SIST

SLOVENSKI STANDARD
SIST EN 17408:2020

01-november-2020

Ugotavljanje sipkosti in uporabnosti viskoelastičnih lepil z uporabo oscilacijske reometrije

Determination of the flowability and application behaviour of viscoelastic adhesives using the oscillatory rheometry

Bestimmung des Fließ- und Applikationsverhaltens von viskoelastischen Klebstoffen mit Hilfe der Oszillationsrheometrie

Détermination de l'attitude du fluage et de l'application des adhésifs viscoélastiques avec la méthode de la rhéologie oscillométrique

Ta slovenski standard je istoveten z: EN 17408:2020

ICS:

83.180	Lepila	Adhesives

SIST EN 17408:2020 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 17408

September 2020

ICS 83.180

English Version

Determination of the flowability and application behaviour of viscoelastic adhesives using the oscillatory rheometry

Détermination de l'aptitude à l'écoulement et à l'application des adhésifs viscoélastiques avec la méthode de la rhéologie oscillométrique

Bestimmung des Fließ- und Applikationsverhaltens von viskoelastischen Klebstoffen mit Hilfe der Oszillationsrheometrie

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

Ref. No. EN 17408:2020 E

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European foreword

This document (EN 17408:2020) has been prepared by Technical Committee CEN/TC 193 “Adhesives”, the secretariat of which is held by UNE.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2021, and conflicting national standards shall be withdrawn at the latest by March 2021.

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1 Scope

This document specifies a measuring method for the characterization of rheological properties of structural adhesives using oscillatory rheometry. Moreover, the testing procedure can be applied to the reactive mixture of several components or the components of a reactive bonding paste material. The advantage of the method in comparison to rotational viscometry measurements lies in the separation of elastic and viscous material properties, thus allowing the defining of the viscoelastic properties. This enables more precise information concerning the flow behaviour of the materials, thereby resulting in a better understanding of their processing properties.

The method described is particularly suitable for filled and paste-like adhesives. These are frequently processed using automated pump and application systems in industrial applications and will be set precisely considering their rheological properties. As the rheological behaviour of uncured adhesives is mostly independent of their properties in the cured state, the document can also serve for the examination of non-structural adhesives.

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.

EN 923, *Adhesives - Terms and definitions*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 923 and the following 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
shear deformation
γ
relation of deflection s to the distance between the plates geometry or gap width H of a sample located between two plates at linear deflection of the upper plate in accordance with the tangent of the angle of deflection φ (see Figure 1)

$$\gamma = s / H = \tan(\varphi) \qquad (1)$$

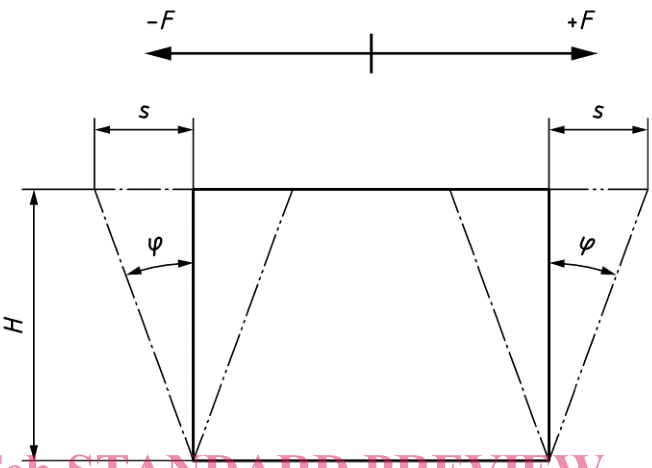

Figure 1 — Deflection s and angle of deflection φ of the test portion in the shear gap H [1]

Note 1 to entry: For a circular deflection in the plate/plate measuring system of a rheometer, this relation only applies for an infinitesimal surface element. The deflection here depends on the distance to the axis of rotation and is hence not uniform within the shear gap. The deformation value is, therefore, usually related to the plate edge (i.e. to r_{max}), sometimes also to a mean distance to the axis of rotation (e.g. 2/3 r_{max}). In this document, the plate edge is used as a reference value. The cone/plate configuration yields a constant deformation based on the gap width H raise equivalent to the deflection s increasing outwards in the entire shear gap.

3.2
deformation function
$\gamma(t)$
mathematical representation of the sinusoidal change in the deformation during oscillatory tests with controlled deformation

$$\gamma(t) = \gamma_A \sin(\omega t) \qquad (2)$$

where

$\gamma(t)$ is the deformation at the time point t;

γ_A is the maximum deformation (deformation amplitude);

ω is the angular frequency, in rad/s, with $\omega = 2\,\pi\,f$.

3.3
shear stress function
τ (t)
the deformation as phase-shifted sinusoidal function of the shear stress related to the response of the sample located in the gap (see Figure 2)

$$\tau\left(t\right)=\tau_A \sin\left(\omega\, t+\ \delta\right) \tag{3}$$

where

τ (t) is the shear stress at the time point t;

τ_A is the maximum shear stress (shear stress amplitude);

ω is the angular frequency, in rad/s, with $\omega = 2\,\pi\,f$;

δ is the angle phase shift (loss angle).

