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Dimensionless parameters

Paramètres sans dimensions

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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/XII (originally ISO/DIS 2188) was drawn up by Technical Committee ISO/TC 12, *Quantities, units, symbols, conversion factors and conversion tables*, and circulated to the Member Bodies in July 1970.

It has been approved by the Member Bodies of the following countries:

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

No Member Body expressed disapproval of the document.

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INTRODUCTION

General remarks

This document, containing a table of *dimensionless parameters*, is the twelfth part of ISO 31, which is a more comprehensive publication dealing 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 introduction — General principles concerning quantities, units and symbols.*

Part I (2nd edition) : *Basic quantities and units of the SI and quantities and units of space and time.* [1)]

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

Part III : *Quantities and units of mechanics.*

Part IV : *Quantities and units of heat.*

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

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

Part VII : *Quantities and units of acoustics.*

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

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

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

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

Part XII : *Dimensionless parameters.*

Part XIII : *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) The title of the first edition of this document was : "Fundamental quantities and units of the MKSA system and quantities and units of space and time".

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	$Gr = \frac{l^3 g \gamma \Delta\theta}{\nu^2}$	$\frac{\Delta\varrho}{\varrho} = \lambda \Delta\theta$
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	$Fo = \frac{\lambda t}{c_p \varrho l^2} = \frac{a t}{l^2}$	
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	$Nu = \frac{h l}{\lambda}$	
12-13	St	Stanton number	$St = \frac{h}{\varrho v c_p}$	$St = Nu/Pe$ Sometimes called Margoulis number: Ms $j = St \cdot Pr^{\frac{2}{3}}$ 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	1-10.1
$\Delta\theta$	a characteristic temperature difference	4-2.1
Δp	pressure difference	3-11.1
θ	temperature	4-2.1
ϱ	density (mass density)	3-2.1
η	viscosity (dynamic viscosity)	3-19.1
ν	kinematic viscosity: η/ϱ	3-20.1
σ	surface tension	3-21.1
g	acceleration of free fall	1-11.2
γ	cubic expansion coefficient: $-\frac{1}{\varrho}\left(\frac{\partial \varrho}{\partial \theta}\right)_p$	4-3.2
λ	mean free path	8-35.1
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	1-10.1
t	a characteristic time interval	1-6.1
$\Delta\theta$	a characteristic temperature difference	4-2.1
g	acceleration of free fall	1-11.2
θ	temperature	4-2.1
ϱ	density (mass density)	3-2.1
η	viscosity (dynamic viscosity)	3-19.1
ν	kinematic viscosity: η/ϱ	3-20.1
c_p	specific heat capacity at constant pressure	4-11.2
γ	cubic expansion coefficient: $-\frac{1}{\varrho}\left(\frac{\partial \varrho}{\partial \theta}\right)_p$	4-3.2
λ	thermal conductivity	4-7.1
a	thermal diffusivity: $\lambda/\varrho c_p$	4-9.1
h	coefficient of heat transfer: heat/(time × cross sectional area × temperature difference).	4-8.1

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

Item No.	Symbol	Name	Definition	Remarks
12-14	Fo^*	Fourier number for mass transfer	$Fo^* = \frac{D\,t}{l^2}$	$Fo^* = Fo/Le$ Compare item 12-9
12-15	Pe^*	Péclet number for mass transfer	$Pe^* = \frac{v\,l}{D}$	$Pe^* = Re \cdot Sc = Pe \cdot Le$ 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	$Nu^* = \frac{k\,l}{\varrho D}$	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 $j_m = St^* \cdot Sc^{\frac{2}{3}}$ 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	$Le = \frac{\lambda}{\varrho\,c_p\,D} = \frac{a}{D}$	$Le = Sc/Pr$