Compressor Load/Unload Cycle Rate and Minimum Receiver

Load and unload times, cycles per hour and load share of a compressor with a receiver at a demand, and the receiver volume that limits the cycle rate.

Method: Isothermal receiver filling and emptying

Input parameters

Unit system: SI

Parameter	Value	Unit
Receiver and system volume	2.0000	m³
Compressor free air delivery	10.000	m³/min
Air demand (free air)	6.0000	m³/min
Pressure band (cut-in to cut-out)	1.0000	bar
Atmospheric pressure	1.0132	bar
Maximum cycles per hour allowed	30.000	

Calculated results

Parameter	Value	Unit
Load time	29.608	s
Unload time	19.738	s
Cycles per hour	72.954	
Load share	60.000	%
Volume for the maximum cycle rate at worst demand	5.0663	m³

Notes for this case

• While loaded the compressor fills the receiver at the surplus Q_c − Q_d; unloaded, the demand draws it down. Each phase takes V·Δp/p_a divided by that flow (isothermal). Cycling is fastest when demand is half the delivery, giving a cycle of 4VΔp/(p_aQ_c); a receiver of at least 3600·p_a·Q_c/(4Δp·N_max) keeps cycles below N_max per hour at any demand. Frequent cycling wastes unload power and wears valves and motors; a wider band or a bigger receiver slows it.

Formula and method

$$t_l = \frac{V\Delta p}{p_a(Q_c - Q_d)}, \quad t_u = \frac{V\Delta p}{p_a Q_d}, \quad V_{min} = \frac{p_a Q_c}{4\Delta p\, N_{max}}$$

Variables

V	Receiver and system volume	m³
Q_c	Compressor free air delivery	m³/s
Q_d	Air demand (free air)	m³/s
Δp	Pressure band (cut-in to cut-out)	Pa
p_a	Atmospheric pressure	Pa
N_{max}	Maximum cycles per hour allowed	-
t_l	Load time	s
t_u	Unload time	s
N	Cycles per hour	-
Q_d/Q_c	Load share	-
V_{min}	Volume for the maximum cycle rate at worst demand	m³

Method and standards

Compressor cycling.

Assumptions and limits

- Isothermal filling; steady demand.

References

Isothermal receiver filling and emptying

Report details

Report reference	FCC-GJQK-BX0W (the same inputs always give the same reference)
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Release checks	3 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/mechanical/compressors/compressor-load-unload-cycles

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.