_1 = \frac{\text{Reference Input Speed}}{\text{Actual Input Speed}} \]

\( K_2 \): Speed coefficient
The speed coefficient \( K_2 \) is calculated based on the reference input speed listed in Table 1 above and the actual input speed.

\[ K_2 = \frac{\text{Operating Torque}}{\text{Permissible Torque}} \]

The average torque may be considered operating torque if the gearhead is subject to load while starting and stopping only, such as when driving an inertial load. The calculation of average torque is explained later in this section.

The load factor \( f_1 \) is determined based on load type, using the following drive examples as a reference:

<table>
<thead>
<tr>
<th>Load Type</th>
<th>Example</th>
<th>Load Factor ( f_1 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uniform Load</td>
<td>- Unidirectional continuous operation - For driving belt conveyors and film reels that are subject to minimal load fluctuation</td>
<td>1.0</td>
</tr>
<tr>
<td>Slight Impact</td>
<td>- Frequent starting and stopping - Cam drive and inertial body positioning via stepper motor</td>
<td>1.5</td>
</tr>
<tr>
<td>Medium Impact</td>
<td>- Frequent instantaneous bi-directional operation, starting and stopping of reversible motors - Frequent instantaneous stopping by brake pack of AC motors - Frequent instantaneous starting and stopping of brushless motors and servo motors</td>
<td>2.0</td>
</tr>
</tbody>
</table>

Note:
The above estimated lifetime is calculated according to the radial load and axial load, which are in proportion to a given load factor. For example, if the load factor is 50%, the lifetime is calculated using 50% radial load and axial load.

Driving an Inertia Load
When driving an inertia load, the average torque shall be 75% of the max. acceleration/deceleration torque, as shown in the following formula.

\[ P_a = P_{max} \times 0.75 \]

Operating Temperature
An increase in gearhead temperature affects the lubrication of the bearing. However, the effect of temperature on gearhead life varies according to the condition of the load applied to the gearhead bearings, frame size and many other factors. Therefore, it is difficult to include the temperature effect in the previous formula to estimate the lifetime.

The following graph shows the temperature effect on the gearhead bearings. The gearhead life is affected when the gearhead’s surface temperature is 55˚C.

How to Obtain the Average Torque
The stepper motor or servo motor is used for intermittent operation of an inertia load, such as driving an index table and arm. In this case, the average torque shall be considered the operating torque, as described below. The load factor for driving an inertia load using a standard AC motor or brushless motor shall be 1.0.

Driving an Inertia Load
The graph below shows torque generated when driving only an inertia load over a long operating cycle. Frictional load caused by bearings and other parts during constant speed operation is negligible and therefore omitted.

\[ P_a = \frac{3}{4} \left( P_{max}^1 \times m_1 \times n_1 + P_{max}^2 \times m_2 \times n_2 \right) \]

\( m_1 \) and \( m_2 \) represent an average speed in the \( n_1 \) and \( n_2 \) area. In the above example:

\[ n_1 = n_2 = \frac{1}{2} n_3 \]

Note:
In some cases, a lifetime of several tens of thousands of hours may be obtained from the calculation under certain conditions. Use the estimated life as a reference only.

Driving an Inertia Load:
When driving an inertia load, the average torque shall be 75% of the max. acceleration/deceleration torque, as shown in the following formula.

The above life estimation is based on the bearing life. An application in excess of the specification values may adversely affect parts other than the bearings. Use the product within the range of specified values listed in the product catalogue.

Service Life of a Circuit Product
The life of each of Oriental Motor’s circuit products is determined by the aluminum electrolytic capacitor inside the product. Our circuit products are designed so that their useful life will be reached after 5 years min. when the product is used continuously under an ambient temperature of 40˚C. (Excluding certain products.)

In addition, an aluminum electrolytic capacitor generally exhibits the characteristics according to the “Arrhenius equation.” Specifically, as shown in the figure below, a temperature rise of 10˚C reduces the life of an aluminum electrolytic capacitor to half, while a temperature drop of 10˚C will extend the life to twice as long.

Since the lifetime of a circuit product varies depending on the operating environment and conditions, Oriental Motor recommends that the curve shown in the figure below be used to determine the need for preventive maintenance to keep the product free from failure.
Service Life of an Electric Linear Actuator

The life of an electric linear slide and electric cylinder is generally affected by the rolling fatigue life of its ball screw, guide and ball bearing. When stress is applied repeatedly to the raceways and the rolling ball, flaking (a phenomenon in which the metal surface turns into small scale-like pieces and separate from the base metal) occurs due to material rolling fatigue. The rolling fatigue life refers to the time until the flaking occurs.

An expected life is calculated for each product based on its max. ratings (max. transportable mass, max. speed, load moment, etc.) as a reference for calculating the product's life.

