### Selection guide of rotary actuator

#### Step 1  Oscillating time check

Use oscillating time within specified range of the below table.

<table>
<thead>
<tr>
<th>Oscillating angle (*)</th>
<th>90</th>
<th>180</th>
<th>270</th>
</tr>
</thead>
<tbody>
<tr>
<td>RRC-8</td>
<td>0.015 to 0.151</td>
<td>0.030 to 0.302</td>
<td>0.045 to 0.452</td>
</tr>
<tr>
<td>RRC-32</td>
<td>0.038 to 0.377</td>
<td>0.075 to 0.754</td>
<td>0.113 to 1.131</td>
</tr>
<tr>
<td>RRC-63</td>
<td>0.073 to 0.440</td>
<td>0.147 to 0.880</td>
<td>0.220 to 1.320</td>
</tr>
</tbody>
</table>

* Oscillating time on table is time to achieve the end of oscillating after starting movement.

#### Step 2  Size selection

- **Static load**
  - (1) Working pressure is determined. \( P \) (MPa)
  - (2) A required force is determined. \( F \) (N)
  - (3) Length of an arm from a rotary actuator is determined. \( \ell \) (m)

  \[ T = F \ell \quad \text{(N·m)} \]

- **Resistance load**
  - When force (resistance load) caused by fictional force, gravity or other external force is applied.
  - (1) Working pressure is determined. \( P \) (MPa)
  - (2) A required force is determined. \( F_r \) (N)
  - (3) Length of an arm from a rotary actuator is determined. \( \ell \) (m)

  \[ T_r = K \times F_r \times \ell \quad \text{(N·m)} \]

  \( K \): slack coefficient
  - If load fluctuation free \( K = 2 \)
  - If load fluctuates \( K = 5 \)

  (When resistance torque caused by gravity functions)

  if load fluctuates, when \( K < 5 \),

  change of angular speed increases.

- **Inertia load**
  - To rotate body.
  - (1) Oscillating angle, oscillating time and working pressure are determined.
    - Oscillating angle \( \theta \) (rad)
    - Oscillating time \( t \) (s)
    - Working pressure \( P \) (MPa)
      - \( 90^\circ = 1.5708 \) (rad)
      - \( 180^\circ = 3.1416 \) (rad)
      - \( 270^\circ = 4.7124 \) (rad)
  - (2) Calculate load moment of inertia according to load shape and weight. Refer to moment of inertia table for the calculation formula.
    \( I \) (kg/m²)

  \( \alpha \) \( = \frac{\theta t^2}{18} \quad \text{(rad/s)} \)
  - \( \theta \): Oscillating angle (rad)
  - \( t \): Oscillating time (s)

  \[ T_a = 5 \times I \times \alpha \quad \text{(N·m)} \]

- **Required torque**
  \( T = T_r + T_a \)

#### Step 3  Check of allowable energy

When using an inertial load, keep the load energy to lower than the rotary actuator’s allowable energy.

- (1) Calculate angular speed \( \omega = \frac{\theta t}{2\pi} \quad \text{(rad/s)} \)
  - \( \theta \): Oscillating angle (rad)
  - \( t \): Oscillating time (s)

- (2) Calculation of load inertia energy
  \( E = \frac{1}{2} I \omega^2 \quad \text{(J)} \)
  - \( I \): Load moment of inertia (kg/m²)

Check if load inertia energy \( E \) to be allowable energy of rotary actuator or less.

When exceeding allowable energy, external shock absorber, etc. is required.
### 2. Figure for moment of inertia calculation

#### When rotary shaft goes through workpiece

<table>
<thead>
<tr>
<th>Sketch</th>
<th>Requirements</th>
<th>Moment of inertia I kg/m²</th>
<th>Radius of gyration K</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dial plate</td>
<td>Diameter d (m)</td>
<td>I = Md²/8</td>
<td>d²/8</td>
<td>No installation direction when using with sliding, please consult with CKD</td>
</tr>
<tr>
<td>Dial plate with a step</td>
<td>Diameter d₁ (m), d₂ (m)</td>
<td>I = (M₁d₁² + M₂d₂²)/8</td>
<td>d₁² + d₂²/8</td>
<td>Ignore, when d₁ section is extremely small comparing to d₂ section</td>
</tr>
<tr>
<td>Bar</td>
<td>Bar length R (m)</td>
<td>I = MR²/3</td>
<td>R²/3</td>
<td>The installation direction is horizontal if vertical installation attitude, oscillating time varies</td>
</tr>
<tr>
<td>Thin rod</td>
<td>Bar length R (m)</td>
<td>I = MR²/12</td>
<td>R²/12</td>
<td>No installation direction</td>
</tr>
<tr>
<td>Thin rod (with side eccentric)</td>
<td>Plate length a₁, a₂, b (m)</td>
<td>I = (M₁a₁² + b₁²) + (M₂a₂² + b₂²)/12</td>
<td>(a₁² + b₁²) + (a₂² + b₂²)/12</td>
<td>The installation direction is horizontal if vertical installation attitude, oscillating time varies</td>
</tr>
<tr>
<td>Rectangular parallelepiped</td>
<td>Length of side a (m), b (m)</td>
<td>I = M₁(a² + b²)/12</td>
<td>a² + b²/12</td>
<td>No installation direction when using with sliding, please consult with CKD</td>
</tr>
</tbody>
</table>

#### Concentrated load

- Shape of concentrated load
- Length to center of gravity of concentrated load R (m)
- Arm length R (m)
- Concentrated load weight M₁ (kg)
- Arm weight M₂ (kg)

\[
I = M₁(R₁² + k₁²) + \frac{M₂R₁²}{3}
\]

Calculate k² according to shape of concentrated load

- The installation direction is horizontal
- When M₂ is extremely small comparing to M₁, may be calculated as M₂ = 0

#### How to convert load J₀ to rotary actuator shaft rotation when using with gear

<table>
<thead>
<tr>
<th>Gear</th>
<th>Moment of inertia of load rotary shaft rotation I₀ = (a/b)² l₀</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gear</td>
<td>Rotary side (the tooth number) a</td>
</tr>
<tr>
<td>Gear</td>
<td>Load inertia Moment N-m</td>
</tr>
</tbody>
</table>

- When shape of gear is increasing, gear moment of inertia should be considered.