Pneumatic Actuator Stroke Time

Time to fill or vent a pneumatic actuator over its stroke from actuator swept volume, pressures and the air flow the positioner, booster or solenoid can deliver.

Method: Isothermal mass balance of the actuator volume (definitions)

Input parameters

Unit system: SI

Parameter	Value	Unit
Actuator swept volume plus dead volume	12.000	L
Starting pressure (absolute)	1.0132	bar
End pressure (absolute)	3.0000	bar
Air delivery (free air, at 1.01325 bar)	6.0000	m³/h

Calculated results

Parameter	Value	Unit
Free air needed	23.529	L
Stroke time	14.118	s

Notes for this case

• Isothermal filling at constant average delivery; real flow falls as the actuator pressure approaches supply, so add 20–50 %. Volume boosters or quick-exhaust valves shorten trip times.

Formula and method

$$V_n = V\frac{|p_2 - p_1|}{p_0}, \quad t = \frac{V_n}{\dot{V}_n}$$

Variables

V	Actuator swept volume plus dead volume	m³
p_1	Starting pressure (absolute)	Pa
p_2	End pressure (absolute)	Pa
$\dot{V}_n$	Air delivery (free air, at 1.01325 bar)	m³/s
V_n	Free air needed	m³
t	Stroke time	s

Method and standards

Isothermal fill.

Assumptions and limits

- Isothermal fill at constant volume and constant average air delivery. Real filling is closer to adiabatic and the delivery falls as the actuator pressure approaches the supply, so real stroke times are longer; the 20–50 % allowance in the note is a rule of thumb, not a sourced figure. Time it on the valve where it matters (ESD valves).
- Isothermal; average delivery.

References

• Isothermal mass balance of the actuator volume (definitions)

Report details

Report reference	FCC-4FA4-EPDV (the same inputs always give the same reference)
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Release checks	2 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/instrumentation/control-valves/valve-stroke-time

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.