

Plastics — Determination of the transient extensional viscosity of polymer melts

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National foreword

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Summary of pages

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*Plastiques — Détermination de la viscosité élongationnelle transitoire
des polymères à l'état fondu*



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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.

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ISO 20965 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 5, *Physical-chemical properties*.

Plastics — Determination of the transient extensional viscosity of polymer melts

1 Scope

This International Standard specifies the general principles of a method for determining the transient extensional viscosity of polymer melts. The procedure details the measurement of polymer melt specimens stretched uniaxially under conditions of constant strain rate and constant temperature.

The method is capable of measuring the transient extensional viscosity of polymer melts at Hencky strain rates typically in the range $0,01 \text{ s}^{-1}$ to 1 s^{-1} , at Hencky strains up to approximately 4 and at temperatures up to approximately $250 \text{ }^{\circ}\text{C}$ (see Notes 1 and 2). It is suitable for measuring transient extensional viscosity values typically in the range from approximately $10^4 \text{ Pa}\cdot\text{s}$ to $10^7 \text{ Pa}\cdot\text{s}$ (see Note 3).

NOTE 1 Hencky strains and strain rates are used (see Clause 3).

NOTE 2 Values of strain, strain rate and temperature outside these limiting values may be attained.

NOTE 3 The operating limit of an instrument, in terms of the lowest transient extensional viscosity values that can be measured, is due to a combination of factors, including the ability of the specimen to maintain its shape during testing and the resolution of the instrument.

A list of documents related to this International Standard is given in the Bibliography.

2 Normative references

The following referenced documents are indispensable for the application 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 472, *Plastics — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 472, together with the following, apply.

Definitions 3.1 to 3.5 are given by Whorlow^[1] for strains and strain rates, and by the Nomenclature Committee of the Society of Rheology for start-up flow in tensile uniaxial extension at constant Hencky strain rate^[2].

3.1

Hencky strain

ε

strain given by the natural logarithm of the elongation ratio

$$\varepsilon = \ln(l/l_0) \quad (1)$$

where l is the specimen length and l_0 is the original specimen length

NOTE 1 It is also referred to as the natural or true strain.

NOTE 2 It is dimensionless.

3.2 Hencky strain rate

$\dot{\epsilon}$
rate of change of Hencky strain with time, given by

$$\dot{\epsilon} = 1/l \times \partial l / \partial t \quad (2)$$

where t is time

NOTE 1 It is independent of the original specimen length l_0 .

NOTE 2 It is expressed in reciprocal seconds.

3.3 net tensile stress

σ_E
for tensile uniaxial extension, stress given by

$$\sigma_E = \sigma_{11} - \sigma_{22} = \sigma_{11} - \sigma_{33} = \sigma_{zz} - \sigma_{rr} \quad (3)$$

where σ_{ii} is a stress tensor in either rectangular or axisymmetric co-ordinates

NOTE 1 The tensile stress growth function is indicated by σ_E^+ where the $^+$ indicates start-up of flow.

NOTE 2 Net tensile stress is expressed in pascals.

3.4 tensile stress growth coefficient

η_E^+
ratio of the net tensile stress to the Hencky strain rate

$$\eta_E^+(t, \dot{\epsilon}) = \sigma_E / \dot{\epsilon} \quad (4)$$

for tensile uniaxial extension, where t is time and $^+$ indicates start-up of flow

NOTE 1 It is also known for the purposes of this International Standard as “transient extensional viscosity”.

NOTE 2 It is a transient term.

NOTE 3 It is expressed in pascal seconds.

3.5 tensile viscosity

η_E
term given by

$$\eta_E(t, \dot{\epsilon}) = \lim_{t \rightarrow \infty} [\eta_E^+(t, \dot{\epsilon})] \quad (5)$$

NOTE 1 It is the limiting tensile stress growth coefficient value and represents an equilibrium extensional viscosity if a steady value is achieved. However, for materials that do not exhibit a steady-state behaviour, the use of an “equilibrium extensional viscosity” such as this is not appropriate.

NOTE 2 It is expressed in pascal seconds.