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Rheology —

Part 1: **General terms and definitions for rotational and oscillatory rheometry**

Réologie —

Partie 1: Termes et définitions générales pour rhéométrie rotational et oscillatoire

ICS: 83.080.01

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 35, *Paints and varnishes*, Subcommittee SC 9, *Generaltest methods for paints and varnishes,* in cooperation with ISO/TC 61, *Plastics*, Subcommittee SC 5, *Physical chemical properties*.

A list of all parts in the ISO 3219 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Rheology —

Part 1: General terms and definitions for rotational and oscillatory rheometry

1 Scope

This document specifies general terms and definitions that are used in the context of rotational and oscillatory rheometry.

Other terms and definitions can be found in the other parts of the standards series where they are used.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1
absolute value of the complex shear modulus
$|G^*|$
ratio of the amplitude of the shear stress τ_0 and the amplitude of the shear strain γ_0

Note 1 to entry: The absolute value of the complex shear modulus $|G^*|$ has the unit pascal (Pa).

3.2
absolute value of the complex shear viscosity
$|\eta^*|$
ratio of the amount of the complex shear modulus $|G^*|$ and the angular frequency ω

Note 1 to entry: The absolute value of the complex shear viscosity $|\eta^*|$ has the unit pascal multiplied by seconds (Pa·s).

3.3
amplitude sweep
oscillatory test with variable amplitude at a constant angular frequency ω

3.4
angular displacement
Φ
angular measure where the angle is indicated by the length of the arc

Note 1 to entry: The angular displacement has the unit radians (rad).

3.5
angular frequency
ω
product of full circle angle 2π and frequency *f*

Note 1 to entry: The angular frequency has the unit radians per second ($rad \cdot s^{-1}$), which is the SI unit, or reciprocal seconds (s^{-1}), which also is very common.

3.6
angular velocity
Ω
temporal change of the angular displacement Φ

Note 1 to entry: The angular velocity Ω has the unit radians per second ($rad \cdot s^{-1}$), the angular displacement Φ has unit radian (rad).

Note 2 to entry: The angular velocity Ω, in radians per second ($rad \cdot s^{-1}$), is linked to rotational speed n, in reciprocal seconds (s^{-1}), via the following relation:

$$\Omega = 2\pi \cdot n$$

3.7
continuous ramp
type of test where the specified variable from the initial value to the final value varies monotonously and constantly during the test

Note 1 to entry: The continuous ramp is performed by linear or logarithmic presetting.

Note 2 to entry: The alternative to the continuous ramp is the step ramp.

3.8
elastic behaviour
elasticity
property of a material to show reversible deformation and storage of energy

3.9
flow curve
graphical representation of the relation between shear stress τ and shear rate $\dot{\gamma}$

3.10
frequency
f
oscillation per unit of time

Note 1 to entry: The frequency f has the unit hertz (Hz), where: 1 Hz is 1 oscillation per second.

Note 2 to entry: The frequency f, in hertz (Hz), is linked to the angular frequency ω via the following relation:

$$f = \frac{\omega}{2\pi}$$

3.11
frequency sweep
oscillatory test with variable angular frequency ω at a constant amplitude

3.12
ideal-elastic behaviour
Hookean behaviour
property of a material to show an immediate, fully reversible recovery after deformation

3.13
in-phase component of the complex shear viscosity
dynamic viscosity
η'
real part of the complex shear viscosityη^*

Note 1 to entry: The dynamic viscosity η' has the unit pascal multiplied by seconds (Pa·s).

3.14
kinematic viscosity
υ
ratio of shear viscosity η and density ρ

Note 1 to entry: The kinematic viscosity υ has the unit square metres per second ($m^2 \cdot s^{-1}$).

3.15
laminar flow
flow where infinitesimally thin layers are moved in parallel to each other

Note 1 to entry: All calculations of rheological parameters for absolute measuring geometries (see ISO 3219-2) only apply on the assumption of laminar flow.

3.16
linear viscoelastic range (LVR)
range where the shear strain γ is proportional to the shear stress τ

3.17
linearity limit
$[\tau_L, \gamma_L]$
point on the curve $\tau(\gamma)$ or $\gamma(\tau)$, above which the ratio of shear stress τ and shear strain γ is not anymore constant

Note 1 to entry: The linearity limit is given as shear stress τ_L with the unit pascal (Pa) and as shear strain γ_L with the unit 1.

