Dimensionless Numbers: Re, Pr, Gr, Ra and Nu for Air or Water

Reynolds, Prandtl, Grashof, Rayleigh, Péclet and Nusselt numbers for air or water at a state, from a length, velocity, temperature difference and h.

Method: Definitions (Incropera, DeWitt, Bergman and Lavine, Fundamentals of Heat and Mass Transfer); Air from NIST Shomate; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Fluid	Air (dry)	
Fluid temperature (film)	50.000	°C
Pressure (absolute)	1.0132	bar
Characteristic length	50.000	mm
Velocity	2.0000	m/s
Temperature difference (for Gr)	30.000	K
Convection coefficient (for Nu)	25.000	W/(m²·K)

Calculated results

Parameter	Value	Unit
Reynolds number v L/v	5,595.5	
Prandtl number	0.73717	
Grashof number g β ΔT L³/v²	356,303	
Rayleigh number Gr Pr	262,656	
Péclet number Re Pr	4,124.8	
Nusselt number h L/k	46.908	

Notes for this case

- β is 1/T for air (ideal gas) and from the IF97 density change for water.

Formula and method

$$Re = \frac{vL}{\nu}, \quad Pr = \frac{c_p \mu}{k}, \quad Gr = \frac{g\beta\Delta T L^3}{\nu^2}, \quad Ra = Gr\,Pr, \quad Nu = \frac{hL}{k}$$

Variables

fluid	Fluid	-
T	Fluid temperature (film)	K
p	Pressure (absolute)	Pa
L	Characteristic length	m
v	Velocity	m/s
ΔT	Temperature difference (for Gr)	K
h	Convection coefficient (for Nu)	W/(m²·K)
Re	Reynolds number v L/v	-
Pr	Prandtl number	-
Gr	Grashof number g β ΔT L³/v²	-
Ra	Rayleigh number Gr Pr	-

Pe	Péclet number Re Pr	-
Nu	Nusselt number h L/k	-

Method and standards

Definitions.

Assumptions and limits

- Single-phase fluid. Where the water expansion coefficient cannot be found (within 0.5 K of saturation or freezing) Gr and Ra are not shown.

References

- Definitions (Incropera, DeWitt, Bergman and Lavine, Fundamentals of Heat and Mass Transfer)
- Air from NIST Shomate
- Sutherland and Eucken (engine); water from IAPWS-IF97 and the IAPWS 2008/2011 transport releases

Report details

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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/mechanical/heat-transfer/heat-transfer-dimensionless-numbers

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.