Chiller COP versus Lift: Condensing Temperature Effect

Carnot fraction of a chiller from its COP at one evaporating and condensing temperature, the COP at another condensing temperature and power per kelvin.

Method: Constant Carnot-fraction COP model

Input parameters

Unit system: SI

Parameter	Value	Unit
Known COP	5.5000	
Evaporating temperature	5.0000	°C
Condensing temperature for the known COP	36.000	°C
New condensing temperature	30.000	°C

Calculated results

Parameter	Value	Unit
Carnot fraction	61.298	%
COP at the new condensing temperature	6.8200	
Compressor power change for the same duty	-19.355	%
Power change per kelvin of condensing temperature	3.2258	%

Notes for this case

• Holding the Carnot fraction constant, COP = η_C·T_e/(T_c − T_e). Real chillers stay close to this over moderate changes; each kelvin of lower condensing temperature (cooler condenser water, clean tubes) typically saves 2–3 % of compressor power. Use the maker's curves for large changes or variable-speed machines.

Formula and method

$$\eta_C = COP_0 \frac{T_{c,0} - T_e}{T_e}, \quad COP_1 = \eta_C \frac{T_e}{T_{c,1} - T_e}$$

Variables

COP_0	Known COP	-
T_e	Evaporating temperature	K
$T_{c,0}$	Condensing temperature for the known COP	K
$T_{c,1}$	New condensing temperature	K
η_C	Carnot fraction	-
COP_1	COP at the new condensing temperature	-
$\Delta P/P_0$	Compressor power change for the same duty	-
$\Delta P/\Delta T$	Power change per kelvin of condensing temperature	-

Method and standards

Lift and COP.

Assumptions and limits

- Constant Carnot fraction; same duty and evaporating temperature.

References

Constant Carnot-fraction COP model

Report details

Report reference	FCC-8EWD-F9PM (the same inputs always give the same reference)
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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/hvac/chillers/chiller-lift-cop-penalty

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.