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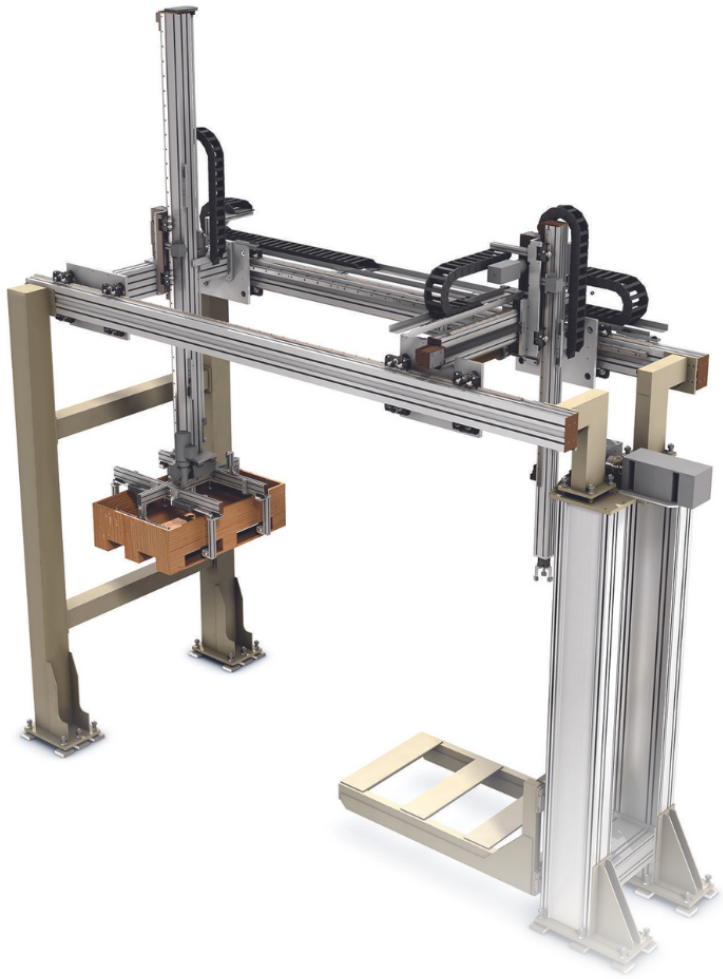
BY TIMKEN

Five reasons to select an electric actuator over a rodless cylinder



Understanding the advantages of electric actuators over rodless cylinders in terms of efficiency, reliability, controllability, and integration into automated systems.

Over the past two decades, electrification has become a priority. Linear actuators using electric modes of power have continually overtaken other forms of linear actuation — especially those based on fluid power. Case in point: Electric actuators have come to displace the pneumatic actuators known as rodless cylinders in a wide variety of mobile equipment, material processing, handling, packaging, and assembly applications. Electric linear actuators can often match the main strengths of rodless cylinders (the ability to deliver quick moves and longer than average strokes) but with more efficiency, controllability, and reliability over many years of service.

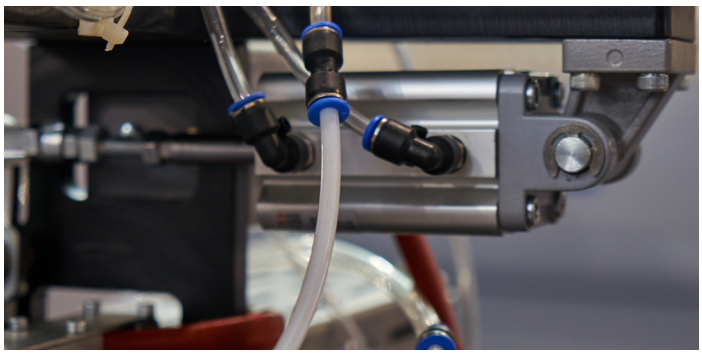


Figure 1. No piston rod extends out of the body of a rodless cylinder because the piston within the cylinder magnetically or mechanically couples to an external carriage. This construction avoids the binding, bending, and wear issues associated with other pneumatic linear-motion designs tasked with handling cantilevered loading with just a rod. Image: Dreamstime

First consider where rodless cylinders excel to understand where it might be suitable to specify electric linear actuators in their place.

