Torishima’s Mechanical Seals

Mechanical seals — the shaft seals used in rotating machinery such as pumps, hydraulic turbines, agitators and centrifuges — play an important role in maintaining the safety and economic efficiency of machinery. As a comprehensive manufacturer of pumps, Torishima has never lost sight of the importance of mechanical seals. We are the fastest in the country at moving products from the research and development phase to manufacturing and commercialization.

Today, we provide a wide range of mechanical seals for applications requiring high levels of safety and quality, such as mechanical seals for sealing high-temperature and high-pressure fluids in power plant pumps (including boiler feed pumps and boiler circulating pumps). We also manufacture mechanical seals for pumps used in sewage plants, chemical plants, and desalination plants handling slurry-rich liquids, special highly corrosive liquids, and seawater. Moreover, we have utilized our years of experience in pump manufacturing to provide eco-friendly non-flushing seals, easy-maintenance cartridge seals, and a variety of other optimal mechanical seals for a diverse range of applications.

### Mechanical Seal Applications

<table>
<thead>
<tr>
<th>Field and Application</th>
<th>Oil Generation</th>
<th>Gas Generation</th>
<th>Steam</th>
<th>Water</th>
<th>Chemicals</th>
<th>Power Generation</th>
<th>Metals, Minerals and Chemical Industry, etc.</th>
<th>General Industry, etc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rubber bushing seals</td>
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<td>Cartridge seals</td>
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<td></td>
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<td>Stationary seals</td>
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<tr>
<td>Special-purpose seals</td>
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<td></td>
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</tbody>
</table>

### Configuration Codes for Torishima Mechanical Seals

A number and a code indicate the configuration and materials used in each Torishima mechanical seal. The seals are classified as H, M, or L according to load, with H and M indicating heavy load and L indicating light load. H and L types are typically single-stage seals, while the M types are multistage seals.

#### Sample configuration code

**MB2704CBTAL090**
- **Seal cover with flushing chamber**
- **Material**: W21, 505, carbon, SIC
- **Shaft diameter**: 30 mm

### Basic Structure of Mechanical Seal

Mechanical seals incorporate a seal (stationary ring) and washer (rotating ring) that prevents leakage of the sealed fluid by rotating relative to the seal face. The washer is held in close contact with seal by spring pressure and the pressure exerted by the sealed fluid. As the seal face wears, the washer advances toward the seal to maintain close contact with the seal face.

The spring ring prevents leakage between the seal and seal cover, while the packing prevents leakage between the washer and shaft. Both also absorb vibration and restrict transmission of vibration to the seal face.

Between the washer and shaft there is only negligible relative movement. The only vibration that occurs is between the washer and shaft. The washer advances toward the seal only very slightly as the seal face wears. Therefore, the packing remains mostly free from wear.
Pumps for Power Plants

Boiler feed pumps
- High-pressure multi-stage ring-section turbine pumps
- Barrel-type high-pressure multi-stage turbine pumps

Condensate pumps
- Vertical multi-stage high-pressure turbine pumps

Boiler circulating pumps
- Hot water circulating pumps

Circulating water/cooling water pumps
- Vertical mixed-flow pumps
- Double-suction volute pumps
Pumps for Seawater Desalination Plants

High-pressure pumps for RO systems

<table>
<thead>
<tr>
<th>MB6000CN</th>
<th>MB2400CN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical double-suction barrel pumps</td>
<td>Vertical mixed-flow pumps</td>
</tr>
</tbody>
</table>

Seawater intake pumps

<table>
<thead>
<tr>
<th>MB2704GN</th>
<th>MB2901</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical mixed-flow pumps</td>
<td>Vertical double-suction barrel pumps</td>
</tr>
</tbody>
</table>

Product water pumps

<table>
<thead>
<tr>
<th>MB2704CN</th>
<th>MB2800CN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Double-suction volute pumps</td>
<td>Double-suction volute pumps</td>
</tr>
</tbody>
</table>
Pumps for Water Works & Sewerage Plants

Water transmission & distribution pumps

Double-auction volute pumps

Multi-stage turbine pumps

MB2704CN

HB2000 Series (HB2700)

Stormwater drainage pumps

Vertical mixed-flow pumps

MU2922

MT4100

MB2901

Effluent pumps

Vertical mixed-flow volute pumps

Pressure: 0.1 to 0.4 MPa
Circumferential speed: Up to 28 m/s
Shaft diameter: Ø50 to 100 mm