Note 1 to entry: In the case of ideal-elastic behaviour (according to Hooke), the loss angle δ is 0°, i.e. deformation and shear stress are always in the same phase. Maximum shear stress is measured at maximum deformation. In the case of ideal-viscous behaviour (according to Newton), the loss angle δ = is 90°, i.e. the shear stress curve is ahead of the deformation curve by 90°. The maximum shear stress at deformation zero results here, i.e. at highest angular velocity of the test specimen.

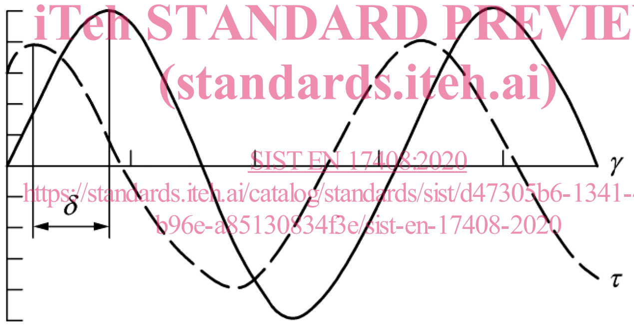

Figure 2 — Deformation and shear stress function during oscillation test [3]

3.4
storage modulus
G'
calculated from the energy stored during deformation, completely available for recovering after the end of the deformation process

$$G' = \frac{\tau_A}{\gamma_A} \cos(\delta) \tag{4}$$

where

τ_A is the maximum shear stress (shear stress amplitude);

γ_A is the maximum deformation (deformation amplitude);

δ is the angle phase shift (loss angle).

Note 1 to entry: The storage modulus represent the elastic portion of the applied energy and describes a typical solid property (solid like).

3.5
loss modulus
G''
calculated from the energy irreversibly consumed during the deformation, dissipated as heat

$$G'' = \frac{\tau_A}{\gamma_A} \sin(\delta) \tag{5}$$

where

τ_A is the maximum shear stress (shear stress amplitude);

γ_A is the maximum deformation (deformation amplitude);

δ is the angle phase shift (loss angle).

Note 1 to entry: The loss modulus represents the viscous (liquid like) portion of the applied energy dissipated as heat or work.

3.6
complex shear modulus
*G**
vector sum of storage modulus *G′* and loss modulus *G′′*

$$G^* = \tau(t) / \gamma(t) = G' + i \cdot G'' \quad (6)$$

$$|G^*| = \sqrt{G'^2 + G''^2} \quad (7)$$

where

$\tau(t)$	is the shear stress at the time point *t*;
$\gamma(t)$	is the deformation at the time point *t*;
G'	is the storage modulus;
G''	is the loss modulus;
i	is the imaginary part.

Note 1 to entry: When performing oscillatory tests on ideally elastic materials, i.e. completely inflexible, stiff and rigid solids, Hooke's Law applies, as indicated in Formula (6).

Note 2 to entry: All kinds of materials have a viscoelastic behaviour, this consists of a viscous and an elastic portion. Their sum is the complex shear modulus *G**, represented in the 'complex plane' (see Figure 3).

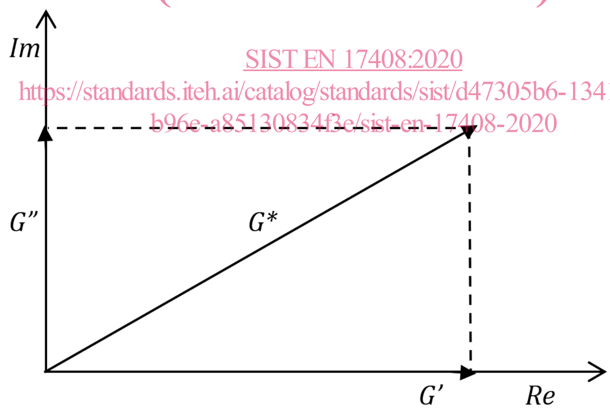

Figure 3 — Vector diagram showing *G′*, *G′′* and the resulting vector *G**

Note 3 to entry: This plane is spread out using the 'real axis' (x-axis) and the 'imaginary axis' (y-axis) and the imaginary unit $i = \sqrt{-1}$ is the 'negative root' that characterizes the complex number.

3.7
loss factor
tan (δ)
calculated as the quotient of loss modulus and storage modulus

$$tan(\delta) = G''/G' \quad (8)$$

where

G' is the storage modulus;

G'' is the loss modulus.

Note 1 to entry: The loss factor corresponds to the ratio between dissipated and reversibly stored deformation energy.

3.8
complex viscosity
η^*
ratio between the time-dependent values of the stress and deformation of shear rate

$$\eta^* = \tau(t) / \dot{\gamma}(t) \quad (9)$$

where

$\tau(t)$ is the shear stress at the time point t;

$\dot{\gamma}(t)$ is the deformation or shear rate at the time point t.

Note 1 to entry: The complex viscosity is linked to the amount of the complex shear modulus via a simple relation as shown in Formula 10.

$$|\eta^*| = |G^*| / \omega \ (\text{with } \omega = 2\pi f) \quad (10)$$

Note 2 to entry: Similar to the complex shear modulus, the complex viscosity also comprises an elastic and a viscous component or better it is a sum of the real part η' and imaginary part η''.