International Standard

ISO 19613

Fine ceramics (advanced ceramics, advanced technical ceramics) — Measurement of viscosity of ceramic slurry by use of a rotational viscometer

Céramiques techniques — Mesure de la viscosité des céramiques en suspension au moyen d'un viscosimètre rotatif

Second edition
2026-09

Reference number
ISO 19613:2026(en)

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Published in Switzerland

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Foreword

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This document was prepared by Technical Committee ISO/TC 206, *Fine ceramics*.

This second edition cancels and replaces the first edition (ISO 19613:2018), which has been technically revised.

The main changes are as follows:

— clarification added to the scope;

— paragraph addition in the Apparatus section on the use of different geometries;

— paragraph addition in the Measurement condition on the choice of the shear rate range;

— reorganisation of the Pretreatment of the sample section;

— rewriting the Measurement procedure section to include the identification of the fluid behaviour.

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.

Fine ceramics (advanced ceramics, advanced technical ceramics) — Measurement of viscosity of ceramic slurry by use of a rotational viscometer

1 Scope

This document specifies a method for measurement of the viscosity of a ceramic slurry using a rotational viscometer. The method only involves rotations with a monotonic angle variation. This document does not apply to measurements using an oscillating rotation.

Ceramic slurry is used in ceramic processes such as dip coating, spray coating, screen printing, slip casting, tape casting, spray drying and polishing. This document does not apply to dispersion of fillers in molten thermoplastic polymers.

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.

ISO 20507, *Fine ceramics (advanced ceramics, advanced technical ceramics) — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 20507 and the following apply.

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

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

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

3.1
shear stress
stress acting on planes parallel to the direction of flow when the fluid is subject to laminar flow

Note 1 to entry: The SI units are Pascal (Pa).

3.2
shear rate
gradient of laminar flow rate perpendicular to the fluid flow

Note 1 to entry: The SI units are s^{-1}.

3.3
viscosity
ratio of *shear stress* (3.1) to *shear rate* (3.2)

Note 1 to entry: This ratio is representative of the internal resistance of the fluid to flow.

Note 2 to entry: The SI unit of viscosity is Pa × s.

Note 3 to entry: mPa × s = 1 cP in terms of c.g.s. units [where 1P = 1 g/(cm × s)].

Note 4 to entry: Viscosity is sometimes called ‘dynamic viscosity’ or ‘shear viscosity’ for clarification. The measured viscosity is conventionally called ‘apparent viscosity’ since the gradient of shear rate is not identical for all parts of the spindle.

3.4
Newtonian fluid
fluid in which shear stress is proportional to shear rate

Note 1 to entry: The ratio of shear stress to shear rate is viscosity.

3.5
non-Newtonian fluid
fluid in which shear stress is not proportional to shear rate

Note 1 to entry: The non-Newtonian behaviour can be determined by measuring shear stress using varying shear rate (or angular velocity). Viscosity of the non-Newtonian fluid changes with the shear rate, in contrast with Newtonian fluid, which has constant viscosity with the shear rate.

3.6
thixotropy
flow behaviour of fluid that shows time dependence, such that the apparent viscosity decreases with time for a constant shear rate, and recovers slowly with withdrawal of the shear force

3.7
shear thickening
<dilatant> increase of shear viscosity of fluid when the shear rate (or stress) is increased

3.8
shear thinning
<pseudoplasticity> decrease of shear viscosity of fluid when the shear rate (or stress) is increased

3.9
Bingham plastic
linear shear stress/shear rate relationship starting from a finite yield stress value below which the fluid does not flow

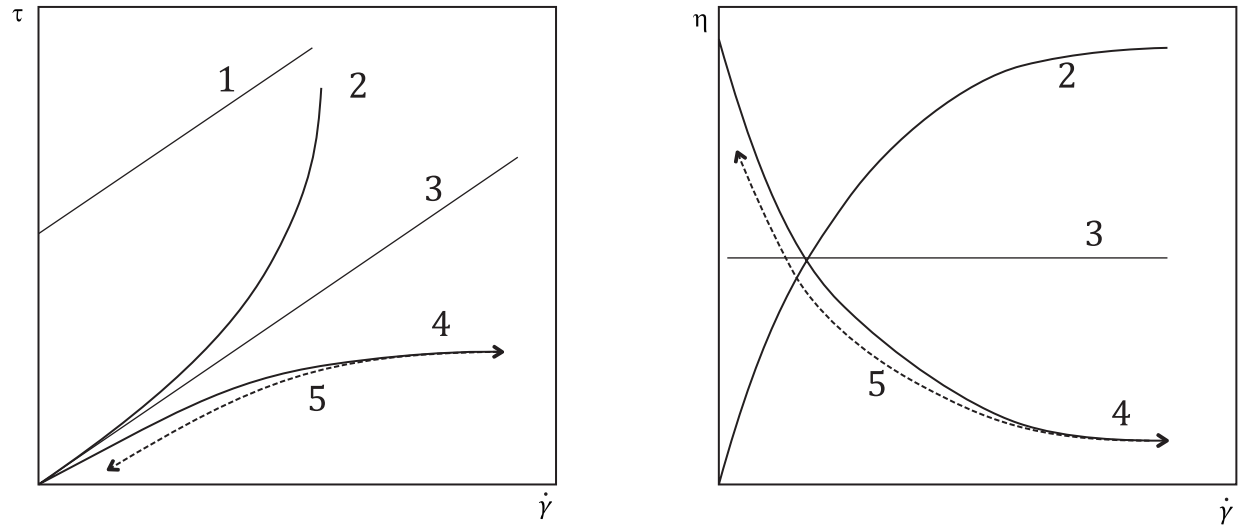
Note 1 to entry: The linear relationship is usually valid on a limited rage of shear rate.

3.10
flow curve
curve showing the relationship between shear rate and shear stress

Note 1 to entry: See Figure 1 a).

3.11
viscosity curve
curve showing the relationship between shear rate (or shear stress) and viscosity

Note 1 to entry: See Figure 1 b).



a) Flow curve **b) Viscosity curve**

Key

$\dot{\gamma}$	shear rate
τ	shear stress
η	viscosity
1	Bingham plastic
2	shear thickening (dilatant)
3	newtonian
4	shear thinning (pseudoplastic)
5	thixotropy (time dependent)

Figure 1 — Summary of rheological behaviours

3.12
ceramic slurry
suspension of grinding frit, clay or ceramic powders mixed or dispersed in water or other liquid. It includes colloidal suspension, slip and paste

Note 1 to entry: The category may include low-viscosity colloids with small particles with sizes in the nanometre or micrometre range, and high-viscosity pastes with inhomogeneous mixtures.

4 Principle

4.1 Rotational viscometer with defined shear rate

The viscosity, η, of a ceramic slurry measured using a rotational viscometer with a defined shear rate is determined using Formula (1):

$$\eta = \frac{\tau}{\dot{\gamma}} \tag{1}$$

where

η is the viscosity, in Pa × s;
τ is the shear stress, in Pa;
$\dot{\gamma}$ is the shear rate, in s^{-1}.

NOTE Symbols are in accordance with ISO 80000-4.