Showboating the line

Slow and steady wins the race, so the saying goes. In fact, consistency is the most challenging part of making linear machines advance at low speed. Component irregularities surface, and what's more, the very applications that require slow speed — plastic-injection molding devices, spray-coating machines, and so on — are often applications that require the utmost in uniformity. For example, in winding machines that spool cable, slow and consistent reciprocation prevents misloads during coiling.

With some considerations, lead and ballscrews can deliver this kind of motion. At low speed, thermal expansion from friction — which can otherwise make linear motors a better choice — is minimal and does not significantly compromise accuracy.

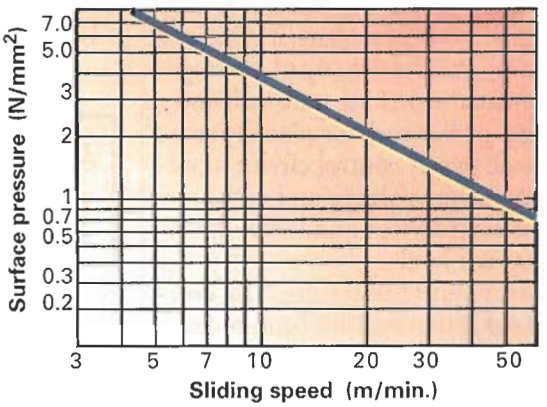
Ballscrew pacing

Finer ballscrew pitch allows for slower movement and greater resolution. This is useful for inspection applications.

Things to remember

- Typical speed range for units designed for slow applications is about 0.01 to 1,000 mm/sec.
- Slow speeds are often associated with high load. In these situations, know that some actuators are designed to slow down as payload increases, according to motor torque curves. Others maintain constant velocity until payload is exceeded — and then the controller faults out. Also: Screws can operate to 5,000 km, but high loads can easily halve that life.

Leadscrew picking



Pressure on and sliding speed of nut surfaces determine the appropriate leadscrew design.

- Leadscrews are very effective in slow situations, but upon startup must overcome a static friction coefficient and backlash. This can be more of a problem in slow applications.
- For low-speed applications, thin oil won't work. High-viscosity oil that stays in place on its own is recommended.

The lead-speed interaction

Screw pitch (dependent on helix angle) is the distance between screw threads. Screws with greater pitches move a nut faster axially for a given screw rpm. Finer pitch makes for smooth slower-velocity operation, and allows for smaller motors as well. *Lead* — a screw's pitch multiplied by its number of threads — is a nut's linear travel per screw revolution. Again, lower leads make for slower motion and produce greater thrust, to decrease drive torque needed to move loads.

Positioning critical

Sometimes accuracy (for example, in parts placement) is more important than consistency. Ballscrews, with their incompressible balls and often preloaded nuts, do not slip — meaning they're capable of accurate micropositioning, even down to 0.1 µm. Average precision units offer resolution to 0.01 mm with positioning accuracy of ±0.02 mm.

Partner in crime: Stepmotor

For constant force over a wide speed range, ac servomotors are suitable. But stepper motors are often more logical for low-speed, high-thrust applications. Under about 1,000 rpm, lead screws coupled with micro-stepping motors usually offer sufficient smoothness — so they're often used together. What is the drawback of this coupling? The magnetic field that drags the rotor along is essentially a spring force — and can transmit inconsistent power to screws at midrange motor resonance. For this reason, many linear stepper/screw systems use software-based drive functions to damp vibration during low-speed operation.

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