Rodless cylinders have a relatively straightforward construction.

Rodless pneumatic cylinders have fewer elements than other fluid-power designs. Compressed air typically passes through endcaps sporting air-supply fittings to enter the cylindrical body (typically constructed of aluminum); this fluid's pressure and volume work to advance an internal piston (also of aluminum) with polymer support rings. Actuation is transmitted out via the piston's connection through a slot along the cylinder's length to an external carriage.

An actuator-assembly frame with bearings much like that of an electric actuator (or even a fully reinforced linear stage in some cases) supports and resolves moments and forces in various orientations. Shields in and outside the slot can protect the cylinder from particle ingress.

Rodless cylinders avoid issues associated with cantilevering loads off a rod.

Rodless cylinders are traditionally favored over rod-type pneumatic cylinders in long-stroke applications because the cylinder rod of the latter can bow, sag, or even bend (exhibiting subtle plastic deformation) when extended to lengthy protractions. Rodless cylinders ensure actuator-element loads as well as external payloads on mechanical wear elements such as bearings and seals stay within specification even when the piston and carriage reach the actuator's end positions. Also avoided is sagging that can compromise the alignment and accuracy of the output carriage positions.

Rodless cylinders are more compact than rod-type pneumatic-cylinder variations.

Rodless cylinders are also used in especially compact machine designs because (unlike

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Clarifying Actuator Terminology

Not all rod-style or rodless actuators are pneumatic, despite the use of "cylinder" usually indicating pneumatics. Some manufacturers, often those with a background in pneumatics, use "rod-style actuators" to denote what many call thrust actuators. These are electric actuators with a rod that moves in and out of a housing to push or pull loads, mimicking traditional pneumatic actuators but powered by electricity. They're particularly used in electrifying vehicles off-highway.

Similarly, "rodless actuators" from some pneumatic-focused suppliers actually describe electric actuators, typically combining a rotary motor with a drive mechanism (like a ballscrew or belt) and sometimes linear guides. These have a carriage-bearing design and are modular, as seen in products by Rollon. Pneumatic rodless cylinders also share a similar rectangular shape, often compared to these electric models.

traditional pneumatic cylinders) the actuator carriage doesn't significantly add to the overall actuator length. Instead, the carriage typically takes the form of a flat platform that rides flush along one of the actuator faces. Where needed, power density is further increased by a double-acting rodless cylinder design.

Rodless cylinders are cleaner and more reliable than rod-type variations. Because there's no rod length exiting and re-entering the cylinder body, the grease needed for many rodless-cylinder subcomponents can be fully contained. That boosts reliability and minimizes the risk of contaminating sensitive environments with lubrication.

As we'll explore, electric linear actuators offer most advantages associated rodless cylinders along with other benefits. These ultimately help electric actuators outperform cylinders in automated equipment for packaging, textile and ceramics manufacturing, pharmaceutical and medical device production, and automated warehousing.

1. Electric actuators offer straightforward and reliable construction.

Modular electric linear actuators from Rollon just one type termed electric rodless actuators in certain contexts feature a rigid housing and linear bearing elements to reliably support and resolve loads and moments sans cantilevered loading. So in terms of construction ruggedness, electric and pneumatic actuators are comparable.

Certain versions of the two linear-motion solutions are also comparably safe.

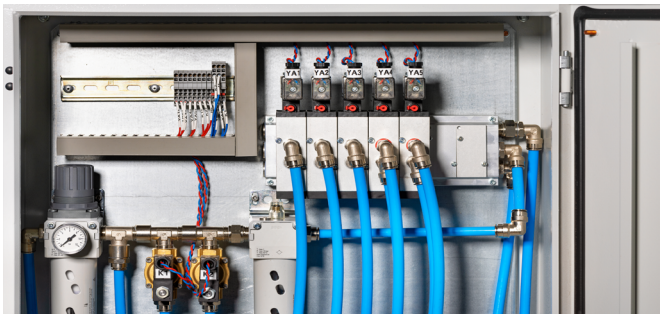

Figure 2. Rodless cylinders are themselves elegantly simple components. However, they require moderately complicated pneumatic circuits complete with filters as shown here to ensure the compressed air is clean.
Image: Sergii Petruk • Dreamstime

