Compressor Polytropic Head, Power and Discharge Temperature

Polytropic head, gas power and discharge temperature of a compressor from suction state, pressure ratio, molar mass, k, Z and polytropic efficiency.

Method: Perry's Chemical Engineers' Handbook; 9th ed. (McGraw-Hill, 2019); ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Gas mass flow	18,000	kg/h
Suction temperature	35.000	°C
Suction pressure (absolute)	1.0000	bar
Discharge pressure (absolute)	4.0000	bar
Molar mass	28.960	kg/kmol
Ratio of specific heats	1.4000	
Mean compressibility	1.0000	
Polytropic efficiency	78.000	%

Calculated results

Parameter	Value	Unit
Polytropic exponent term	0.36630	
Polytropic head	159.80	kJ/kg
Discharge temperature	238.88	°C
Gas power	1,024.4	kW

Notes for this case

- Keep discharge temperature within the lube and seal limits; intercool when the ratio per stage exceeds about 3–4.

Formula and method

$$\frac{n-1}{n}=\frac{k-1}{k\eta_p},\quad H_p=\frac{ZRT_1}{M}\frac{n}{n-1}\left[\left(\frac{p_2}{p_1}\right)^{(n-1)/n}-1\right],\quad T_2=T_1\left(\frac{p_2}{p_1}\right)^{(n-1)/n},\quad P=\frac{\dot{m}H_p}{\eta_p}$$

Variables

$\dot{m}$	Gas mass flow	kg/s
T_1	Suction temperature	K
p_1	Suction pressure (absolute)	Pa
p_2	Discharge pressure (absolute)	Pa
M	Molar mass	kg/kmol
k	Ratio of specific heats	-
Z	Mean compressibility	-
η_p	Polytropic efficiency	-
$(n-1)/n$	Polytropic exponent term	-
H_p	Polytropic head	J/kg
T_2	Discharge temperature	K
P	Gas power	W

Method and standards

Polytropic compression of an ideal gas with a mean Z.

Assumptions and limits

- Constant k and Z; no intercooling. Above a ratio of about 4 the result is for uncooled compression and a note suggests intercooled stages.

References

- Perry's Chemical Engineers' Handbook
- 9th ed. (McGraw-Hill, 2019)
- sec. 10 (compressors): polytropic compression

Report details

Report reference	FCC-TVZN-WG79 (the same inputs always give the same reference)
Generated	17 November 2026, 19:34 UTC
Calculator	Compressor Polytropic Head, Power and Discharge Temperature
Method last reviewed	13 November 2026
Software release	FireCAD Calc, release of 17 November 2026
Release checks	2 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/chemical/unit-operations/compressor-polytropic-head

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.