Screw Compressor Sizing: Speed, Tip Mach Number, Power and Temperature

Twin-screw compressor displacement per revolution, rotor speed for an inlet volume, tip Mach number, adiabatic and shaft power and discharge temperature.

Input parameters

Unit system: SI

Parameter	Value	Unit
Rotor diameter	6.0000	in
Length-to-diameter ratio	1.6000	
Lobe-geometry constant	2.2310	
Inlet volume flow	600.00	ft³/min
Volumetric efficiency	85.000	%
Molar mass of the gas	20.000	kg/kmol
Isentropic exponent	1.2500	
Inlet temperature	80.000	°F
Inlet pressure	30.000	psi
Discharge pressure	75.000	psi
Adiabatic efficiency	70.000	%
Temperature-rise efficiency	90.000	%
Mechanical losses (0.07 of adiabatic power)	7.0000	%

Calculated results

Parameter	Value	Unit
Displacement per revolution	0.089646	ft³
Displacement	705.88	ft³/min
Rotor speed	7,874.1	rpm
Rotor tip speed	206.14	ft/s
Speed of sound at inlet	1,295.0	ft/s
Rotor tip Mach number	0.15918	
Adiabatic power	112.84	hp
Shaft power	120.74	hp
Discharge temperature	252.29	°F

Notes for this case

- Read the volumetric efficiency, the optimum tip Mach number and the adiabatic efficiency from the maker's or the curves for the pressure ratio and built-in volume ratio; efficiency falls when the tip speed departs from the optimum or the pressure ratio from the built-in one.

Formula and method

$$Q_r = \frac{d^3(L/d)}{C}, \quad Q_d = \frac{Q_1}{E_v}, \quad N = \frac{Q_d}{Q_r}, \quad u = \pi d N, \quad a = \sqrt{kRT_1/M}$$

$$W_a = \frac{P_1 Q_1 \frac{k}{k-1}\left(r_p^{\frac{k-1}{k}} - 1\right)}{\eta_a}, \quad t_2 = t_1 + \frac{T_1\left(r_p^{\frac{k-1}{k}} - 1\right)}{\eta_a \eta_t}, \quad W_s = W_a(1 + f_m)$$

Variables

d	Rotor diameter	m
L/d	Length-to-diameter ratio	-
C	Lobe-geometry constant	-
Q_1	Inlet volume flow	m³/s
E_v	Volumetric efficiency	-
M	Molar mass of the gas	kg/kmol
k	Isentropic exponent	-
T_1	Inlet temperature	K
P_1	Inlet pressure	Pa
P_2	Discharge pressure	Pa
η_a	Adiabatic efficiency	-
η_t	Temperature-rise efficiency	-
f_m	Mechanical losses (0.07 of adiabatic power)	-
Q_r	Displacement per revolution	m³
Q_d	Displacement	m³/s
N	Rotor speed	rad/s
u	Rotor tip speed	m/s
a	Speed of sound at inlet	m/s
u/a	Rotor tip Mach number	-
W_a	Adiabatic power	W
W_s	Shaft power	W
T_2	Discharge temperature	K

Method and standards

The rotary screw compressor sizing.

Assumptions and limits

- Ideal-gas, uncooled compression; efficiencies from curves.

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/screw-compressor-sizing

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Reopens the calculator with the inputs of this report.