But while the construction and operation of a rodless pneumatic cylinder body itself is exceptionally straightforward, the cylinders require a compressor, valves, filter/regulator/lubricator, hose, and fittings to operate. These are all elements that add to the actuators' overall complexity and with potential leak locations, contamination points, and other vulnerabilities spread over a wider area of the machine. Electric actuators on the other hand have internal assemblies that are admittedly complex but beyond that only require an electrical supply. [1]

The function of electric actuators is also more reliable. That's because electric actuators don't depend on contaminant free air and delicate sealing for their proper operation. While it's true that electric actuators integrate seals and wipers (and in some cases shields) to protect the rotary-to-linear mechanical drive and other elements within the actuator housing, these seals aren't fundamental to the core operation of the electric actuator. The failure of a given seal on an electric linear actuator (while

[1] Rollon Plus and Smart-series actuators, TH precision series, and Uniline series are (from a formfactor perspective) leading alternatives to rodless pneumatic solutions. As always, the most suitable component depends on speed, force, and other application requirements.

detrimental) typically won't cause the ceasing of operation. In contrast, rodless pneumatic cylinders need seals to maintain fluid pressure for power transmission. Cylinder efficiency plummets if seals begin to wear and leak and the failure of a seal - a relatively delicate subcomponent - can cause the cylinder's operability to fail with it.

2. Electric actuators are more efficient than rodless cylinders.

In most cases, compressed air itself is essentially an indirect delivery of electrically generated power. That's because compressed air is a power source originating from an electric compressor motor. No wonder that even when they are in perfect working order, rodless pneumatic cylinders are relatively inefficient. In contrast, electric motor-based designs make direct use of electrical power plus (with many motor types used in larger actuators) need little to no current to hold a load at a set position — especially if the axis is fitted with a spring-set brake. A main factor that degrades the efficiency of rodless pneumatic cylinders is the way in which holding a load or set position requires maintenance of compressed-air power. This has a dramatic effect on overall operating costs.

Consider how a linear actuator's duty cycle is defined by the time it's actively moving loads divided by its overall time in service - including periods of rest. An axis needing 0.3 kW of power to move payloads on a 70% duty cycle (for which an axis is off 30% of the time) might cost a thousand dollars a year to operate with a rodless cylinder depending on local utility rates. In contrast, operating the same axis with an electric actuator might cost one quarter that per year. These operating costs greatly overshadow the upfront procurement costs for the two actuator types - especially for machine designs needing to deliver many years of service life.

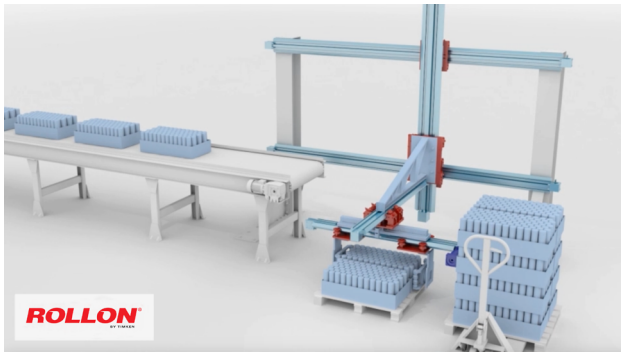

Figure 3. While pneumatic actuation is simple to understand, specify, and install, electric actuation performs better over the near and long term. Shown here is a cartesian-type palletizing workcell consisting of Rollon electric actuators.

Of course, the rotary-to-linear components paired with rotary electric motors inside electric linear actuators introduce their own efficiencies; those range from 90% or better efficiencies from ballscrews to 95% or better efficiencies for belt drives. In addition, rotary electric motors have undergone massive advancements over the last 40 years that have increasingly improved their efficiencies.

