9.5 Cool Type

9.5.1 Extra High Dm-N Value Ball Screws - Cool Type I

• **Cool type I:**
  - New era for high speed ball screw - achieving extra high Dm-N value (up to 200,000) and high positioning accuracy.
  - Cool type I and a hollow shaft design.
  - High speed machine tools and machining center.

• **Design Principle:**
  - The cool type series feature using forced cooling fluid to pass through the nut, which minimize heat generation and thermal expansion during ball screw operation.
  - **Cool type I as shown in the Figure 9.1:**
    - Flowing fluids are circulated in passages that inside the nut, and exchanging heat with the cooler as shown in the Figure 9.2. In cooperation with hollow shaft design, it makes high quality of thermal control and maintains high accuracy. That combination is the most suitable for high-speed machine tools.

• **Specification:**
  1. We recommend shaft diameter above Ø32mm to cool type design.
  2. Nut type: FSV, FSW, PFDW, OFSW, DFSV, FSH, FSI, etc.
  3. Please contact HIWIN with other specification you need.
  4. The cool type I, compared with the standard specifications, will make a minor external dimension change of the nut, please contact HIWIN.

• **Specification number:**
  Example: R50 - 30C1 - OFSWC1 - 1180 - 1539 - 0.008
  ↓
  C1: HIWIN cool type ball screw for type I

• **Performance Comparison:**
  - For high-speed machine tools, hollow shaft design only is not enough against heat generation and thermal expansion, because nut itself is a heat source, as shown in Figure 9.3.

  **Test condition:**
  - Specification: Ø50, lead 30 mm
  - Speed: 2500 rpm (75 m/min), back and forth feed continuously
  - Acceleration: 9.8 m/sec²
  - Stroke: 1180 mm
  - Preload: 205 kgf
  - Moving weight: 300 kgf
  - Cooling rate: oil 2.5 liter/min
  - Inlet temperature: 16°C
  - Room temperature: 25°C

  **Performance Comparison Table:**
<table>
<thead>
<tr>
<th>No cooling</th>
<th>N Co. suggested hollow shaft</th>
<th>HIWIN Cool Type I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature Rise (°C)</td>
<td>Time (min.)</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
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<td>0</td>
<td>20</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>20</td>
</tr>
</tbody>
</table>

**Fig. 9.1 Cool type I**

**Fig. 9.2 Cool type I with cooler**

**Fig. 9.3 Nut temperature rise**
**Features:**

1. Optimized design for high reliability:
   Use of computer simulation and FEM analysis, the cool type ballscrew features well thermal protection and high reliability.

2. Promote higher speed rotation and extra high Dm-N value (up to 200,000):
   Cool type ballscrew will eliminate high-speed rotation aftereffect, i.e., thermal problem, and promote higher speed rotation.

3. Prevent thermal distortion:
   Optimized heat transfer design to minimize heat generation and prevent thermal distortion.

4. Strengthen durability:
   When operating repeatedly, friction between balls cause heat generation. That may be made balls oxidized or decarburized, and shortened the service life. Cool type ballscrew will strengthen durability under a cooling environment.

5. Extended lubricant life cycle:
   When using lubrication, minimum heat generation further inhibits deterioration in the quality of lubrication and extends the lubricant life cycle.

6. Keep temperature uniform and reduce warm-up time:
   When high-speed operation, nut and shaft cooling effect indeed keep feed-system temperature constant and reduce warm-up time.

7. Higher feeding accuracy:
   Cooling effect of cool type ballscrew will stabilize against thermal expansion and equalize feeding accuracy.
9.5.2 High Load Ballcsrew - Cool Type II

- **Cool type II:**
  - New era for ballscrew applied in electric-driven injection machine, presses, power units, and other replaceable hydraulic drives.
  - Electric-driven injection machine, presses, power units and other replaceable hydraulic drives.

- **Design Principle:**
  The cool type series feature using forced cooling fluid to pass through the nut, which minimize heat generation and thermal expansion during ballscrew operation.

  - **Cool type II as shown in the Figure 9.4:**
    Flowing fluids are circulated through a space, which inside the nut, and exchanging heat with the cooler as shown in the Figure 9.5. It is the most suitable for electric-driven injection machine, presses, and power units. The cool type II, compared with the standard specifications, will make a minor external dimension change of the nut. Please contact HIWIN.

- **Specification:**
  1. We recommend shaft diameter above Ø32mm to cool type design.
  2. Nut type: FSV, FSW, PFDW, OFSW, DFSV, FSH, FSI, etc.
  3. Please contact HIWIN with other specification you need.
  4. The cool type II, compared with the standard specifications, will make a minor external dimension change of the nut, please contact HIWIN.

- **Specification number:**
  Example: R63 - 16B3 - RSWC2 - 400 - 600 - 0.05
  ↓
  C2 : HIWIN cool type ballscrew for type II

- **Performance Comparison:**
  Test condition:
  - specification : Ø50, lead 30 mm
  - speed : 1500 rpm (45 m/min),
  - back and forth feed continuously
  - acceleration : 4.9 m/sec²
  - stroke : 300 mm
  - preload : 20% kgf
  - moving weight : 300 kgf
  - cooling rate : oil 2.5 liter/min
  - inlet temperature : 16°C
  - room temperature : 25°C

<table>
<thead>
<tr>
<th>Temperature Rise (°C)</th>
<th>Time (min.)</th>
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</thead>
<tbody>
<tr>
<td>50</td>
<td>120</td>
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<tr>
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<td>10</td>
<td>40</td>
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<tr>
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<td>20</td>
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</table>

  Fig. 9.6 Cool type II : Temperature rise of ballscrew
Average Life Cycle for Injection Machine Ballscrew

- **Features:**
  1. Optimized design for high reliability:
     Use of computer simulation and FEM analysis, the cool type ballscrew features well thermal protection and high reliability.
  2. Promote higher speed rotation and extra high Dm-N value (up to 200,000):
     Cool type ballscrew will eliminate high-speed rotation aftereffect, i.e., thermal problem, and promote higher speed rotation.
  3. Prevent thermal distortion:
     Optimized heat transfer design to minimize heat generation and prevent thermal distortion.
  4. Strengthen durability:
     When operating repeatedly, friction between balls cause heat generation. That may be made balls oxidized or decarburized, and shortened the service life. Cool type ballscrew will strengthen durability under a cooling environment.
  5. Extended lubricant life cycle:
     When using lubrication, minimum heat generation further inhibits deterioration in the quality of lubrication and extends the lubricant life cycle.
  6. Higher feeding accuracy:
     Cooling effect of cool type ballscrew will stabilize against thermal expansion and equalize feeding accuracy.

**Diagram:**
- Temperature vs. Time graph showing the relationship between temperature and duration for ballscrew using in injection machine.
- Special grease needed for forced cooling.
- Ballscrew failed after 50°C.
- 5-year duration is expected for ballscrew using in injection machine.
- Solution: Long duration design for Ballscrew. High Load ballscrew Cool Type II.

Fig 9.7 Life cycle for ballscrew using in general injection machine