3.18
loss angle
phase angle
δ
phase shift between shear stress τ and shear strain γ at a harmonic steady-state excitation

Note 1 to entry: The loss angle δ has the unit degrees (°) or radians (rad).

3.19
loss factor
damping factor
$\tan \delta$
ratio of shear loss modulus G'' and shear storage modulus G'

Note 1 to entry: The loss factor $\tan \delta$ has the unit 1.

3.20
Newtonian flow behaviour
ideal-viscous flow behaviour
behaviour where the shear viscosityη is independent of shear rate $\dot{\gamma}$, shear stress τ and time t

3.21
Newtonian standard sample
sample of a Newtonian liquid whose kinematic viscosity has been measured at one or more temperatures using standard viscometers and whose viscosity values and its traceability to the national standard for the viscosity unit have been documented

Note 1 to entry: Capillary viscometers are used as standard viscometers.

Note 2 to entry: Precondition for a Newtonian liquid is that the change in viscosity with time is sufficiently small.

3.22
non-Newtonian flow behaviour
behaviour where the shear viscosity η is dependent either on shear rate $\dot{\gamma}$ and shear stress τ or on shear rate $\dot{\gamma}$, shear stress τ and time t

3.23
normal force
$\boldsymbol{F_n}$
force acting perpendicularly to the surface of a volume element

Note 1 to entry: The normal force F_n has the unit newton (N).

Note 2 to entry: Normal forces can either be triggered by shear deformation of the sample or be applied by the rheometer. In addition to this, not shear induced normal forces can be caused by the sample preparation or by changes during the measurement (e.g. swelling, drying, and shrinking).

3.24
oscillatory test
test where both shear planes of the measuring geometry harmonically oscillate around the same axis of rotation

3.25
oscillatory test with controlled (shear) strain
oscillatory test with controlled (shear) deformation (CD)
test where the amplitude of the shear deformation γ_0 and the angular frequency ω are given

3.26
oscillatory test with controlled (shear) stress (CS)
test where the amplitude of the shear stress τ_0 and the angular frequency ω are given

3.27
out-of-phase component of the complex shear viscosity
η''
imaginary part of the complex shear viscosity η^*

Note 1 to entry: The out-of-phase component of the complex shear viscosity η''has the unit pascal multiplied by second (Pa·s).

3.28
rheology
science of deformation behaviour and flow behaviour of materials

3.29
rheometry
part of rheology that covers the measurement of deformation behaviour and flow behaviour of materials

3.30
rheopexy
rheopectic behaviour
reversible, time-dependent increase of shear viscosity η at a constant shear rate $\dot{\gamma}$ or shear stress τ

Note 1 to entry: Details on the determination of rheopexy see ISO 3219-3.

3.31
rotational speed
rotational frequency
n
number of rotations per unit time

Note 1 to entry: The rotational speed *n* has the SI unit reciprocal seconds (s^{-1}), in practice it is often given in reciprocal minutes (min^{-1}).

3.32
rotational test
test where both shear planes of the measuring geometry are rotating relative to each other around the same axis of rotation

3.33
rotational test with controlled (shear) rate (CR)
test where the shear rate $\dot{\gamma}$ is given as a function of time *t*

Note 1 to entry: In case there is no absolute measuring geometry (see ISO 3219-2) used, it is a speed-controlled rotational test.

3.34
rotational test with controlled (shear) stress (CS)
test where the shear stress τ is given as a function of time *t*

Note 1 to entry: In case there is no absolute measuring geometry (see ISO 3219-2) used, it is a torque-controlled rotational test.

3.35
shear compliance
J
ratio of shear deformation γ and shear stress τ

Note 1 to entry: The shear compliance *J* is the reverse of the shear modulus *G*.

Note 2 to entry: The shear compliance *J* has the unit reciprocal pascal (Pa^{-1}).

3.36
shear loss modulus
viscous shear modulus
G''
measure of the viscous behaviour of a viscoelastic material

Note 1 to entry: The shear loss modulus *G''* has the unit pascal (Pa).

Note 2 to entry: The shear loss modulus *G''* is the imaginary part of the complex shear modulus *G**.

3.37
shear modulus
G
ratio of shear stress τ and shear strain γ

Note 1 to entry: The shear modulus *G* has the unit pascal (Pa).

3.38
shear rate
shear strain rate
shear deformation rate
$\dot{\gamma}$