GRP tanks and vessels for use above ground —

Part 1: Raw materials — Specification conditions and acceptance conditions

The European Standard EN 13121-1:2003 has the status of a British Standard

ICS 23.020.10

BSi
British Standards

National foreword

This British Standard is the official English language version of EN 13121-1:2003.

The UK participation in its preparation was entrusted by Technical Committee PRI/5, UK Steering Committee for CEN/TC210, to Subcommittee PRI/5/1, Glass reinforced tanks and vessels, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

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GRP tanks and vessels for use above ground - Part 1: Raw materials - Specification conditions and acceptance conditions

Réservoirs et récipients en PRV pour applications hors sol - Partie 1: Matières premières - Conditions de spécifications et conditions d'utilisation

Oberirdische GFK-Tanks und -Behälter - Teil 1: Ausgangsmaterialien - Spezifikations- und Annahmebedingungen

This European Standard was approved by CEN on 17 March 2003.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

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Foreword

This document (EN 13121-1:2003) has been prepared by Technical Committee CEN/TC 210, "GRP tanks and vessels", the secretariat of which is held by DIN.

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 November 2003, and conflicting national standards shall be withdrawn at the latest by November 2003.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association and supports essential requirements of EU directive(s).

For relationship with EU-Directive(s), see informative Annex ZA, which is an integral part of this document.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

EN 13121 consists of the following parts under the general title "GRP tanks and vessels for use above ground":

Part 1 — Raw materials – Specification conditions and acceptance conditions

Part 2 — Composite materials – Chemical resistance

Part 3 — Design and workmanship

Part 4 — Delivery, installation and maintenance

These four Parts together define the responsibilities of the tank or vessel manufacturers, the materials manufacturers or suppliers and the purchasers.

The design and manufacture of GRP tanks and vessels involve a number of different materials such as resins, plastics and reinforcing fibres and a number of different manufacturing methods. It is implicit that tanks and vessels conforming to this European Standard should be made only by manufacturers and operators who are competent and suitably equipped to fulfil all requirements, using materials manufactured by competent and experienced material manufacturers.

Part 1 of this standard specifies the requirements for specification conditions and acceptance conditions for raw materials — resins, curing agents, thermoplastic linings, reinforcing materials and additives — in terms of both material technical properties and the manufacturing process. These requirements are necessary in order to establish the chemical resistance properties determined in Part 2 and the mechanical, thermal and design properties determined in Part 3. Together with the workmanship principles determined in Part 3, specification conditions and acceptance conditions for raw materials ensure that the tank or vessel will be able to meet its design requirements, particularly in terms of its chemical/thermal resistance and pressure and load supporting requirements. Part 4 of this standard specifies requirements for delivery, handling and installation and recommendations for maintenance of GRP tanks and vessels.

1 Scope

This European Standard gives requirements for specification and acceptance conditions of raw materials for GRP tanks and vessels with or without lining for storage or processing of fluids, factory made or site built, non pressurised or pressurised, for use above ground.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 59, Glass reinforced plastics — Measurement of hardness by means of a Barcol impressor.

EN 10204:1991, Metallic products — Types of inspection documents.

prEN 13121-2:1999, GRP tanks and vessels for use above ground — Part 2: Composite materials — Chemical resistance.

prEN 13121-3:2001, GRP tanks and vessels for use above ground — Part 3: Design and workmanship.

EN 29092, Textiles — Nonwovens — Definition.

EN ISO 75-2, Plastics — Determination of temperature of deflection under load — Part 2: Plastics and ebonite (ISO 75-2:1993).

EN ISO 178, Plastics — Determination of flexural properties (ISO 178:2001).

EN ISO 306, Plastics — Thermoplastic materials — Determination of Vicat softening temperature (VST) (ISO 306:1994).

EN ISO 472:2001, Plastics — Vocabulary (ISO 472:1999).

EN ISO 527-2, Plastics - Determination of tensile properties - Part 2: Test conditions for moulding and extrusion plastics (ISO 527-2:1993 including Corr 1:1994).

