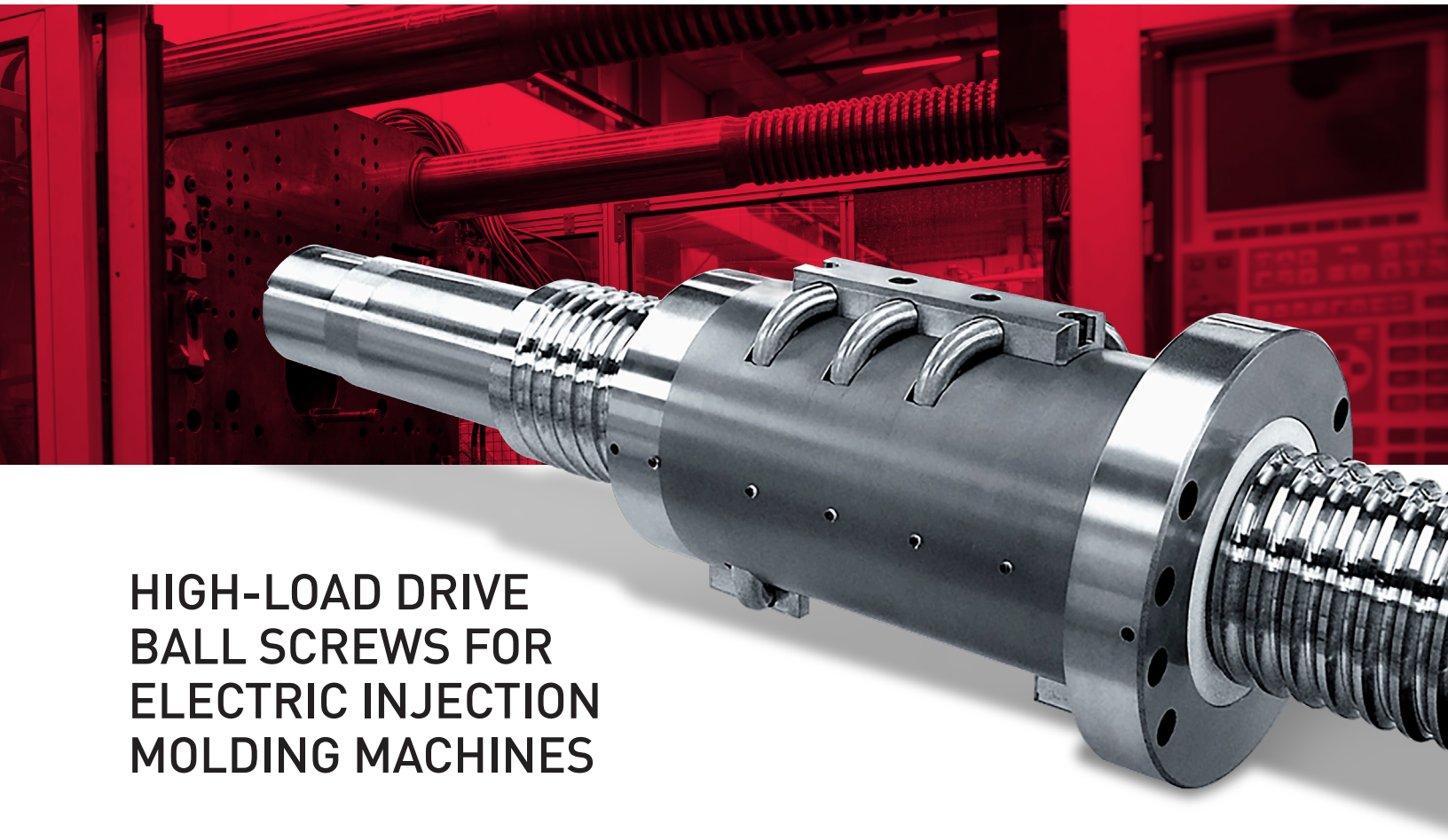
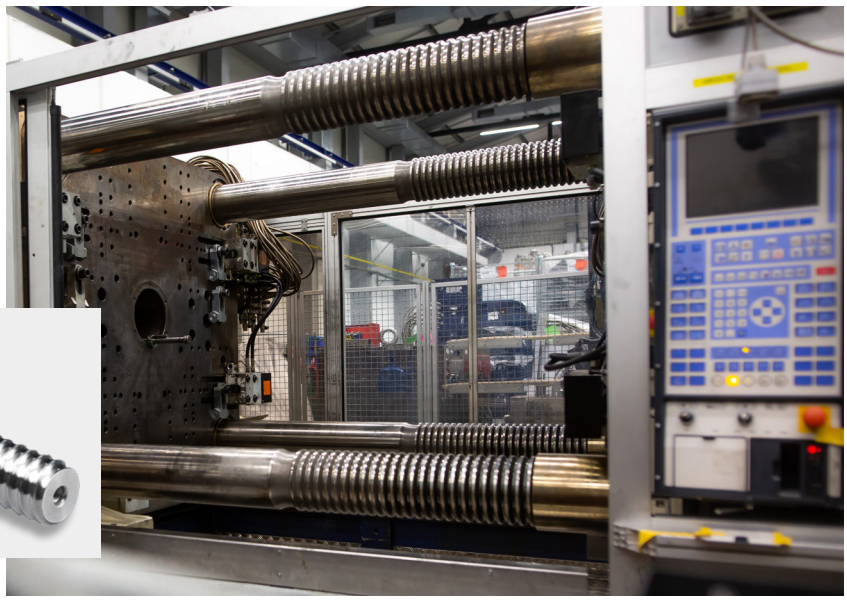