Estimated Service Life of Each Series

<table>
<thead>
<tr>
<th>Series</th>
<th>Lead 3 mm</th>
<th>Lead 6 mm</th>
<th>Lead 12 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>EAS series</td>
<td>1500 km</td>
<td>3000 km</td>
<td>5000 km</td>
</tr>
<tr>
<td>EZS Series</td>
<td>–</td>
<td>3000 km</td>
<td>5000 km</td>
</tr>
<tr>
<td>EAC Series</td>
<td>1500 km</td>
<td>3000 km</td>
<td>5000 km</td>
</tr>
</tbody>
</table>

For each series, if the calculation of the load moment of the guide reveals that the load factor with respect to the dynamic permissible moment is 1 more, the reference life becomes below the expected life distance. The expected life distance can be checked with the formula below.

Expected Life (km) = \( \frac{1}{\left(\frac{L_m}{M_r} + \frac{L_m}{M_l} + \frac{L_m}{M_n}\right)^3} \)

*The expected life of EAS2, EAC2 is 3000 km.

Maintenance

This section describes the maintenance needed to safely and efficiently operate linear and rotary actuators.

Check Items and Time Period

If linear and rotary actuators are operated for 8 hours a day, check and maintain them for each time period shown in the table below. If the operating ratio is high or is operated continuously day and night, shorten the maintenance period according to the conditions.

List of Maintenance Periods (Reference)

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Check Time</th>
<th>Check Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>EAS Series</td>
<td>At startup</td>
<td>6 months after startup</td>
</tr>
<tr>
<td>EZS Series</td>
<td>–</td>
<td>Every 6 months thereafter</td>
</tr>
<tr>
<td>EAC Series</td>
<td>–</td>
<td>Every month thereafter</td>
</tr>
<tr>
<td>DRS2 Series</td>
<td>1 week after startup</td>
<td></td>
</tr>
</tbody>
</table>

Checking the Grease Conditions of Traveling Surface and Sliding Surface

The grease conditions of the traveling surface and sliding surface of linear actuators are checked visually. Check the items listed in the table. Even if the grease has changed color, good lubrication is maintained as long as the traveling surface appears shiny.
### Service Life of a Cooling Fan

Cooling fan life represents the condition in which the fan’s capability to generate air flow has deteriorated due to continuous operation over a certain period of time, or the fan can no longer be used due to significant noise.

#### Service Life of a Cooling Fan

1. **Rotation life** – Life as defined by certain deterioration in fan rotation
2. **Sound life** – Life as defined by certain increase in noise

The rotation life in 1 can be easily measured, and the factors involved can be clearly specified numerically. This is usually what is meant when referring to life.

Sound life in 2, on the other hand, is defined by an increase in decibel level, while determining exactly what amount of increase marks the end of sound life is determined by the user’s judgment. Moreover, fans can still meet the operating conditions even after reaching the predetermined increase level in noise. In short, there are generally no specific references or lifetime.

Oriental Motor defines life by 1 rotation life; a fan is judged to have reached the end of its life when speed drops to 70% of the rated speed.

### Cooling Fan Bearing Life

Cooling fans use a ball bearing. The following explanation applies to the life of a ball bearing. Since the load applied to cooling fan’s bearings is negligible, life of a cooling fan is determined by the deterioration of the grease in the bearings.

Since the cooling fan’s operating and starting torques are already smaller than those of a power motor, lack of lubrication due to grease deterioration will cause the starting and dynamic torques of the bearing to increase excessively, which may prevent the fan from starting. Deterioration of grease also increases the noise generated by the bearings, further affecting the life of a cooling fan.

Grease life is given by the following formula:

\[
\log t = K_1 - K_3 \frac{n}{N_{\text{max}}} - \left( K_1 - K_2 \frac{n}{N_{\text{max}}} \right) T
\]

- \( t \): Average grease life
- \( K_1, K_2, K_3, K_4 \): Constants determined by grease
- \( N_{\text{max}} \): Max. rotation allowed by grease lubrication
- \( n \): Speed of bearings
- \( T \): Operating temperature of bearings

As indicated by the above formula, \( N_{\text{max}} \) is predetermined by the bearings, so grease life depends on the temperature and speed of bearings. However, Oriental Motor’s products are designed so that the bearing life is only minimally affected by the speed of bearings. Thus, the average grease life is determined by temperature since \( \frac{n}{N_{\text{max}}} \) is a constant value.

### Estimated Life Characteristics

The figure below gives the estimated life characteristics of a cooling fan. These characteristics are those of the small AC cooling fan **MU1238A**.

This graph estimates the service life of the bearing using the formula for estimating the life of bearings based on actual measurements of temperature rise at the rated voltage.

### Relationship between the Duration of Use and Failure Rate

Generally, the failure rate of parts relative to the duration of use fits the pattern of 3 states: initial failure, random failure and wear-out failure, as shown in the figure below.

The risks of initial failures are eliminated in the manufacturing and inspection processes, but random failures are sudden failures that occur randomly and unexpectedly during the durable life of the product before wear progresses. Therefore, it is difficult to provide technical measures against random failures, and the only measure available presently is to predict occurrences based on statistical data.

Wear-out failures occur towards the end of the product’s durable life as a result of deterioration and wear. The rate of wear-out failure increases dramatically after a certain period. Replacing certain parts at this point will provide an effective means for preventive maintenance.

(Excerpt from “Recommendation for Periodic Inspection of General-Purpose Inverters” by the Japan Electrical Manufacturers’ Association)