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Textile glass reinforced plastics — Sheet moulding compound (SMC) — Basis for a specification

Plastiques renforcés au verre textile — Mats préimprégnés SMC — Base de spécification

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Contents

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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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 8605 was prepared by Technical Committee ISO/TC 61, *Plastics*.

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Textile glass reinforced plastics — Sheet moulding compound (SMC) — Basis for a specification

1 Scope

This International Standard establishes a basis for a specification for sheet moulding compound (SMC) used in the production of composite parts by hot moulding.

It applies only to sheet moulding compound having glass fibres as the sole or main reinforcement.

It should be noted that the term sheet moulding compound covers products which can be complex mixtures and which may differ from the definition of "mat" given in ISO 472.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were 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 editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 62:1980, *Plastics — Determination of water absorption.*

ISO 75:1987, *Plastics and ebonite — Determination of temperature of deflection under load.*

ISO 178:1975, *Plastics — Determination of flexural properties of rigid plastics.*

ISO 179:1982, *Plastics — Determination of Charpy impact strength of rigid materials.*

ISO 180:1982, *Plastics — Determination of Izod impact strength of rigid materials.*

ISO 291:1977, *Plastics — Standard atmospheres for conditioning and testing.*

ISO 472:1988, *Plastics — Vocabulary.*

ISO 604:1973, *Plastics — Determination of compressive properties.*

ISO 1172:1975, *Textile glass reinforced plastics — Determination of loss on ignition.*

ISO 1183:1987, *Plastics — Methods for determining the density and relative density of non-cellular plastics.*

ISO 1268:1974, *Plastics — Preparation of glass fibre reinforced, resin bonded, low-pressure laminated plates or panels for test purposes.*

ISO 1886:1980, *Textile glass — Method of sampling applicable to batches.*

ISO 2577:1984, *Plastics — Thermosetting moulding materials — Determination of shrinkage.*

ISO 3268:1978, *Plastics — Glass reinforced materials — Determination of tensile properties.*

ISO 3672-1:1979, *Plastics — Unsaturated polyester resins — Part 1: Designation.*

ISO 3673-1:1980, *Plastics — Epoxide resins — Part 1: Designation.*

ISO 4585:—[1], *Textile glass reinforced plastics — Determination of apparent interlaminar shear properties by short-beam test.*

IEC 93:1980, *Methods of test for volume resistivity and surface resistivity of solid electrical insulating materials.*

1) To be published.

IEC 112:1979, *Method for determining the comparative and the proof tracking indices of solid insulating materials under moist conditions.*

IEC 243:1967, *Recommended methods of test for electric strength of solid insulating materials at power frequencies.*

IEC 250:1969, *Recommended methods for the determination of the permittivity and dielectric dissipation factor of electrical insulating materials at power, audio and radio frequencies including metre wavelengths.*

IEC 695-2-1:1980, *Fire hazard testing — Part 2: Test methods — Glow-wire test and guidance.*

3 Definition

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

sheet moulding compound (SMC): A homogeneous mixture of resin and chopped and/or unchopped reinforcement, with or without fillers, produced in sheet form in thicknesses generally between 1 mm and 25 mm, and capable of being cured by moulding under heat and pressure.

NOTE 1 Additives may be added to the mixture to obtain an SMC with specific properties.

4 Classification of SMC

4.1 General

A large number of combinations of resin systems, reinforcements, additives and fillers are necessary in order to manufacture a wide variety of different types of moulded part, each of which requires a well defined composition to give it its particular

— shape,

— mechanical properties,

— electrical properties,

— colour and

— surface finish.

In view of this large number of possible combinations, two systems of classification are proposed:

— the first one based on the composition,

— the second one based on the shrinkage.

4.2 Classification based on composition

4.2.1 Resin (matrix)

Various types of resin can be used, such as:

— unsaturated polyester resin (UP);

— epoxide resin (EP);

— polyurethane resin (PUR);

— vinyl ester resin (VE);

— phenolic resin (P).

For a description of the resin concerned, refer to the relevant International Standard[2].

4.2.2 Reinforcement(s)

4.2.2.1 Form

Although this International Standard covers only glass reinforcements, other types may nevetheless be used together with the main (glass) reinforcement.

The glass reinforcement generally takes the form of chopped or unchopped strands, used alone or in combination with continuous yarns deposited in various ways, depending on the properties required for the parts to be produced from the SMC (e.g. continuous-strand mats, looped-strand mats).

4.2.2.2 Strand length

With isotropic reinforcement produced using chopped strands, the length varies from one type of SMC to another. The length of the chopped strands shall be stated in the specification.