HIGH-LOAD DRIVE BALL SCREWS FOR ELECTRIC INJECTION MOLDING MACHINES

Since their introduction, injection molding machines have traditionally used hydraulics for their major functions, mostly due to the high load capacities and mold clamping forces they can achieve. With the advent of electric IMMs a few decades ago, manufacturers realized a dramatic reduction in energy use – as much as 70% – with improved part quality and consistency. Further, when a desired injection process has been finalized, electric IMMs can virtually run themselves, reducing labor costs.

Driven by ball screws, electric IMMs historically haven't been able to match the loads and clamping forces that hydraulic systems can generate, which is a limiting factor to the size of the parts they can produce. For this reason, development of a high-load drive ball screw has been a critical goal.



VISIT OUR WEBSITE

High-load capacity ball screws are critical components in IMMs, essential for mechanical drive parts including:

- Injection Cylinder
- Mold Clamping Cylinder
- Ejector Shaft
- Press Cylinder
- Plasticization Unit

Factors Impacting Load Capacity

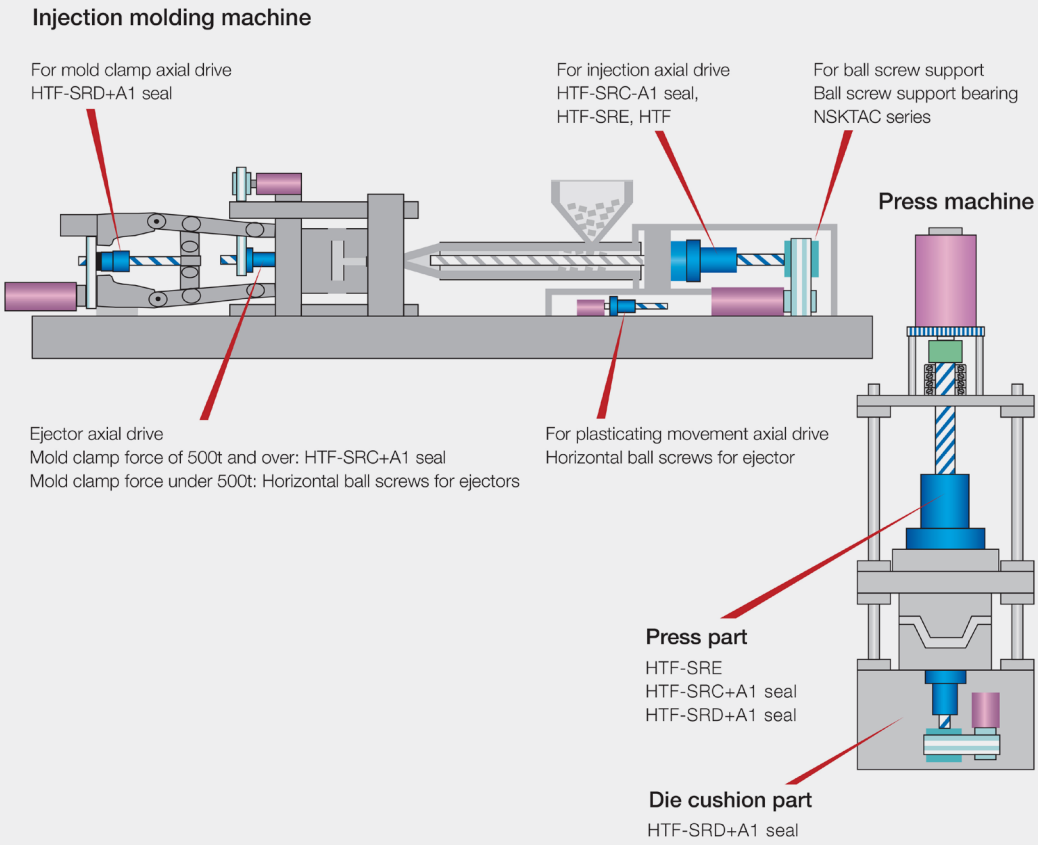
NSK is widely regarded as the global leader in ball screw design, engineering, and manufacturing. For the development of the HTF-Series high-load drive units, they focused their energies on a number of key criteria:

- Ball circulation
- Ball load distribution
- Groove geometry
- Seal and retainer technology

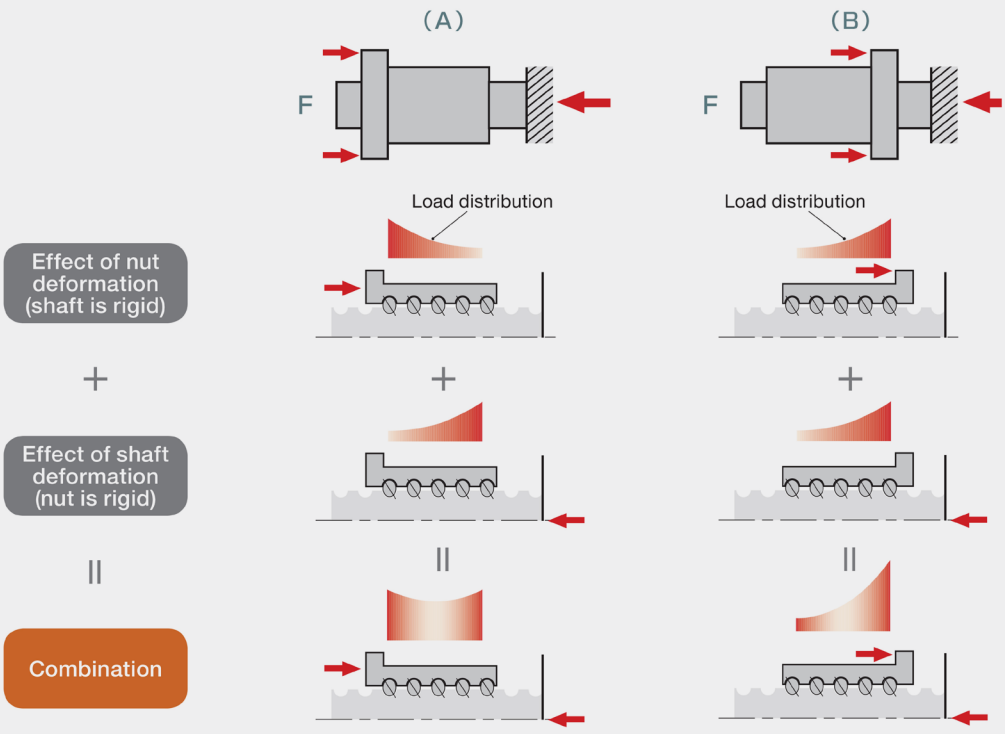
Design Considerations for High Load Applications

