Reciprocating Compressor Cylinder: Capacity, Power and Temperature

Cylinder displacement, volumetric efficiency with clearance and real-gas Z ratio, suction capacity, piston speed, discharge temperature and gas power.

Input parameters

Unit system: SI

Parameter	Value	Unit
Bore	14.000	in
Stroke	7.0000	in
Rod diameter (double acting)	2.2500	in
Speed	450.00	rpm
Action	Double acting	
Clearance (fraction of displacement)	15.000	%
Inlet pressure	100.000	psi
Discharge pressure	300.00	psi
Inlet temperature	90.000	°F
Isentropic exponent	1.3950	
Inlet compressibility	1.0000	
Discharge compressibility	1.0000	
Loss allowance (0.03-0.05)	3.0000	%
Compression efficiency	82.000	%

Calculated results

Parameter	Value	Unit
Piston displacement	553.98	ft³/min
Volumetric efficiency	76.030	%
Suction capacity	421.20	ft³/min
Mean piston speed	525.00	ft/min
Discharge temperature (isentropic)	290.57	°F
Cylinder power	288.84	hp

Notes for this case

• The 0.97 allows for valve and port losses; L is 0.03 for ordinary service and up to 0.05 for high differential pressure or light gases. The ratio Z_1/Z_2 corrects the re-expansion of clearance gas for real-gas behaviour. Power is the gas power at the cylinder; add mechanical losses for the shaft.

Formula and method

$$P_d = sN(2A - a), \quad E_v = 0.97 - \left[\frac{Z_1}{Z_2} r_p^{1/k} - 1\right] C - L, \quad Q_1 = E_v P_d$$

$$T_2 = T_1 r_p^{(k-1)/k}, \quad W = \frac{P_1 Q_1 \frac{k}{k-1}\left(r_p^{(k-1)/k} - 1\right)}{\eta}$$

Variables

D	Bore	m
s	Stroke	m
d_r	Rod diameter (double acting)	m
N	Speed	rad/s
acting	Action	-
C	Clearance (fraction of displacement)	-
P_1	Inlet pressure	Pa
P_2	Discharge pressure	Pa
T_1	Inlet temperature	K
k	Isentropic exponent	-
Z_1	Inlet compressibility	-
Z_2	Discharge compressibility	-
L	Loss allowance (0.03-0.05)	-
η	Compression efficiency	-
P_d	Piston displacement	m³/s
E_v	Volumetric efficiency	-
Q_1	Suction capacity	m³/s
PS	Mean piston speed	m/s
T_2	Discharge temperature (isentropic)	K
W_{cyl}	Cylinder power	W

Method and standards

The reciprocating cylinder performance method.

Assumptions and limits

- Single stage; isentropic temperature; k 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/compressors/reciprocating-compressor-cylinder-performance

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Reopens the calculator with the inputs of this report.