With directional reinforcements, the fibres may be continuous or discontinuous, with lengths varying between 10 cm and 40 cm. The orientation of these directional fibres is generally such that their ends are distributed in a homogeneous manner in a direction longitudinal to the sheet or to the roll of SMC (i.e. staggered).

4.2.2.3 Proportion of reinforcement

Sheet moulding compound may contain between 15 % (*m*/*m*) and 70 % (*m*/*m*) of reinforcing materials. The proportion of reinforcement shall be stated after the designation of the type of SMC.

2) For polyester resins, see ISO 3672. For epoxy resin, see ISO 3673.

4.2.3 Modes of reinforcement

Depending on the length of the fibres (i.e. whether they are chopped or not) and their orientation, distinction can be made between the following types of SMC.

4.2.3.1 **SMC-R** (R = random)

This type of SMC is produced using strands chopped and deposited without preferential orientation. This is the type called "standard", which permits flow in all directions and has mechanical properties which are average and isotropic.

Example

SMC-R containing 40 % (*m*/*m*) of reinforcement is designated SMC-R 40.

4.2.3.2 **SMC-C** (C = continuous)

This is produced using a continuous reinforcement deposited with a roughly defined orientation.

The values of the mechanical properties in the direction of the reinforcement are distinctly higher than those in the other direction. The tendency to creep in the direction of the reinforcement is very slight, however.

In certain types of SMC, fabrics may be used as a continuous reinforcement. Technical properties and creep characteristics of the resulting laminate will depend on the structure of the fabric.

4.2.3.3 **SMC-D** (D = directional)

This is produced from strands chopped to give fibres having a length greater than for SMC-R and deposited with a roughly defined orientation. SMC-D is in fact a compromise between SMC-R and SMC-C with regard to mechanical properties and creep.

4.2.3.4 Combinations of SMC-R with directional reinforcements

These combinations, which are more widely used than SMC-C or SMC-D, are designated SMC-C/R and SMC-D/R, respectively.

They give a moulded part in which the mechanical properties and creep characteristics are predominant in one direction in the laminate.

Example

SMC-C/R with 25 % (*m*/*m*) isotropic reinforcement and 15 % (*m*/*m*) unchopped directional reinforcement is designated SMC-C 15/R 25.

4.2.3.5 SMC with looped-strand reinforcement

This is produced using a reinforcement consisting of either continuous-strand mat or continuous strands arranged in partly overlapping loops of specified dimensions. It could be designated SMC-FC as for the SMC-C/R or D/R.

Chopped strands deposited without preferential orientation may be added to the principal continuous-strand mat reinforcement. This combination could be designated SMC-FC/R.

4.2.4 Fillers

Fillers are relatively inert, solid materials. They are used for specific reasons, such as

— to improve the properties (e.g. fire behaviour, stiffness, mechanical strength) and to ensure that the properties are retained over a long period;

— to improve the surface finish;

— to reduce the cost of the moulding composition.

4.2.5 Additives

As well as the additives required for the actual manufacturing of the SMC as such (cure initiator, thickening agent, internal release agent), the following additives may be specified:

a) pigments: added in the form of a powder, paste or paste dispersion;

b) shrinkage modifiers: usually thermoplastic resins used for low-shrink, very-low-shrink or zero-shrink SMC;

c) other additives:

— fire-retarding agents,

— UV absorbers,

— crosslinking retarders (inhibitors),

— etc.

4.3 Classification based on shrinkage behaviour

4.3.1 General-purpose SMC

Designates products for which shrinkage during curing is between 0,2 % and 0,5 %.

4.3.2 Low-shrinkage SMC

Designates products for which shrinkage during curing is between 0,05 % and 0,2 %.

4.3.3 Very-low-shrinkage (low-profile) SMC

Designates products for which shrinkage during curing is less than 0,05 %.

4.3.4 Zero-shrinkage SMC

Designates products for which shrinkage during curing is zero.

The shrinkage will depend on the orientation and length of the reinforcing fibres. It will thus be different from one direction to another for SMC-C and SMC-D, as well as for SMC-C/R and SMC-D/R. In these cases, the maximum value of the shrinkage shall be used to classify the product. It will be lower in the case of SMC reinforced with looped-strand mat (SMC-FC).

NOTE 2 With SMC, shrinkage is one of the major causes of sink marks on moulded parts with ribs or bosses.

5 Properties

The following list gives properties which may be specified, with tolerances, in the specification for a given sheet moulding compound.

