Compressed Air: Saving from Lowering Generation Pressure

Compressor power saving from lowering the discharge pressure, from the polytropic work ratio, with the extra saving from reduced leakage at lower pressure.

Method: Polytropic specific work □ (p₂/p₁)^((n−1)/n) − 1; choked leak flow □ upstream absolute pressure

Input parameters

Unit system: SI

Parameter	Value	Unit
Suction (atmospheric) pressure	1.0132	bar
Present discharge pressure (absolute)	9.0132	bar
New discharge pressure (absolute)	8.0132	bar
Polytropic index	1.3000	
Present compressor input power	160.00	kW
Share of air lost to leaks	25.000	%
Hours per year	7,000.0	h
Electricity price per kWh	8.0000	

Calculated results

Parameter	Value	Unit
Saving in specific work	6.7592	%
Saving from lower leakage	2.7737	%
Power saved	14.953	kW
Cost saved per year	837,347	

Notes for this case

- Check that every user still gets its minimum pressure after line losses.

Formula and method

$$x_w = 1 - \frac{(p_n/p_a)^{(n-1)/n} - 1}{(p_2/p_a)^{(n-1)/n} - 1}, \quad x_l = x_L \left(1 - \frac{p_n}{p_2}\right)$$

Variables

p_a	Suction (atmospheric) pressure	Pa
p_2	Present discharge pressure (absolute)	Pa
p_n	New discharge pressure (absolute)	Pa
n	Polytropic index	-
P	Present compressor input power	W
x_L	Share of air lost to leaks	-
t	Hours per year	s
c	Electricity price per kWh	-
x_w	Saving in specific work	-
x_l	Saving from lower leakage	-
ΔP	Power saved	W
ΔC	Cost saved per year	-

Method and standards

Polytropic work.

Assumptions and limits

- Constant air demand.
- Single-stage polytropic work: for two-stage machines with intercooling the work changes less with pressure, so the saving is slightly overstated.

References

- Polytropic specific work □ $(p_2/p_1)^{((n-1)/n)} - 1$; choked leak flow □ upstream absolute pressure

Report details

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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/environmental/carbon-energy/compressed-air-pressure-reduction

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.