Duct Heat Gain or Loss and Air Temperature Change

Heat gained or lost by air in a duct running through a warmer or colder space, and the leaving air temperature, from flow, duct size, length and U-value.

Method: Incropera; DeWitt; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Air flow	6,000.0	m³/h
Duct width	600.00	mm
Duct height	400.00	mm
Length through the space	30.000	m
Duct U-value (per outer surface area) About 0.6–1 W/m²K with 25–50 mm insulation, 5–8 bare.	0.80000	W/(m²·K)
Air temperature entering	13.000	°C
Surrounding temperature	40.000	°C
Air density	1.2000	kg/m³
Air specific heat	1.0060	kJ/(kg·K)

Calculated results

Parameter	Value	Unit
Air temperature leaving	13.637	°C
Temperature change	0.63651	K
Heat gained (negative: lost)	1.2807	kW

Formula and method

$$T_2 = T_a + (T_1 - T_a)\exp\left(-\frac{U2(W+H)L}{\rho\dot{V}c_p}\right), \quad \dot{Q} = \rho\dot{V}c_p(T_2 - T_1)$$

Variables

$\dot{V}$	Air flow	m³/s
W	Duct width	m
H	Duct height	m
L	Length through the space	m
U	Duct U-value (per outer surface area)	W/(m²·K)
T_1	Air temperature entering	K
T_a	Surrounding temperature	K
ρ	Air density	kg/m³
c_p	Air specific heat	J/(kg·K)
T_2	Air temperature leaving	K
ΔT	Temperature change	K
$\dot{Q}$	Heat gained (negative: lost)	W

Method and standards

Energy balance along the duct.

Assumptions and limits

- Constant U and surroundings.
- The perimeter 2(W + H) uses the dimensions entered: with U per outer surface area, enter the outside (insulated) dimensions; thick insulation makes the outer perimeter noticeably larger than the sheet size.

References

- Incropera
- DeWitt
- Bergman and Lavine
- Fundamentals of Heat and Mass Transfer
- ch. 8 (mean temperature in a duct with a uniform external temperature, $T_2 = T_a + (T_1 - T_a) \exp(-UPL/\dot{m}c_p)$)

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/hvac/ducts/duct-heat-gain

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.