Hydraulic Accumulator Size (Boyle's Law)

Gas volume of a bladder or piston accumulator to deliver a volume of oil between a maximum and minimum pressure, for isothermal and adiabatic (fast) operation.

Method: Boyle's law and polytropic gas compression p V^n = constant

Input parameters

Unit system: SI

Parameter	Value	Unit
Oil volume to deliver	2.0000	L
Gas pre-charge pressure (gauge)	90.000	bar
Minimum working pressure (gauge)	100.00	bar
Maximum working pressure (gauge)	200.00	bar
Polytropic exponent (1 isothermal, 1.4 adiabatic nitrogen)	1.4000	

Calculated results

Parameter	Value	Unit
Accumulator gas volume	5.5488	L
Gas volume if isothermal (n = 1)	4.4620	L

Notes for this case

• Absolute pressures are used inside (gauge + 1 atm). A pre-charge about 90 % of the minimum working pressure is common practice; follow the maker.

Formula and method

$$V_0 = \frac{\Delta V}{\left(\frac{p_0}{p_1}\right)^{1/n} - \left(\frac{p_0}{p_2}\right)^{1/n}}$$

Variables

ΔV	Oil volume to deliver	m³
p_0	Gas pre-charge pressure (gauge)	Pa
p_1	Minimum working pressure (gauge)	Pa
p_2	Maximum working pressure (gauge)	Pa
n	Polytropic exponent (1 isothermal, 1.4 adiabatic nitrogen)	-
V_0	Accumulator gas volume	m³
$V_{0,iso}$	Gas volume if isothermal (n = 1)	m³

Method and standards

Polytropic gas law between the two pressures.

Assumptions and limits

- Ideal gas.
- One exponent n from pre-charge to p_1 and on to p_2. Makers often treat pre-charge and slow filling as isothermal and only a fast discharge as adiabatic; the isothermal result V_0,iso and the adiabatic V_0 bracket that mixed case.

References

• Boyle's law and polytropic gas compression p V^n = constant

Report details

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

This calculator online

https://calc.firecad.com/mechanical/hydraulics-pneumatics/hydraulic-accumulator-volume

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Reopens the calculator with the inputs of this report.