Sludge transfer pumps

Non-slogging volute pumps

LU1000 and LD1000 Series (LU1107/LD1107)

LU1107

LU1187

LU1017

LU1018

Pressure: 0.1 to 0.4 MPa
Circumferential speed: Up to 28 m/s
Shaft diameter: Ø50 to 100 mm

Pressures: 0.2 to 0.5 MPa
Circumferential speed: Up to 30 m/s
Shaft diameter: Ø50 to 100 mm

Pressures: 0.2 to 0.5 MPa
Circumferential speed: Up to 30 m/s
Shaft diameter: Ø50 to 100 mm

Pressures: 0.2 to 0.5 MPa
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Pressures: 0.2 to 0.5 MPa
Circumferential speed: Up to 30 m/s
Shaft diameter: Ø50 to 100 mm
Pumps for Rivers, Agricultural Pumping & Drainage, and Irrigation

River drainage pumps
[Vertical mixed-flow pumps]

MB2901

Pressure: 0 to 1 MPa
Circumferential speed: Up to 15 m/s
Shaft diameter: ø10 to 30 mm

MT4100

Pressure: 0 to 1 MPa
Circumferential speed: Up to 15 m/s
Shaft diameter: ø10 to 30 mm

Agricultural drainage pumps
[Horizontal mixed-flow pumps]

MT9200

Pressure: 0 to 1 MPa
Circumferential speed: Up to 15 m/s
Shaft diameter: ø10 to 30 mm
Negative pressure: Up to 20 m

Irrigation pumps
[Double-suction volute pumps]

HU2000 and HB2000 Series (HU2700/HB2700)

Pressure: 0 to 1 MPa
Circumferential speed: Up to 15 m/s
Shaft diameter: ø10 to 30 mm

Agricultural pumps
[Horizontal axially split multi-stage volute pumps]

MB8500CN/MB2400CN

Pressure: 0 to 1 MPa
Circumferential speed: Up to 15 m/s
Shaft diameter: ø10 to 30 mm
Pumps for General & Specialized Industrial Plants

Cooling water pumps for paper mills
(Double-suction volute pumps)

MB2704CN

Boiler feed pumps for utility plants
(High-pressure multi-stage ring-section turbine pumps)

MB8500CZ

Process pumps for food processing plants
(Single-suction volute pumps)

LU1000 Series (LU1107)

MU2000 Series (MU2000)

Hot water pumps for buildings
(Multi-stage turbine pumps)

HB2000 Series (HB2700)
Rubber Bellows Mechanical Seals

LU1000 Series

([LU1107])

Features
The rubber bellows expands to compensate for face wear and shaft movement. Because the packing does not slide, the shaft does not wear, unlike it accommodates surging directionally, thereby avoiding problems. Because the rubber bellows is static, the stationary ring and the rotating ring are supported by the rubber bellows. It has excellent flow-controlling characteristics. The wide-angle rotating transmission can be used regardless of the direction of rotation.

Application
- Pressure: 0 to 0.2 MPa
- Axial load in/out: ±20 mm
- Water, oil, and steam water

Material
- Seals: NBR, FKM

LD1000 Series (Double seal)

([LD1107])

Features
This is the static-resistant rubber bellows type mechanical seal. It incorporates high-performance sealing material for long life and excellent resistance to corrosive fluids. The shaft mounting dimension makes it suitable for retrofitting into pumps with small housings.

Application
- Pressure: 0 to 0.2 MPa
- Axial load in/out: ±20 mm
- Water, oil, and steam water

Material
- Seals: NBR, FKM

HU2000 Series (Unbalanced type)

([HU2700])

Features
Can be used as a shaft seal for chemical fluids at intermediate pressures, in Iscor water, and cooling equipment. The rotating side seal is made as a unit for easy handling. The pre-load type clamps is used for transmission of rotation. It is best suited for fluid machinery subject to frequent start/stop switching and back-reversal rotation.

Application
- Pressure: 0 to 0.2 MPa
- Axial load in/out: ±20 mm
- Water, steam, oil, and acids and alkaline liquids

Material
- Seals: NBR, FKM

HB2000 Series (Balanced type)

([HB2700])

Features

Application

Material
### Rotating Mechanical Seals

**MU2000 Series (Unbalanced type)/MB2000 Series (Balanced type)**

**Features**
- Because it is a multi-spring compact rotating seal, it can be used as a double seal in tandem seal. This mechanical seal can be used in industrial process pump applications such as oil refining and industrial chemical fields.

