International Standard ISO 31/12

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Dimensionless parameters

Paramètres sans dimension

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been set up has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 31/12 was developed by Technical Committee ISO/TC 12, *Quantities, units, symbols, conversion factors and conversion tables.*

This second edition was submitted directly to the ISO Council, in accordance with clause 5.10.1 of part 1 of the Directives for the technical work of ISO. It cancels and replaces the first edition (i.e. ISO 31/12-1975), which had been approved by the member bodies of the following countries:

Australia	Germany, F.R.	Poland
Belgium	Greece	Portugal
Canada	India	South Africa, Rep. of
Chile	Japan	Sri Lanka
Czechoslovakia	Korea, Rep. of	Sweden
Denmark	Netherlands	Thailand
Finland	New Zealand	United Kingdom
France	Norway	USSR

No member body had expressed disapproval of the document.

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Dimensionless parameters

Introduction

General remarks

This document, containing a table of *dimensionless parameters*, is part 12 of ISO 31, which deals with quantities and units in the various fields of science and technology. The complete list of parts of ISO 31 is as follows :

Part 0 : *General principles concerning quantities, units and symbols.*

Part 1 : *Quantities and units of space and time.*

Part 2 : *Quantities and units of periodic and related phenomena.*

Part 3 : *Quantities and units of mechanics.*

Part 4 : *Quantities and units of heat.*

Part 5 : *Quantities and units of electricity and magnetism.*

Part 6 : *Quantities and units of light and related electromagnetic radiations.*

Part 7 : *Quantities and units of acoustics.*

Part 8 : *Quantities and units of physical chemistry and molecular physics.*

Part 9 : *Quantities and units of atomic and nuclear physics.*

Part 10 : *Quantities and units of nuclear reactions and ionizing radiations.*

Part 11 : *Mathematical signs and symbols for use in the physical sciences and technology.*

Part 12 : *Dimensionless parameters.*

Part 13 : *Quantities and units of solid state physics.*

Special remarks

This document contains a selection of dimensionless parameters and constants used for the description of transport phenomena.

Each recommended symbol for such a quantity consists of two letters. When such a symbol appears as a factor in a product, it is recommended that it be separated from the other symbols by a space, by a multiplication sign or by brackets.

1. Dimensionless parameters : momentum transport

Item No.	Symbol	Name	Definition	Remarks
12-1	Re	Reynolds number	$Re = \frac{\varrho v l}{\eta} = \frac{v l}{\nu}$	
12-2	Eu	Euler number	$Eu = \frac{\Delta p}{\varrho v^2}$	
12-3	Fr	Froude number	$Fr = \frac{v}{\sqrt{lg}}$	Sometimes called Reech number.
12-4	Gr	Grashof number	$Gr = \frac{l^3 g \gamma \Delta\theta}{\nu^2}$	$-\frac{\Delta\varrho}{\varrho} = \gamma\Delta\theta$
12-5	We	Weber number	$We = \frac{\varrho v^2 l}{\sigma}$	
12-6	Ma	Mach number	$Ma = \frac{v}{c}$	
12-7	Kn	Knudsen number	$Kn = \frac{\lambda}{l}$	
12-8	Sr	Strouhal number	$Sr = \frac{lf}{v}$	

2. Dimensionless parameters : transport of heat

Item No.	Symbol	Name	Definition	Remarks
12-9	Fo	Fourier number	$Fo = \frac{\lambda t}{c_p \varrho l^2} = \frac{at}{l^2}$	
12-10	Pe	Péclet number	$Pe = \frac{\varrho c_p v l}{\lambda} = \frac{v l}{a}$	$Pe = Re \cdot Pr$
12-11	Ra	Rayleigh number	$Ra = \frac{l^3 \varrho^2 c_p g \gamma \Delta\theta}{\eta\lambda} = \frac{l^3 g \gamma \Delta\theta}{\nu a}$	$Ra = Gr \cdot Pr$
12-12	Nu	Nusselt number	$Nu = \frac{hl}{\lambda}$	
12-13	St	Stanton number	$St = \frac{h}{\varrho v c_p}$	$St = Nu/Pe$ Sometimes called Margoulis number : Ms. $j = St \cdot Pr^{2/3}$ is called heat transfer factor.

Symbols used in the definitions of section 1

Symbol	Name of quantity	Reference in ISO 31
l	a characteristic length	1-3.1
v	a characteristic velocity	1-9.1
$\Delta\theta$	a characteristic temperature difference	4-2.1
Δp	pressure difference	3-13.1
θ	temperature	4-2.1
ϱ	density (mass density)	3-2.1
η	viscosity (dynamic viscosity)	3-21.1
ν	kinematic viscosity : η/ϱ	3-22.1
σ	surface tension	3-23.1
g	acceleration of free fall	1-10.2
γ	cubic expansion coefficient : $-\frac{1}{\varrho}\left(\frac{\partial\varrho}{\partial\theta}\right)_p$	4-3.2
λ	mean free path	8-37.1
f	a characteristic frequency	2-3.1
c	velocity of sound	7-13.1

