

Duty Cycle - Electric vs. Pneumatic Actuators

There are pros and cons to both pneumatic and electric actuators for valve operation. For pinch valve applications, the price break point is around the 8" size. For valves from ½" to 6" size, pneumatic actuators generally are less expensive. For valves 10" and larger, electric actuators are generally less expensive. Eight inch valves totter either way. This is a rough rule-of-thumb; and is influenced by service, line pressure, hazardous environments, and does not take into account the cost for compressed air equipment.

Pneumatic valve actuators have been around for close to a century. The combination of a rubber bag and spring provides a simple, robust means of moving a valve stem up and down. A valve with a pneumatic actuator can cycle at virtually any speed, continuously, with no mandatory rest periods. An electric actuator cannot operate continuously in this fashion.

Electric actuation eliminates the capital and maintenance costs associated with air compressors, and the danger of frozen air lines is eliminated. However, electric actuators have very specific limitations which must be observed during the design, start up, tuning, and operating phase of operation.

The principle differences between pneumatic and electric actuators:

1. Pneumatic actuators can operate at virtually any stem speed by throttling the air flow. In a pneumatic actuator and positioner assembly, stem speed is proportional to the difference between target and actual positions. When subject to a step change in set point, the actuator starts out fast, but as the valve approaches the target position, the stem gradually decelerates. This arrangement combines fast response with minimum overshoot. Pneumatic actuators in modulating service are faster, more accurate, and more stable than electric actuators, caeteris paribus, and they can move with virtually unlimited frequency.
2. Electric actuators have one fixed speed. When you command the actuator to move to a new position, it immediately jumps to its design speed; it travels at this constant rate to the target, and then stops abruptly. This complicates tuning. You have to set your controller with enough dead-band to tolerate position overshoot that results from the inertia of the motor and drive chain.
 - a. On electric actuators for modulating service, your trade off is this: Buying an actuator with a faster RPM improves response time but increases over-shoot, which can aggravate stability problems. Buying an actuator with a slower RPM will improve the over-shoot and stability criteria, but retards response time. For modulating applications, actuators should generally be in the range of 13 to 26 RPM.
 - b. On electric actuators for on-off service, you want maximum speed. Sleeve wear is caused primarily by turbulence that occurs when the valve is in the near-closed position. Moving the valve as quickly as possible through this transition zone will maximize sleeve life. Actuators for On-Off service generally operate between 54 and 108 RPM.



Pneumatic Actuator



Electric Actuator on 20" valve

3. A pneumatic actuator can operate continuously without any mandatory “rest” period.
4. **An electric actuator can operate for only a limited amount of time without overheating.**
5. Electric actuators have what is known as an “**IEC – S4 - 25% x 15 minute x 600 start/hr**” duty cycle rating. What this means in English:
 - a. The actuator can operate no more than **25%** of the time. If the actuator runs for 1 minute, it needs 3 minutes to cool back down. If it runs for 4 minutes, it needs 12 minutes to cool down.
 - b. The actuator can run continuously for more no more than **15 minutes** at a time. If you force the actuator to run without a rest interval, in 15 minutes the thermal overloads in the motor windings are going to pop, and they will force the actuator off-line for 45 minutes while it cools back down.
 - c. You can start and stop the electric actuator no more than **600 starts** every hour. Every time you start the actuator moving, it pulls a higher current than its rated run current. This elevated amperage turns into heat that eventually burns out motor starters and windings.
6. What typically happens during tuning of the control loop: The instrument technician increases gain in the controller (also known as reducing dead-band). This improves accuracy of the flow control. However, every increase in gain forces the electric actuator to cycle more often with a shorter rest interval. This generates heats. Cross a certain threshold, and the actuator commits self immolation.
7. There are alternate duty cycles available, for example actuators can be specified with a 30 minute duty cycle, or with a 1,200 start per hour rating, but there is a substantial premium added to the actuator price for these enhancements.
8. These enhancements in duty cycle and frequency do not allow you to escape the 25% duty cycle. Stated differently, you are still locked in to allowing your electric actuator to rest 75% of the time to cool back down.
9. There are a few “continuous duty” electric actuators available that can run non-stop. Examples include the Jordan actuator available on valves in the ½” to 4” size range. For larger valves, there are continuous duty electro-hydraulic actuators such as the Rexa unit, but they command a *substantial* price premium.



Jordan Electric Actuator on 1” Valve

David Gardellin, P.E.
 Onyx Valve Co
 5-Jan-2012