NSK ball screws for high load drive have increased load capacities by:

1. maximizing the diameter of balls in relation to the lead
2. increasing the number of valid load balls
3. optimizing the shape of ball groove for high loads, and
4. engineering seals and ball retainers specifically for injection molding applications



VISIT OUR WEBSITE

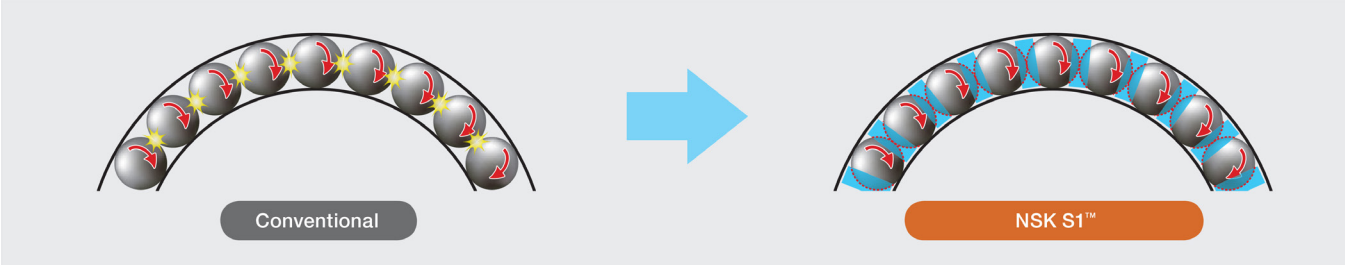


EVEN LOAD DISTRIBUTION

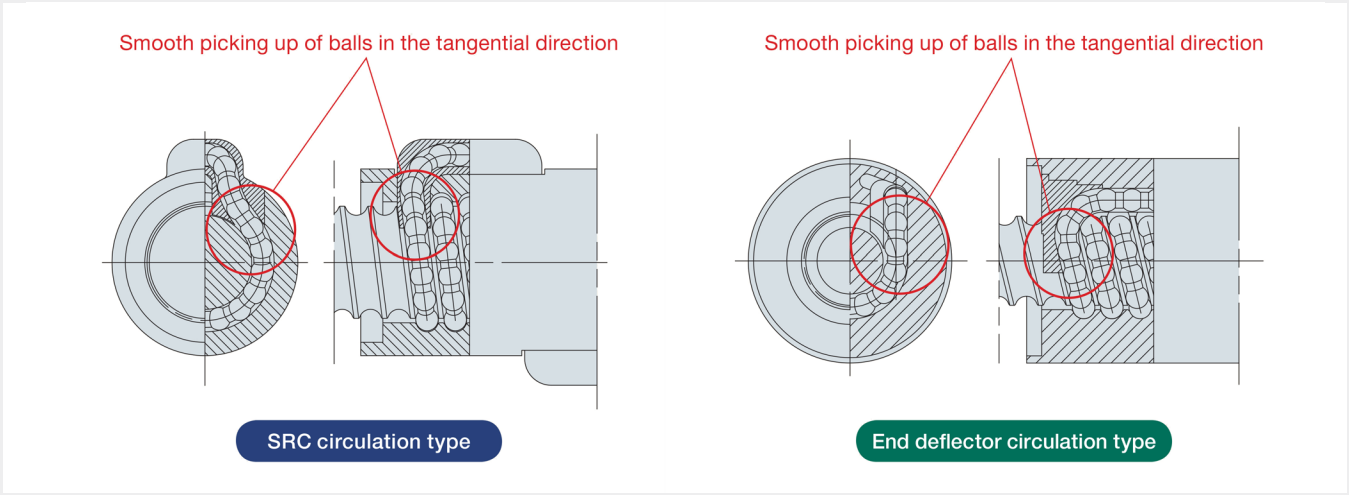
With ball screws that carry large loads, it is critical to distribute the load evenly to each ball. The deformation of components (axis, nut) cannot be disregarded. Based on the load points adapted for screws and nuts in the illustration below (recommended installation), the influence of contraction and expansion in the screw shaft and nut axial direction is offset, and inner nut load is evenly distributed. To make these measures even more effective, axis and the cross section of nut are placed as close to each other as possible.

