INTERNATIONAL STANDARD

ISO 3219-1

First edition
2021-05

Rheology —

Part 1: Vocabulary and symbols for rotational and oscillatory rheometry

Rhéologie —

Partie 1: Vocabulaire et symboles pour la rhéométrie rotative et oscillatoire

Reference number
ISO 3219-1:2021(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established 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. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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, *General test methods for paints and varnishes*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 139, *Paints and varnishes*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement), and in cooperation with ISO/TC 61, *Plastics*, Subcommittee SC 5, *Physical-chemical properties*.

This first edition cancels and replaces the second edition (ISO 3219:1993), which has been technically revised.

The main changes compared to the previous edition are as follows:

— the terms and definitions have been moved to ISO 3219-1, the general principles have been moved to ISO 3219-2;

— new terms and definitions have been added;

— Table 1 on symbols has been added.

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: **Vocabulary and symbols 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.

Further terms and definitions can be found in the other parts of the ISO 3219 series where they are used.

2 Normative references

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 https://www.iso.org/obp

3.1
absolute value of the complex shear modulus
$|G^*|$
ratio of the amplitude of the *shear stress* τ_0 (3.41) and the amplitude of the *shear strain* γ_0 (3.40)

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 $|G^*|$ (3.1) and the *angular frequency* ω (3.5)

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 (3.5)

3.4
angular displacement
angular deflection
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
temporal change of the *angular displacement* *φ* (3.4) in oscillation

Note 1 to entry: The angular frequency *ω* has the unit radians per second ($rad{\cdot}s^{-1}$) or, since rad is dimensionless (i.e. metre divided by metre), the unit reciprocal seconds (s^{-1}).

Note 2 to entry: The angular frequency *ω*, in reciprocal seconds (s^{-1}), is linked to the frequency *f*, in hertz (Hz) or in reciprocal seconds (s^{-1}), via the following relation:

$$\omega = 2\pi \cdot f$$

3.6
angular velocity
Ω
temporal change of the *angular displacement* *φ* (3.4) in rotation

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

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: An alternative to the continuous ramp is the *step ramp* (3.46).

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

3.9
flow curve
graphical representation of the relation between *shear stress* *τ* (3.41) and *shear rate* $\dot{\gamma}$ (3.38)

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) or in reciprocal seconds (s^{-1}), is linked to the *angular frequency* *ω* (3.5) in reciprocal seconds (s^{-1}) via the following formula:

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

3.11
frequency sweep
oscillatory test (3.24) with variable *angular frequency* *ω* (3.5) at a constant amplitude

3.12
ideal-elastic behaviour
Hookean behaviour
property of a material to show an immediate, fully reversible recovery after *deformation* (3.47)

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

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 (3.42) 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 (3.40) is proportional to the *shear stress* τ (3.41)

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 (3.41) and *shear strain* γ (3.40) 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 which is dimensionless.

3.18
loss angle
phase angle
δ
phase shift between *shear stress* τ (3.41) and *shear strain* γ (3.40) 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'' (3.36) and *shear storage modulus* G' (3.39)

Note 1 to entry: The loss factor $\tan \delta$ is dimensionless.

3.20
Newtonian flow behaviour
ideal-viscous flow behaviour
behaviour where the *shear viscosity* η (3.42) is independent of *shear rate* $\dot{\gamma}$ (3.38), *shear stress* τ (3.41) and time t

3.21
Newtonian standard sample
sample of a Newtonian liquid whose viscosity values and its traceability to a national measurement standard for the viscosity unit have been documented

3.22
non-Newtonian flow behaviour
behaviour where the *shear viscosity* η (3.42) is dependent on *shear rate* $\dot{\gamma}$ (3.38), *shear stress* τ (3.41) and/or time t

3.23
normal force
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* (3.40) 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
oscillatory test with CD
oscillatory test where the amplitude of the *shear deformation* γ_0 (3.40) and the *angular frequency* ω (3.5) are given

3.26
oscillatory test with controlled (shear) stress
oscillatory test with CS
oscillatory test where the amplitude of the *shear stress* τ_0 (3.41) and the *angular frequency* ω (3.5) 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* (3.47) behaviour and flow behaviour of materials

3.29
rheometry
part of *rheology* (3.28) that covers the measurement of *deformation* (3.47) behaviour and flow behaviour of materials

3.30
rheopexy
rheopectic behaviour
reversible, time-dependent increase of *shear viscosity* η (3.42) at a constant *shear rate* $\dot{\gamma}$ (3.38) or *shear stress* τ (3.41)

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
rotational test with CR
rotational test where the *shear rate* $\dot{\gamma}$ (3.38) 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* (3.32).

3.34
rotational test with controlled (shear) stress
rotational test with CS
rotational test where the *shear stress* τ (3.41) 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* (3.32).

3.35
shear compliance
J
ratio of *shear deformation* γ (3.40) and *shear stress* τ (3.41)

Note 1 to entry: The shear compliance J is the reverse of the *shear modulus* G (3.37).

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* (3.54) 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 (3.41) and *shear strain* γ (3.40)

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

3.38
shear rate
shear strain rate
shear deformation rate
$\dot{\gamma}$
time dependent change of the *shear strain* γ (3.40)

Note 1 to entry: The shear rate $\dot{\gamma}$ has the unit reciprocal seconds (s^{-1}).

3.39
shear storage modulus
elastic shear modulus
G'
measure of the *elastic behaviour* (3.8) of a viscoelastic material

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

Note 2 to entry: The shear storage modulus G' is the real part of the complex shear modulus G^*.

3.40
shear strain
shear deformation
γ
deformation of the sample caused by tangential displacement

Note 1 to entry: The shear strain γ is dimensionless. Alternatively, it is stated as a percentage (%), where 100 % = 1.

3.41
shear stress
τ
ratio of tangentially acting force and shear plane

Note 1 to entry: The shear stress τ has the unit pascal (Pa).

Note 2 to entry: An alternative symbol is σ.

3.42
shear viscosity
η
ratio of *shear stress* τ (3.41) and *shear rate* $\dot{\gamma}$ (3.38):

$$\eta = \frac{\tau}{\dot{\gamma}}$$

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

3.43
shear-thickening flow behaviour
dilatant flow behaviour
property of a material to show increasing *steady-state shear viscosity* η_{st} (3.45) with increasing *shear rate* $\dot{\gamma}$ (3.38) or *shear stress* τ (3.41)

3.44
shear-thinning flow behaviour
pseudoplastic flow behaviour
property of a material to show decreasing *steady-state shear viscosity* η_{st} (3.45) with increasing *shear rate* $\dot{\gamma}$ (3.38) or *shear stress* τ (3.41)