**Application**
- **MU2000**
  - Pressure: 0~1 MPa,
  - Temperature: 0~150 °C,
  - Shaft diameter: 10~80 mm
- **MB2000**
  - Pressure: 0~3 MPa,
  - Temperature: 0~250 °C,
  - Shaft diameter: 50~300 mm
- Water, warm water, oil, acids, and alkaline liquids, chemical fluids

**Material**
- Seals/face: Carbon/CVI, SiC/SiC, carbon/carbon/Carbon fibers
- Packing: HNBR, FMX

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**MT2700 (Balanced type)**

**Features**
- This is the optimal mechanical seal for high-heat applications involving high pressure and high temperature. The multi-spring type rotating seal enables the mechanical seal through expansion in the pumping ring.

**Application**
- Pressure: 6~2 MPa,
- Temperature: Up to 300 °C,
- Shaft diameter: 50~500 mm
- Solid, dry powdery substances, circulating water, high-pressure water

**Material**
- Seals/face: SiC/SiC, SiC/C, tungsten carbide/alkali metal

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### Cartridge Mechanical Seals

**MB2704CN (Inside rotating type)/MB2704CZ (Inside rotating type, with pumping ring)**

**Features**
- This is a rotating balanced-type cartridge mechanical seal. The cartridge seal has a simple structure that makes it easy to install.

**Application**
- Pressure: 6~2 MPa,
- Temperature: Up to 280 °C,
- Shaft diameter: 50~300 mm
- Hardened steel, oil and water, and alkaline liquids

**Material**
- Seals/face: SiC/C, SiC/C, tungsten carbide/alkali metal
Cartridge Mechanical Seals

**MB8500CN (Stationary inside type)/MB8500CZ (Stationary inside type, with pumping ring)**

Features
- Stationary balanced cartridge-type mechanical seals are suitable for high-speed, high-pressure, and high-temperature fluids. Not affected by mechanical distortion, these seals provide excellent sealing.

Application
- Pressure: 0 to 5 MPa
- Circumferential speed: Up to 50 m/s
- Shaft diameter: φ50 to 100 mm
- Target fluids: Water, seawater, seawater, etc.

Material
- Sv/fab: SiC/SiC, SiC/SiC, high-performance vitreous carbon

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**MB2901 (Stationary balanced type, self-flushing)**

Features
- Split mechanical seals can be replaced without disassembling equipment. This type can be used on positive-pressure equipment.

Application
- Pressure: 0 to 1 MPa
- Circumferential speed: Up to 20 m/s
- Shaft diameter: φ50 to 150 mm
- Target fluids: Water, seawater, seawater, etc.

Material
- Sv/fab: SiC/SiC, SiC/SiC, composite

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**MU2922 (Stationary balanced type, dry running application)**

Features
- This split mechanical seal is capable of negative-pressure operation and can be used for both positive-pressure and negative-pressure applications.

Application
- Pressure: 0 to 1 MPa
- Circumferential speed: Up to 20 m/s
- Shaft diameter: φ50 to 150 mm
- Target fluids: Water, seawater, etc.

Material
- Sv/fab: Ceramic coating/ceramic coating

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**MB2400CN (Outside rotating type)**

Features
- This is a compact outside rotating type seal. The outer diameter of the sliding box is narrow enough to be mounted without modification.

Application
- Pressure: 0 to 1 MPa
- Circumferential speed: Up to 30 m/s
- Shaft diameter: φ50 to 100 mm
- Target fluids: Water, seawater, oil and acid, and alcohol liquids

Material
- Sv/fab: SiC/SiC, SiC/SiC, high-performance vitreous carbon

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**MT9200 (Stationary balanced type, dry running application)**

Features
- This split mechanical seal is capable of negative-pressure operation. It can be operated with biodegradable grasses led to the seal box.

Application
- Negative pressure: Up to 10 m/s
- Circumferential speed: Up to 20 m/s
- Shaft diameter: φ50 to 150 mm
- Target fluids: Water, seawater, etc.

Material
- Sv/fab: Ceramic coating/ceramic coating
Selecting Auxiliary Equipment for Torishima Mechanical Seals

MB2500 (Balanced type)

Features
Stationary mechanical seals are used for heavy loads under high speed, high pressures, and high temperatures. These seals remain unaffected by the centrifugal forces caused by rotation. In addition, they demonstrate enhanced sealing performance, as they remain secure in the sealant and are unaffected by deterioration of equipment and heat distortion. These mechanical seals are cooled by circulation through a pumping ring.

