# Compressed Air Leak Flow and Cost

Air lost through a leak of a given hole size at line pressure, as free air delivery, compressor power, energy and cost per year (choked nozzle flow).

**Method:** Isentropic nozzle flow of an ideal gas

## Input parameters

Unit system: SI

| Parameter | Value | Unit |
|---|---|---|
| Hole diameter | 3.0000 | mm |
| Line pressure | 7.0000 | bar g |
| Air temperature in the line | 30.000 | °C |
| Discharge coefficient of the hole<br>About 0.6–0.65 for a sharp-edged hole or crack; nearer 0.9 for a rounded fitting. | 65.000 | % |
| Isentropic exponent of air | 1.4000 | |
| Atmospheric pressure (absolute) | 101.33 | kPa |
| Compressor inlet temperature | 30.000 | °C |
| Compressor specific power (kW per m³/min of FAD)<br>From the compressor data sheet or a plant energy audit; about 6–7 kW per m³/min at 7 bar g for a good screw compressor. | 6.5000 | |
| Hours under pressure per year | 8,000.0 | h |
| Energy price per kWh (your currency) | 8.0000 | |

## Calculated results

| Parameter | Value | Unit |
|---|---|---|
| Leak as free air | 0.44036 | m³/min |
| Leak mass flow | 30.766 | kg/h |
| Compressor power wasted | 2.8624 | kW |
| Energy wasted per year | 22,899 | kWh |
| Cost per year (your currency) | 183,191 | |
| Choked flow (1 = yes) | 1.0000 | |

## Formula and method

$$\rho_0 = \frac{p_0 M}{R T_0} \qquad \dot{m} = C_d A \sqrt{k\, p_0\, \rho_0} \left(\frac{2}{k+1}\right)^{\frac{k+1}{2(k-1)}} \quad \text{(choked)}$$

$$\dot{m} = C_d A \sqrt{\frac{2k}{k-1}\, p_0 \rho_0 \left[r^{2/k} - r^{(k+1)/k}\right]}, \; r = \frac{p_a}{p_0} \quad \text{(not choked)}$$

$$\dot{V}_a = \frac{\dot{m}}{\rho_a} \qquad P = \dot{V}_a\, SP \qquad E = P t_y \qquad C = E c_e$$

### Variables

| | | |
|---|---|---|
| $d$ | hole diameter | m |
| $p_0$ | line pressure | Pa |
| $T_0$ | line temperature | K |

| | | |
|---|---|---|
| $C_d$ | discharge coefficient | – |
| $k$ | isentropic exponent | – |
| $p_a$ | atmospheric pressure | Pa |
| $T_a$ | compressor inlet temperature | K |
| $SP$ | specific power (P = V̇_a SP, with V̇_a in m³/min and SP in kW per m³/min) | kW per m³/min |
| $t_y$ | hours per year | s |
| $c_e$ | energy price | currency/kWh |
| $\dot{V}_a$ | leak as free air | m³/s |
| $\dot{m}$ | mass flow | kg/s |
| $P$ | power wasted | W |
| $E$ | energy per year | J |
| $C$ | cost per year | currency |
| $\mathrm{choked}$ | choked flow flag | – |
| $r$ | pressure ratio p_a/p_0 | – |
| $A$ | hole area | m² |
| $\rho_0, \rho_a$ | line and inlet air density | kg/m³ |

### Method and standards

Isentropic nozzle flow of an ideal gas (dry air of the PTC 4 composition), choked below the critical pressure ratio, else the subsonic form.

### Assumptions and limits

- Dry air; round hole; no pipe friction upstream.
- A line pressure entered as gauge is turned into absolute with the standard atmosphere, not the site p_a; at altitude enter it as absolute (a note appears when p_a differs from 1.01325 bar).

### References

- Isentropic nozzle flow of an ideal gas

## Report details

| | |
|---|---|
| Report reference | FCC-CK9A-WV2S (the same inputs always give the same reference) |
| Generated | 17 November 2026, 19:46 UTC |
| Calculator | Compressed Air Leak Flow and Cost |
| Method last reviewed | 12 November 2026 |
| Software release | FireCAD Calc, release of 17 November 2026 |
| Release checks | 3 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/mechanical/compressors/compressed-air-leak-cost

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.