Resin Retaining Piece

A moment load caused by misalignment of a ball screw can hinder smooth motion of the balls, thus causing ball jamming in the ball recirculation circuits and adversely affecting the durability of the ball screw. By incorporating the NSK S1™ resin retainer between balls, durability of ball screws under a moment load is exponentially improved.



VISIT OUR WEBSITE



HIGH-SPEED FEEDING

High feeding speed is critical for machine efficiency, faster cycle times, and overall productivity. The HTF-Series ball screws deliver maximum speeds of 930 mm/s with a fine lead, and 1,600 mm/s with a coarse lead.

High D/N Circulation Route Design

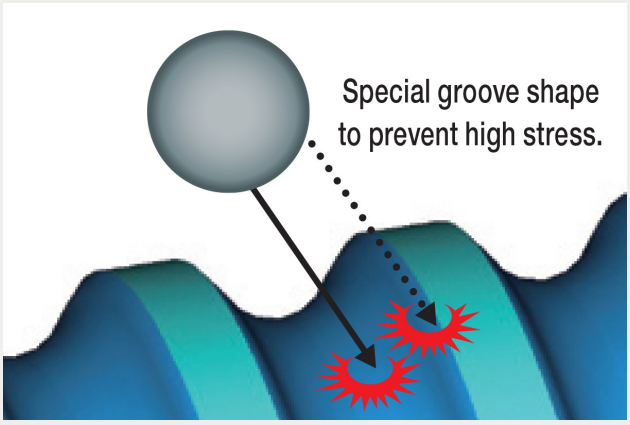
By smoothly picking up balls in the direction tangent to the screw groove, the impact of the balls colliding on other components will be reduced. D/N values (shaft diameter x number of rotations) for speed of circulation components are more than twice as fast as conventional tube recirculation systems.

Ball Groove Shape for High Speed

While rotating at a high speed, the ball collides with the axis at a high speed. With optimally designed ball grooves, pressure on the ball groove surface is minimized during ball collision, preventing shaft damage.

Coarse Lead Setting

To achieve higher feeding, coarse lead setting is possible (for example, shaft diameter 50 mm for a lead of 40 mm). This, in combination with high d/n values, enables high-speed feeding.

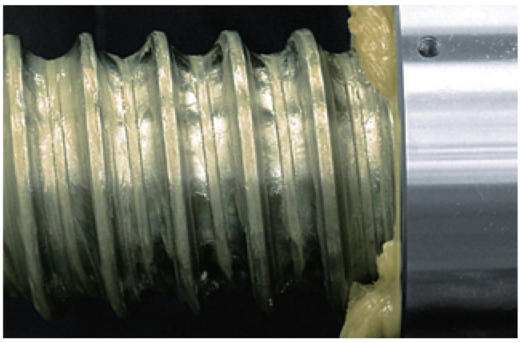


VISIT OUR WEBSITE

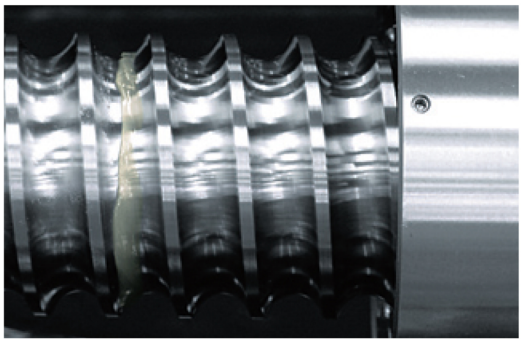
ENVIRONMENTAL CONSIDERATIONS

Grease leakage at initial cycle operation

(Test piece: HTF-ASRC6316-10.5 with high-load grease with an extreme pressure additive [worked penetration: 300])