MT4100 (Balanced type)

Features
These stationary seals incorporate highly wear-resistant materials such as tungsten carbide and PEEK on seal face materials. These seals are also suitable for pumping fluid containing slurries.

Application
- Pressure: 0 to 1 MPa
- Centrifugal speed: Up to 12,000 rpm
- Shaft diameter: Up to 60 mm
- Medium: Water, seawater, seawater

Material
- Seal face: Tungsten carbide/Tungsten carbide, W-C

Auxiliary Equipment for Mechanical Seals

The full performance and benefits of mechanical seals can be achieved with the proper combination of auxiliary equipment. Thus, care is required in the selection of auxiliary equipment and mechanical seals. Auxiliary equipment for mechanical seals is broadly categorized for cooling (or warming), flushing, or quenching; this equipment can be employed alone or in combination. Cooling (or warming) through a cooling jacket may have to be performed when stopped depending on the fluid temperature and the nature of the fluid.

1. Cooling (Warming)

This equipment is used for cooling high-temperature sealed fluid and for maintaining the warmth of fluids that can freeze. Cooling (or warming) can be achieved by either of two methods: cooling/warming the periphery of the seal face or installing a jacket on the seal box or seal cover.

A design for cooling should incorporate temperature adjustment of the sealed fluid within the heat tolerance and cold tolerance of the packing and should have sufficient capacity to absorb the heat generated at the seal face. Be careful that the fluid temperature does not fall excessively, as some fluids can become polymerized. When the purpose is cooling, design to reduce the saturation temperature of the sealed fluid at ambient atmospheric pressure by 20°C to 30°C. In the case of normal water, cooling is used when the temperature inside the sealed box exceeds 40°C, because some heat is conducted by the body of the equipment, the cooling capacity must be designed to incorporate the above conditions.

Example of Cooling (Warming)

Completely purge all air inside the sealed box.
Air or gas trapped inside the sealed box reduces thermal conductivity and significantly reduces the cooling (warming) effect. This contributes to abnormal heating and premature wear of the seal face. The sealed box must be completely purged of all air and gas.
2. Flushing

Flushing is intended to cool the seal face by causing the sealed fluid to flow, thus preventing the stagnation of foreign matter and intrusion to the seal face. Use a clear solution for the flushing fluid and inject as close to the seal face as possible. If the injection velocity is too fast, the outer circumference will wet if the seal face material is a carbon type. The velocity should be 1.3 m/s. It is possible to use the self-flushing method by using own fluid as an injection fluid for flushing or to use the external flushing method using a separate fluid. In addition, it is possible to perform cooling, heating, and slurry removal by installing auxiliary equipment such as coolers, heaters, filters, and cyclone separators at a point along the flushing piping.

When flushing in order to cool the seal face, use the following figure as a guideline because the flow of the flushing fluid differs according to the temperature inside the sealed box and the temperature of the flushing fluid.

Injection pressure should be 0.089–0.12 MPa higher than the pressure in the sealed box.

3. Quenching

Quenching is used to wash out deicers, toxic or explosive fluids; volatile fluids such as LPDs; and laquered fluids that precipitate and harden when exposed to outside air. Normally, the injection fluid is clear water, but care is required because a fluid high in ion content can cause failure of the washer as minerals adhere to the seal face of the packing. It is essential that the injection fluid not react with the leaked fluid. If there is no suitable fluid, nitrogen gas or argon gas may be used.

To prevent leakage of the quenching fluid, a mechanical seal may be used in addition to an auxiliary bushing, oil seal, or gland packing.

The pressure of the quenching injection fluid should be lower than that of the sealed box, typically 0.02–0.05 MPa. If the quenching flow is intended for cooling, about 70% of the flushing flow is required.

Separating Solids from the Flushing Fluid

For fluids containing slurry, external flushing is the preferable method; however, if no other suitable source of fluid is available, the self-flushing method may be employed.

In this case, the following methods may be used to separate solids from the flushing fluid:

A. The filter method (30 to 100 mesh)
B. The magnetic filter method
Both A) and B) require monitoring to deal with mesh clogging; a safe approach is to switch between two filters positioned in parallel and to use a pressure gauge and thermometer. But these methods might not remove all of the slurry that is most harmful to the mechanical seal.
Method B) is used for removing ferrous slurry.
C. The cyclone separator method
This method is used to remove any slurry with a specific gravity higher than that of the sealed fluid.