In short, rodless pneumatic cylinders (because of their reliance on compressed air to operate) have 15% to 30% effective efficiencies. In contrast, electric actuators maintain 75% to 85% efficiencies.

3. Electric actuators are more rigid than rodless cylinders - in two ways.

Electric actuators have more rigid physical construction. The frame, bearing, and mounting options for electric linear actuators are numerous to let OEMs and other engineers customize them at will. Suppliers offer aluminum, steel, and even engineered polymer elements in heavy-duty permutations to maximize stiffness and the support loads and various moments sans deflection. What's more, electric actuators' mechanical components are designed to minimize backlash and play — especially those destined for servo applications. These maximize rigidity for maximized positioning accuracy. [2]

In contrast, pneumatic rodless cylinders typically feature extruded aluminum profiles engineered to minimize weight while still supporting forces on the piston and carriage. Though pitch moments tend to be no issue, yaw and especially roll moments (often caused by imbalanced paylods) can be problematic.

Electric actuators are capable of more rigidly controllable operation. Electrical signals carrying energy (as well as data for that matter) travel nearly the speed of light via the electromagnetic fields of moving electrons. It's this energy that's directly harnessed by electric motors and the source of their nearly instantaneous and rigid response to being electrically driven. Though mechanical drivetrain components attached to the electric motor in a linear actuator introduce some backlash (as described above) electric linear actuators offer high responsiveness to commands for unmatched positioning accuracy. Their mode of operation is also compatible with high-stiffness control systems that quickly correct for errors between command and actual actuator outputs.

In contrast, the output pneumatic rodless cylinders exhibits the effects of air's compressibility for lower overall rigidity than that of electric actuators. The cylinders' flexible sealing can also introduce system compliance.

4. Electric actuators deliver more controllable linear motion than rodless cylinders.

Credit where credit is due: Most rodless cylinders have higher power densities than comparable electric actuators, meaning they're capable of outputting more force than similarly sized electric options. Rodless pneumatic cylinders are also exceptionally fast-acting - capable of many meters per second with light payloads and right-sized cylinders. Indeed, a major limitation is the choice between power and speed that rodless cylinders force design engineers to make. [3]

Figure 4. This Rollon TH-Series linear table is designed for compactness and high axial force take-up. Its repeatability is up to ± 5 µm.

These caveats aside, many rodless pneumatic cylinders can execute strokes (when set via a manual valve or electronic controls) having modestly variable speeds for multi-function or positioning axes as well as adjustable accelerations for smooth jerk-free payload transport.

[2] New machine designs (as opposed to retrofits to replace pneumatics) are best able to take advantage of electric actuators' benefits.

[3] New electric actuators outperform rodless cylinders on axes where advanced motion control is required. Why? Electric actuators are more accurate and repeatable than rodless cylinders due to the advantages of electric drives.

Electric linear actuators with ballscrew, belt, and rack-and-pinion drives are inherently capable of wider output speed force combinations. The use of electrical signals to both energize the electric motor and transmit motion-controller data greatly simplifies the addition of electronic controls and feedback. What's more, electric-actuator suppliers have in recent years worked to make their offerings more compact for easier integration into tight spaces traditionally automated with rodless cylinders.

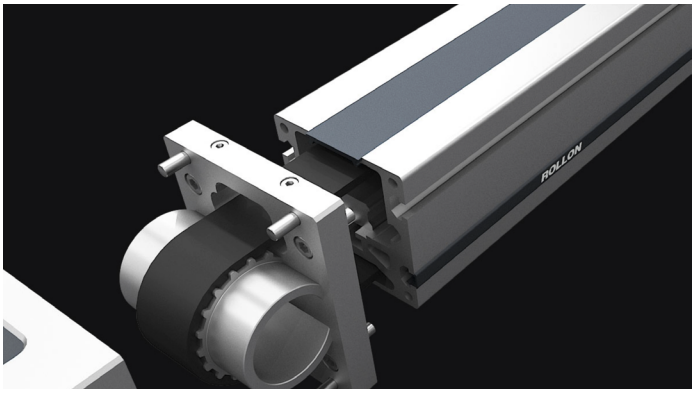

Figure 5. Electric linear actuator repeatability is only limited by the mechanical power transmission. Rollon linear actuators abound to deliver high thrust force. Shown here is a partially exploded view of a Rollon Plus System actuator featuring a steel reinforced polyurethane belt drive. The moving carriage is guided and supported by a profile-rail.