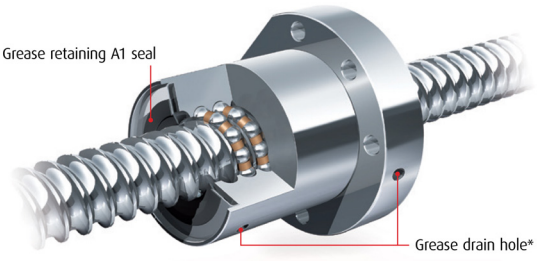
With conventional labyrinth seals



With grease retaining A1 seals

Greatly Improved Grease Retaining Performance

Thanks to the special ball groove profile of the screw shaft together with the grease retaining A1 seal, the grease retaining characteristics are greatly improved compared with those of existing plastic seals. The A1 seal suppresses grease scattering, delivering a significant improvement over contemporary plastic seals, helping to preserve a clean environment.



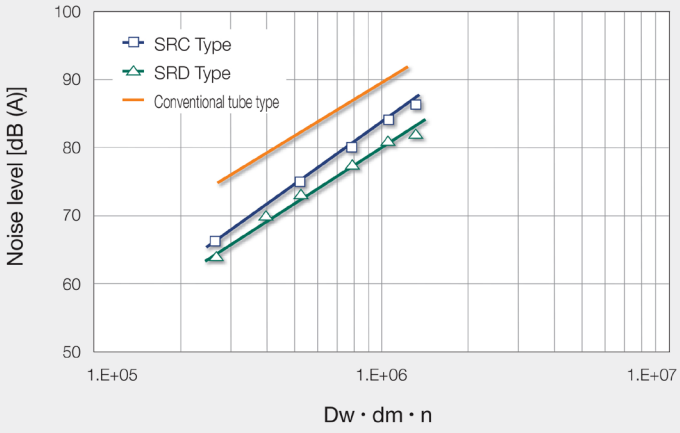
By opening the discharge holes for running-in after grease supplementation, etc., excess grease is discharged. By removing excess grease, grease splatter in high speed operation is reduced.

Low Friction Torque and Low Heat Generation

The increase of dynamic torque caused by the A1 seal is very small (30 to 50 Ncm in case of ball screw with 80 mm diameter). This level of increase has essentially no impact on the driving torque. The practical temperature rise caused by the A1 seal is 2° to 3° C higher than that of typical plastic seals.

Low Noise

By smoothly picking up balls in the screw shaft tangent direction, impact of ball collision on other components can be reduced. Compared to conventional tube type, the noise is reduced by over 6dB.



VISIT OUR WEBSITE

SUPPORT BEARINGS

In support of these ball screws for high-load drives, NSK offers ball screw support angular contact thrust ball bearings. They employ large diameter balls, and optimized roller guides produced with leading edge material and surface finishing technologies. They deliver high load capacity, high rigidity, and the ability to be used in controlled clean environments.

SUMMARY

The major limiting factor in the adoption of electric injection molding technology has been the size of part they can produce. With high-load drive ball screws, that factor is significantly less limiting. Considering the other advantages of electric IMMs – faster start-up, faster cycle times, higher part consistency and quality, lower scrap, and lower consumables – the value of high-load capacity ball screws becomes clear: larger parts, superior performance, lower total cost. NSK contributes to the future of injection molding as the only manufacturer that offers a comprehensive development and service offering for these increasingly essential systems.