5.1 Properties measured on SMC, as received

5.1.1 Physical and chemical characteristics

NOTE 3 These properties, able to qualify the product, are concerned with test methods being studied and shall be introduced in the standard after publication of the official documents:

— sheet dimensions;

— mass per unit area;

— reinforcement and filler content;

— fibre length;

— volatile-matter content;

— reactivity;

— mouldability.

5.1.2 Defects

The specification shall include all the information required to define the normal visual appearance of the SMC and to define acceptable defects.

The types of defect permitted, and the maximum number of each per unit mass, shall be defined in the specification or by agreement between the parties concerned.

The following are usually considered as defects, either of the product itself or of the roll or other unit of manufacture:

— patches short of resin (dry spots caused by incomplete impregnation);

— patches with excess resin;

— contamination (foreign matter);

— colour heterogeneity:

— creases and wrinkles;

— tears, holes or cracks in the container or protective cover in which the product is packed.

5.2 Properties measured on moulded specimens

Specimens shall be prepared from flat plates manufactured in accordance with ISO 1268. In the case of anisotropic materials, the specification shall define the direction(s) in which properties are to be measured.

The following methods shall be used to measure the properties indicated.

5.2.1 Mechanical properties

— Tensile strength, tensile elongation and tensile modulus of elasticity: ISO 3268 with type II specimen. [For SMC with directionally oriented reinforcements (SMC-C , SMC-D and combinations of SMC-C/R and -D/R), type III specimens shall be used and their width shall be equal to or greater than 20 mm in order to ensure that the dispersion of the results is acceptable.]

— Flexural strength and flexural modulus of elasticity: ISO 178.

— Impact strength (unnotched test specimen): ISO 179 or ISO 180.

— Compression strength: ISO 604.[3)]

— Shear strength: ISO 4585.

— Temperature of deflection under load: ISO 75.

5.2.2 Physical properties

— Density: ISO 1183.

— Moulding shrinkage: ISO 2577.

— Surface roughness (using a profilometer).

— Loss on ignition: ISO 1172.

— Coefficient of thermal expansion.

— Moisture absorption: ISO 62 (method 1).

— Fire hazard (glow-wire test): IEC 695-2-1.

5.2.3 Electrical properties

— Proof tracking index: IEC 112.

— Electric strength: IEC 243.

— Surface resistivity: IEC 93.

— Dielectric constant (permittivity): IEC 250.

6 Sampling

6.1 Sampling procedure

Each production batch constituting a single consignment shall be considered as a dispatched batch (as defined in ISO 1886). Take the sample (rolls or cases) from each batch in accordance with ISO 1886.

The test specimens shall be taken from the sample and prepared as specified in the relevant test methods.

Care shall be taken to protect the rolls or cases in the sample in order to prevent their moulding properties from deteriorating (for example by loss of volatile components such as styrene) and to prevent premature curing before moulding.

6.2 Conditioning of sample

If no specific conditioning is required, the sample shall be wrapped in suitable protective film impermeable to styrene (e.g. cellophane) to avoid any loss of volatile products, and shall be kept for at least 6 h in the standard atmosphere 23 °C ± 2 °C and 50 % ± 5 % R.H. (see ISO 291).

7 Shelf life

The manufacturer shall state the maximum storage life of the material, in its original unopened packaging, under the conditions recommended by him (for example maximum temperature, relative humidity).

The material shall be mouldable and conform to the requirements specified (see clause 5) during the whole of the stated storage life, provided the SMC is used as quickly as possible after removal of the protective film.

8 Packing, packaging and labelling

8.1 Packing

In rolls of SMC and in cases containing flat sheets of SMC, each layer shall be separated by a barrier sheet made, for instance, of a suitable plastic or paper.

At the time the product is used, it shall be possible to remove the barrier sheet easily without leaving any traces.

Rolls of SMC shall be wound on tubes of adequate strength.

The requirements concerning the length and mass of rolls shall be specified.

8.2 Packaging

The contents of each unit package (roll or case) shall be protected by a film of a material, such as cellophane or aluminized kraft paper, which is impermeable to volatile products, for example styrene. The unit packages shall then be palletized or otherwise assembled and protected (especially the ends of rolls and the edges of sheets in cases) in such a manner that they will not suffer any damage under normal conditions of transport and storage.

If it is known that a consignment will be sampled (by the customs in international trade, for instance), it is recommended that a small, representative sample be included with the consignment, in order to avoid the packages being opened and damage being caused.

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3) A method for the determination of the compression strength of textile glass reinforced plastics will be the subject of a future International Standard.