Symbols used in the definitions of section 2

Symbol	Name of quantity	Reference in ISO 31
l	a characteristic length	1-3.1
v	a characteristic velocity	1-9.1
t	a characteristic time interval	1-6.1
$\Delta\theta$	a characteristic temperature difference	4-2.1
g	acceleration of free fall	1-10.2
θ	temperature	4-2.1
ϱ	density (mass density)	3-2.1
η	viscosity (dynamic viscosity)	3-21.1
ν	kinematic viscosity : η/ϱ	3-22.1
c_p	specific heat capacity at constant pressure	4-15.2
γ	cubic expansion coefficient : $-\frac{1}{\varrho}\left(\frac{\partial\varrho}{\partial\theta}\right)_p$	4-3.2
λ	thermal conductivity	4-9.1
a	thermal diffusivity : $\lambda/\varrho c_p$	4-13.1
h	coefficient of heat transfer : heat/(time × cross sectional area × temperature difference)	4-10.1

3. Dimensionless parameters : transport of matter in a binary mixture

Item No.	Symbol	Name	Definition	Remarks
12-14	Fo^*	Fourier number for mass transfer	$Fo^* = \frac{Dt}{l^2}$	$Fo^* = Fo/Le$ Compare item 12-9.
12-15	Pe^*	Péclet number for mass transfer	$Pe^* = \frac{vl}{D}$	$Pe^* = Re \cdot Sc = Pe \cdot Le$ Compare item 12-10.
12-16	Gr^*	Grashof number for mass transfer	$Gr^* = \frac{l^3 g \beta \Delta x}{\nu^2}$	Compare item 12-4. $-\frac{\Delta \varrho}{\varrho} = \gamma \Delta\theta + \beta \Delta x$
12-17	Nu^*	Nusselt number for mass transfer	$Nu^* = \frac{kl}{\varrho D}$	Sometimes called Sherwood number : Sh. Compare item 12-12.
12-18	St^*	Stanton number for mass transfer	$St^* = \frac{k}{\varrho v}$	$St^* = Nu^*/Pe^*$ Compare item 12-13. $j_m = St^* \cdot Sc^{2/3}$ is called mass transfer factor.

4. Dimensionless constants of matter

Item No.	Symbol	Name	Definition	Remarks
12-19	Pr	Prandtl number	$Pr = \frac{\eta c_p}{\lambda} = \frac{\nu}{a}$	
12-20	Sc	Schmidt number	$Sc = \frac{\eta}{\varrho D} = \frac{\nu}{D}$	
12-21	Le	Lewis number	$Le = \frac{\lambda}{\varrho c_p D} = \frac{a}{D}$	$Le = Sc/Pr$

Symbols used in the definitions of section 3

Symbol	Name of quantity	Reference in ISO 31
l	a characteristic length	1-3.1
v	a characteristic velocity	1-9.1
t	a characteristic time interval	1-6.1
Δx	a characteristic difference of mole fraction	8-15.1
g	acceleration of free fall	1-10.2
ϱ	density (mass density)	3-2.1
ν	kinematic viscosity : η/ϱ	3-22.1
β	$\beta = -\frac{1}{\varrho}\left(\frac{\partial \varrho}{\partial x}\right)_{T,p}$	—
D	diffusion coefficient	8-38.1
k	mass transfer coefficient : mass/(time × cross sectional area × mole fraction difference)	—
γ	cubic expansion coefficient	4-3.2

Symbols used in the definitions of section 4

Symbol	Name of quantity	Reference in ISO 31
ϱ	density (mass density)	3-2.1
η	viscosity (dynamic viscosity)	3-21.1
ν	kinematic viscosity : η/ϱ	3-22.1
D	diffusion coefficient	8-38.1
c_p	specific heat capacity at constant pressure	4-15.2
λ	thermal conductivity	4-9.1
a	thermal diffusivity : $\lambda/\varrho c_p$	4-13.1

5. Dimensionless parameters : magnetohydrodynamics

Item No.	Symbol	Name	Definition	Remarks
12-22	Rm	magnetic Reynolds number	$Rm = \dfrac{vl}{1/\mu\sigma} = v\mu\sigma l$	
12-23	Al	Alfvén number	$Al = \dfrac{v}{v_A}$	$v_A = B/(\varrho\mu)^{1/2}$ is called Alfvén speed.
12-24	Ha	Hartmann number	$Ha = Bl\left(\dfrac{\sigma}{\varrho\nu}\right)^{1/2}$	
12-25	Co	Cowling number	$Co = \dfrac{B^2}{\mu\varrho v^2}$	$Co = (v_A/v)^2 = Al^{-2}$ Often called "second" Cowling number : Co_2. The "first" Cowling number is often defined as : $Co_1 = Ha^2/Re = \dfrac{B^2 l\sigma}{\varrho v} = Co \cdot Rm$

Symbols used in the definitions of section 5

Symbol	Name of quantity	Reference in ISO 31
ϱ	density (mass density)	3-2.1
l	a characteristic length	1-3.1
v	a characteristic velocity	1-9.1
ν	kinematic viscosity : η/ϱ	3-22.1
μ	magnetic permeability	5-24.1
B	magnetic flux density	5-19.1
σ	electric conductivity	5-36.1