Moving limits for pneumatics

Both very slow and extremely fast motion pose challenges to pneumatics. A few design subsystems can extend their practical speeds.

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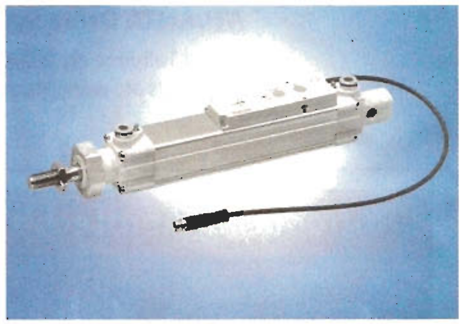
In applications where pneumatics are required to operate at the slow end of their normal speed range — say, around 0.5 in./sec on average — friction poses the biggest problem. That's because the relative magnitude of stick-slip friction becomes more pronounced at lower speed, degrading more acutely the smooth motion of pneumatic cylinders.



Some cylinder sensors include digital switching points for optimal settings in speed-extreme applications.

One very sophisticated solution is glass-lined cylinder walls. These are used in highly specialized applications. More common, however, is the use of special lubricants that actually introduce a slight increase in friction at lower speeds. These minimize any jerkiness from stick-slip friction under slow motion, effectively acting to damp it out of the system. In fact, this solution, originally introduced by manufacturers specifically for use in slower applications, is now common on standard cylinders as well.

Another approach to getting more controllable motion profiles at low speeds is to reduce line pressure into cylinders. (This also serves to minimize stick-slip friction, and reduce costly exhaustion of air.) However, as with other cylinder design details, this approach requires design iteration and tweaking for full optimization.

Pneumatics in higher-speed applications can be subject to shock, overshooting, and other instabilities, and so require more clever design adaptations. But as in very slow applications, sometimes turning down the line pressure into a cylinder can improve performance. How?

Say a design has 90 psi on its rod side, and then air pressure is introduced to the piston side. Suddenly, there is a pressure drop on the former — introducing inconsistent and unpredictable motion. But designing a system to have lower pressure on its homing inactive side still allows the cylinder to return pistons to their start position — with fewer motion and energy issues. In short, this is because there is less air to vent.

In fact, controlling the release of energy is how another subsystem further extends cylinder speed limits. At end of stroke, much kinetic energy is released from a cylinder. It is common for systems to use cushioning rings or rubber bumpers to absorb this energy. But air cushions — especially combined with a secondary rubber ring — are particularly effective at controlling stops.

How does it work? A component on the piston assembly traps a bubble of air that increases in pressure, which is then bled out slowly to make for a controlled stop. Some are even designed with a sweet spot for ideal cushioning: Metal-to-metal contact is make at end of stroke, but with negligible impact and no transmitted impulse. Stainless steel cylinders in heavy applications derive the most benefit from this subsystem.

The best pneumatic cylinder for a design is that which most closely meets motion requirements. Magnetic sensors used during their design can help here. These sensors track magnets on a piston for direct measurement of kinetic energy, so that the safest speed for a given load can be calculated for individual units.

Pneumatic cylinder homing strokes do not need the same power as forcing strokes: Valve circuitry can be different for each. In fact, asymmetrical designs are useful in fast applications, as upper limits are often determined by how fast a unit can bleed air.

Sensors can also be used for continuous condition monitoring, tracking the entire stroke using an analog output signal — to make position inquiries with digital switching points, or (moving from pure accessory to integral pneumatic-actuator component) through analog methods along the entire stroke.