In servo applications, encoder and other sensor feedback inform commands of electric linear actuators to run through preprogrammed speeds and speed changes; motion profiles involving specific acceleration and deceleration routines; and (in contrast with typical pneumatic solutions) numerous and exact position stops along the entire actuator stroke. Read more about this topic at the Rollon blog: How to select pneumatic or rodless electric actuators on how this benefits applications needing quick actions and varied speeds. The inherent compatibility of electric actuators with motion controls also simplifies their integration into multi-axis cartesian systems and other larger automated machinery needing coordination of disparate functions.

5. Electric actuators provide greater connectivity options compared to rodless cylinders.

When electronically controlled and networked, pneumatic rodless-cylinders communications are common via analog or digital IO-Link signals. Feedback originates from threshold, hall, reed, and other specialty sensors and switches. Various industry initatives continue to advance the connectivity options of all fluid-power systems.

Communication options for integrating electric linear actuators into advanced control systems on the other hand are practically limitless. Electric linear actuators are readily connected to a wide array of control achitectures, industrial networks, and the rapidly expanding array of Ethernet based protocols for seamless integration with larger machine design.

Closing thoughts and next steps: Connect with Rollon

Rodless cylinders remain suitable for a wide variety of sorting, pushing, transporting, and clamping appplications as well as those needing actuation of axes in hazardous machine volumes containing flammable substances where electric operation is

precluded. Rodless cylinders are also a top choice where pneumatic subsystems are already present and where simplicity, low upfront cost, and ultra fast strokes are top design objectives.

In most all other situations, electric linear actuators based on electric motors integrated with belt and ballscrew drives are the leading choice. There are however some caveats. Machine builders can indeed use Rollon's modular electric actuators in place of rodless pneumatic cylinders but the two solutions aren't quite drop-ins for each other. After all, the pneumatic solutions only provides thrust force. In contrast, Rollon's electric actuators also provide load bearing and attachments as well as other modularity features for use in multi-axis designs.

That said, Rollon applications engineers do support machine builders in applying modular actuators in place of pneumatic cylinders where suitable.

In many applications involving large payloads and using rodless pneumatic cylinders, there are external guides already existing in the assembly. Such arrangements are common where the payload simply needs to be moved back and forth, occasionally adjusted, or subject to some thrust force. Here, the engineering to switch to electric may be more involved.

Where is a switch most recommended? Well, modular electric actuators offer the most significant advantage over pneumatic options where axes need long stroke-to-overall-length values as well as stroke-capacity values. After all, no rodless pneumatic cylinders reach to many meters like modular electric actuators can.

Rollon Group is a premier linear electric actuator supplier with significant operations in the US., Italy, Germany, and China - and assembly and logistics divisions in India as well as subsidiaries in France and the U.K. The Rollon Corp. headquarters in the U.S. are in Hackettstown, NJ. and a vast network of regional facilities, branch officies, and distributors offers local support to OEMs and other machine builders.

Rollon supplies a wide array of actuators having various linear-bearing and linear-drive types. More specifically, Rollon actuators come in linear-stage variations featuring either trapezoidal (track roller and wheel) linear guides or profiled-rail (recirculating ball bearing) linear guides. Available power-transmission options include motor-driven belts, screws, and rack and pinions to deliver application suitable precision and speed.

Rollon's vast array of offerings also means that its applications team can give design engineers technology agnostic guidance on motion-system design decisions.

For more information on automation that leverages the strengths of electric-based linear actuation, visit rollon.com. Or enter your own application's parameters and explore the extensive capabilites of Rollon's cartesian offerings, visit the myRollon configurator.

To learn more about **Rollon's Actuators**, visit **Rollon.com**.

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