

**White Paper**

# Advantages and Drawbacks of Pneumatic, Hydraulic, and Electric Linear Actuators

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## Introduction

The need for actuators has grown exponentially; nearly everywhere you look you can see one of the three motion systems at work in an endless variety of applications. There are many stereotypes surrounding pneumatic, hydraulic and electric actuators, and while some of these ideas may stand true, many of the thoughts we have associated with these motion components are outdated and need to be revisited. Whereas you may think that your application's need for actuation rests on one specific type of actuator, technological advances have allowed us to reexamine the specifics of each, which could mean more than one option for your project.

It is essential to first identify the basic way in which each type of actuator completes its job.

**Pneumatic linear actuators** are composed of a simple piston inside of a hollow cylinder. A manual pump or external compressor will move the piston within the cylinder housing, and as this pressure increases, the cylinder will move along the axis of the piston, which then creates the linear force needed. It returns to its original retracted length by either a spring-back force or fluid being provided to the opposite side of the piston.

**Hydraulic linear actuators** are quite similar to pneumatic actuators, except for the use of an incompressible liquid is being supplied from a pump as opposed to pressurized air moving the cylinder in a linear motion. This hydraulic actuator is made up of two basic parts: a control device, such as variable throttles (nozzles with slide gates or paired slide valves with an initial axial gap) and an actuation component, such as a piston or controlling valve slide.

[Electric linear actuators](#) take the rotational force of a motor (electrical energy) and convert it into linear movement (torque). By rotating the actuator's screw via the motor, the nut will move in a line up and down, creating the push/pull effect for the load.

Each of these linear actuators are essential to their appropriate application, but as mentioned before, significant advances in the manufacturing world have allowed for these motion devices to be interchangeable. However, each have their advantages and disadvantages, so be sure to weigh the options before deciding on the right actuator for your project.

Advantages and Drawbacks of Pneumatic, Hydraulic, and Electric Linear Actuators:

Characteristics	Pneumatic	Hydraulic	Electric
<b>Complexity</b>	Simple system composition	Moderately complex system composition	Control systems and motion component can work together in multiple complex configurations
<b>Peak power</b>	High	Very high	High
<b>Control</b>	Simple valves	User must	Flexibility of motion control capabilities with electronic controller
<b>Position accuracy</b>	Very difficult to achieve position accuracy	Mid-stroke positioning requires additional components and user support	Positioning capabilities and velocity control allow for synchronization
<b>Speed</b>	Very high speeds	Moderate speeds	Moderate speeds
<b>Load ratings</b>	High load ratings	Extremely high load ratings	Can be high depending on the speed and positioning desired
<b>Lifetime</b>	Moderate lifetime guarantee- easy to replace if need be	With proper maintenance, it can last a long lifetime	With proper maintenance, it can last a long lifetime
<b>Acceleration</b>	Very high	Very high	Moderate
<b>Shock Loads</b>	Able to handle shock loads	Explosion-proof, shock-proof, and spark-proof	
<b>Environmental</b>	High noise levels	Hydraulic fluid leaks and disposal	Minimal
<b>Utilities</b>	Compressor, power, pipes	Pump, power, pipes	Power only option
<b>Efficiency</b>	Low	Low	High
<b>Reliability</b>	Excellent	Good	Good
<b>Maintenance</b>	High amount of maintenance	High user-maintenance throughout the life of the system	Little to no maintenance except for when replacements are necessary
<b>Purchase cost</b>	Low cost	High cost	High cost
<b>Operating cost</b>	Moderate cost	High cost	Low cost
<b>Maintenance cost</b>	Low costs	High costs	Low costs

Although the advances in the manufacturing world have come a very long way, there are still certain applications in which electric linear actuators cannot compete with the [load ratings](#), force or speed necessary. There are some environments in which electric actuation is not suitable, and will have a velocity maximum that cannot be exceeded. Although it is rare, electric actuators can overheat if there are extreme changes in duty cycle or it is being used outside of its [warranty](#).

Shock loads on an electromechanical actuator affects its lead screw or bearing, resulting in the possibility of it affecting the entire system's performance. Some electric actuators can have difficulty holding a locked position or issues with backlash, usually dependent on the screw pitch.

And although the initial cost of the electric motion system may be more costly than other actuator options, the increased efficiency of the total operation coupled with the little to no maintenance required over its life span makes the total cost lower in comparison with other types of actuators.

## Summary

Each of these actuators all exhibit both good and bad characteristics that one must weigh when determining the right one for their application project. By determining what characteristics are nonnegotiable from the start, you will begin to rule out certain actuators based off of these needs. If it comes down to two specific actuators both able to efficiently do the job necessary, you may want to consider the entire cost of the system: this includes the initial investment, maintenance and repair fees, as well as the cost of potential risks you could take with each motion component system.

It is also essential to choose the right company to purchase your product from in order to receive optimum results. TiMOTION is an industry-leading provider of electric linear actuators, capitalizing on a global team that specializes in innovative solutions to help manufacture the best products for industrial, furniture, medical and ergo markets worldwide. We understand that any problem can indeed be solved with the use of the right technology, and that drop-in replacement, customizable electric linear actuators are ever steadily being used in applications that have outgrown pneumatics and hydraulics. TiMOTION strives to provide the highest quality, customizable components at competitive pricing. For more information, visit us online today at [TiMOTION](https://www.timotion.com).