Roots (Twin-Lobe) Blower Power and Discharge Temperature

Gas power, shaft power and discharge temperature of a rotary-lobe (Roots) blower, which has no internal compression, compared with ideal isentropic compression.

Method: Positive-displacement compression without internal compression: $W = V_1(p_2 - p_1)$

Input parameters

Unit system: SI

Parameter	Value	Unit
Inlet volume flow	1,000.0	m³/h
Inlet pressure (absolute)	1.0132	bar
Discharge pressure (absolute)	1.6133	bar
Inlet temperature	30.000	°C
Mechanical efficiency (gears, bearings, seals)	92.000	%
Ratio of specific heats	1.4000	
Gas constant	0.28705	kJ/(kg·K)

Calculated results

Parameter	Value	Unit
Gas power (inlet volume × pressure rise)	16.667	kW
Shaft power	18.116	kW
Ideal isentropic gas power	14.000	kW
Isentropic efficiency of the lobe compression	83.999	%
Discharge temperature	81.289	°C
Mass flow	1,164.4	kg/h

Notes for this case

• A Roots blower carries pockets of gas at inlet pressure to the outlet, where discharge gas flows back and compresses them suddenly. The work per cycle is therefore the inlet volume times the full pressure rise, $V_1(p_2 - p_1)$, more than isentropic compression needs; the gap grows with the pressure ratio, which is why lobe blowers are used below about 1 bar rise. All the gas work turns into heat in the gas, giving the discharge temperature rise. Slip back through the clearances reduces the delivered flow; enter the delivered inlet flow.

Formula and method

$$P_g = \dot{V}_1(p_2 - p_1), \quad P_{is} = \dot{m} c_p T_1 \left[\left(\frac{p_2}{p_1} \right)^{(\kappa-1)/\kappa} - 1 \right], \quad T_2 = T_1 + \frac{P_g}{\dot{m} c_p}$$

Variables

$\dot{V}_1$	Inlet volume flow	m³/s
p_1	Inlet pressure (absolute)	Pa
p_2	Discharge pressure (absolute)	Pa
T_1	Inlet temperature	K
η_m	Mechanical efficiency (gears, bearings, seals)	-
κ	Ratio of specific heats	-
R	Gas constant	J/(kg·K)
P_g	Gas power (inlet volume × pressure rise)	W

P_s	Shaft power	W
P_{is}	Ideal isentropic gas power	W
η_{is}	Isentropic efficiency of the lobe compression	-
T_2	Discharge temperature	K
$\dot{m}$	Mass flow	kg/s

Method and standards

Lobe blower.

Assumptions and limits

- Ideal gas; no heat loss; delivered inlet flow given.

References

Positive-displacement compression without internal compression: $W = V_1(p_2 - p_1)$

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/roots-blower-power

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Reopens the calculator with the inputs of this report.