INTERNATIONAL STANDARD

ISO 3521

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Plastics — Unsaturated polyester and epoxy resins — Determination of overall volume shrinkage

Plastiques — Résines d'époxydes et de polyesters non saturés — Détermination du retrait global en volume

Reference number
ISO 3521:1997(E)

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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 3521 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 12, *Thermosetting materials*.

This second edition cancels and replaces the first edition (ISO 3521:1976), of which it constitutes a technical revision.

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Plastics — Unsaturated polyester and epoxy resins — Determination of overall volume shrinkage

1 Scope

This International Standard specifies a method for the determination of the overall volume shrinkage of unsaturated polyester and epoxy resins.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 1675:1985, *Plastics — Liquid resins — Determination of density by the pyknometer method.*

3 Definition

For the purposes of this International Standard, the following definition applies.

3.1 overall volume shrinkage: The sum of the shrinkage during curing and the shrinkage after curing of a casting when cooled to ambient temperature.

4 Principle

The overall volume shrinkage is calculated from the specific gravity of a last specimen before and after curing.

First, the specific gravity of the resin composition is determined

a) at the initial temperature of mixing of the components, excluding the initiators normally added to unsaturated polyesters (see 6.1.3, note 1);

b) at 23 °C after curing and conditioning of the last specimen.

The overall volume shrinkage is then calculated as a percentage of the change in the specific gravity before and after curing, as follows:

$$\text{Overall volume shrinkage} = \frac{\text{Uncured specific gravity} - \text{Cured specific gravity}}{\text{Uncured specific gravity}} \times 100$$

The specific gravity at the moment of mixing is determined for the mixed components at known intervals and the results extrapolated to zero time.

For components that react at elevated temperature, the specific gravity of the mixture is determined by calculation from the individual specific gravities of the components.

The specific gravity at 23 °C of the last specimen after curing and conditioning is determined by weighing in silicone oil.

5 Apparatus

5.1 Balance, accurate to 1 mg, with a device for measurement of specific gravity (if possible, a rapid-acting balance).

5.2 Sinker, weighing 25 g ± 5 g, and of dimensions such that wall effects are avoided. Its volume at the curing temperature and its volume at 23 °C ± 0,1 °C shall be known.

5.3 Temperature-stabilized silicone-oil bath, containing oil whose specific gravity at the hardening temperature and at 23 °C ± 0,1 °C is known.

5.4 Test tubes, length approximately 180 mm, diameter 20 mm.

5.5 Stopwatch.

5.6 Desiccator.

6 Procedure

6.1 Determination of specific gravity of compositions that cure at temperatures higher than ambient

6.1.1 Preparation of apparatus

Determine, to an accuracy of ± 10^{-3} ml, the volume V_S of the sinker at the curing temperature of the composition. Weigh the sinker in air at ambient temperature (mass m_S). Then weigh the sinker together with its suspension wire in silicone oil maintained at the curing temperature of the composition (mass m_{S+W}).

Determine the mass (mass m_W) of the suspension wire in air at ambient temperature.

If the specific gravity of the silicone oil at the curing temperature of the composition is not known, determine it in accordance with ISO 1675 but at the curing temperature.

6.1.2 Epoxy resins

Weigh out each of the components in the proportions used to form the composition, taking a quantity large enough to carry out the determination described below and to cast the test specimen prepared in 6.3.

Heat each of the components separately to the curing temperature. Mix the components, starting the stopwatch immediately after the introduction of the last component. This moment is taken as zero time. Continue to mix until a homogeneous mixture is obtained, then pour the mixture into the test tube all at once. Hang the sinker (preheated to the curing temperature) in the mixture and note the total mass (m_{S+W}), i.e. the apparent mass of the sinker and its suspension wire, after each of a series of equal intervals of time. The length of the time interval and the number of readings taken will depend on the composition being examined.