Typical Configurations of Double Mechanical Seals

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Typical Configuration</th>
<th>Typical Application</th>
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</thead>
<tbody>
<tr>
<td>Back-to-back</td>
<td><img src="image" alt="Back-to-back Diagram" /></td>
<td>Applied to liquid containing gas or solid matter, toxic or corrosive liquid.</td>
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<tr>
<td>Tandem</td>
<td><img src="image" alt="Tandem Diagram" /></td>
<td>Applied to liquid containing gas and solid matter, toxic or corrosive liquid, and liquid of high pressure that cannot be sealed with a single seal.</td>
</tr>
<tr>
<td>Face-to-face</td>
<td><img src="image" alt="Face-to-face Diagram" /></td>
<td>Applied to very high pressure equipment, 1st stage seal is for pressure drop and 2nd stage is for sealing.</td>
</tr>
</tbody>
</table>

**Quenching Example**

- **Sealed fluid pressure and amount of flushing fluid**
  - Flow rate: 1.3 m/s
  - Pressure: 0.089–0.12 MPa higher than the pressure in the sealed box.

**Graph:**
- X-axis: Sealed fluid pressure (MPa)
- Y-axis: Amount of flushing fluid (ml/min)
Piping Plans for Auxiliary Equipment (API 682)

An appropriate match between piping and auxiliary equipment is required in order to maximize the performance of mechanical seals. In the piping examples shown in the diagrams below, all plans are numbered according to API standards (API 682-2nd).

Flushing Plans for Single Seals

<table>
<thead>
<tr>
<th>API Plan</th>
<th>Schematic</th>
<th>API Plan</th>
<th>Schematic</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Self flushing (Internal flushing)</td>
<td>21</td>
<td>Self flushing (Cooler)</td>
</tr>
<tr>
<td>02</td>
<td>Dead ended</td>
<td>22</td>
<td>Self flushing (Cooler + Strainer)</td>
</tr>
<tr>
<td>11</td>
<td>Self flushing</td>
<td>23</td>
<td>Pumping ring circulation (Cooler)</td>
</tr>
<tr>
<td>12</td>
<td>Self flushing (Strainer)</td>
<td>31</td>
<td>Self flushing (Cyclone separator)</td>
</tr>
<tr>
<td>13</td>
<td>Reverse flushing</td>
<td>32</td>
<td>External flushing</td>
</tr>
<tr>
<td>14</td>
<td>Through flushing</td>
<td>41</td>
<td>Self flushing (Cyclone separator + Cooler)</td>
</tr>
</tbody>
</table>

Piping Plans for Quenching / Draining Systems and Dual Seals

<table>
<thead>
<tr>
<th>API Plan</th>
<th>Schematic</th>
<th>API Plan</th>
<th>Schematic</th>
</tr>
</thead>
<tbody>
<tr>
<td>51</td>
<td>Single seal (Quenching pot type)</td>
<td>54</td>
<td>Dual seal (External circulation type/pressurized/wet)</td>
</tr>
<tr>
<td>52</td>
<td>Dual seal (Reservoir type/no-pressurized/wet)</td>
<td>61</td>
<td>Single seal (with no quenching provided)</td>
</tr>
<tr>
<td>53A</td>
<td>Dual seal (Reservoir type/pressurized/wet)</td>
<td>62</td>
<td>Single seal (with quenching provided)</td>
</tr>
<tr>
<td>53B</td>
<td>Dual seal (Bladder accumulator/pressurized/wet)</td>
<td>65</td>
<td>Single seal (Drain/leak detection system)</td>
</tr>
<tr>
<td>53C</td>
<td>Dual seal (Piston type accumulator/pressurized/wet)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Piping diagram codes:
- **Orifice**
- **Flow regulator**
- **Pressure gauge**
- **Lower level switch**
- **Strainer**
- **Relief valve**
- **Pressure switch**
- **Bladder accumulator**
- **Cooler**
- **Flowmeter**
- **Upper limit pressure switch**
- **Piston accumulator**
- **Stop valve**
- **Cyclone separator**
- **Lower limit pressure switch**
- **Drain pot**
- **Check valve**
- **Thermometer**
- **Upper level switch**
- **Reservoir**