EN ISO 868, Plastics and ebonite — Determination of indentation hardness by means of a durometer (Shore hardness) (ISO 868:2003).

EN ISO 1133, Plastics — Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics (ISO 1133:1997).

EN ISO 1163-1:1999, Plastics — Unplasticized poly (vinyl chloride) (PVC-U) moulding and extrusion materials — Part 1: Designation system and basis for specifications (ISO 1163-1:1995).

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

EN ISO 1889 Reinforcement yarns - Determination of linear density (ISO 1889:1997).

EN ISO 2114:2000, Plastics (polyester resins) and paints and varnishes (binders) - Determination of partial acid value and total acid value (ISO 2114:2000).

EN ISO 2535:2002, Plastics — Unsaturated polyester resins — Measurement of gel time at ambient temperature (ISO 2535:2001).

EN ISO 2554, Plastics — Unsaturated polyester resins — Determination of hydroxyl value (ISO 2554:1997).

EN ISO 2555, Plastics — Resins in the liquid state or as emulsions or dispersions — Determination of apparent viscosity by the Brookfield Test method (ISO 2555:1989).

EN ISO 2592:2001, Determination of flash and fire points -- Cleveland open cup method (ISO 2592:2000).

EN ISO 3001, Plastics — Epoxy compounds — Determination of epoxy equivalent (ISO 3001:1999).

EN ISO 3219, Plastics — Polymers/resins in the liquid state or as emulsions or dispersions — Determination of viscosity using a rotational viscometer with defined shear rate (ISO 3219:1993).

EN ISO 3251:2003, Paints, varnishes and plastics - Determination of non-volatile-matter content (ISO 3251:2003).

EN ISO 3344, Reinforcement products — Determination of moisture content (ISO 3344:1997).

EN ISO 6721-2, Plastics — Determination of dynamic mechanical properties — Part 2: Torsion-pendulum method (ISO 6721-2:1994, including Technical Corrigendum 1:1995).

EN ISO 9073-1, Textiles - Test methods for nonwovens - Part 1: Determination of mass per unit area.

EN ISO 9073-2, Textiles - Test methods for nonwovens - Part 2: Determination of thickness (EN ISO 9073-2:1995).

EN ISO 9073-3, Textiles - Test methods for nonwovens - Part 3: Determination of tensile strength and elongation.

EN ISO 9702, Plastics — Amine epoxide hardeners — Determination of primary, secondary and tertiary amine group nitrogen content (ISO 9702:1996).

EN ISO 9771, Plastics — Phenolic resins — Determination of the pseudo-adiabatic temperature rise of liquid resols when cured under acid conditions (ISO 9771:1995).

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

ISO 1887, Textile glass — Determination of combustible-matter content.

ISO 2113, Reinforcement fibres — Woven fabrics — Basis for a specification.

ISO 2211, Liquid chemical products — Measurement of colour in Hazen units (platinum-cobalt scale).

ISO 2559, Textile glass — Mats (made from chopped or continuous strands) — Designation and basis for specifications.

ISO 2797, Textile glass — Rovings — Basis for a specification.

ISO 3374, Reinforcement products – Mats and fabrics — Determination of mass per unit area.

ISO 5661, Petroleum products — Hydrocarbon liquids — Determination of refractive index.

ISO 6271, Clear liquids — Estimation of colour by the platinum-cobalt scale.

ISO 11359-2, Plastics – Thermomechanical analysis (TMA) – Part 2: Determination of coefficient of linear thermal expansion and glass transition temperature.

3 Terms, definitions, symbols and abbreviations

3.1 Terms and definitions

For the purposes of this European Standard the terms and definitions given in prEN 13121-3:2001 and EN ISO 472:2001 apply.

3.2 Symbols and abbreviations

For the purposes of this European Standard, the symbols and abbreviations given in Table 1 apply.

Table 1 — Symbols and abbreviations

Symbol/abbreviation	Unit	Abbreviation
HDT	°C	Heat deflection temperature
MFR	g/10 min	Melt flow rate
T_g	°C	Glass transition temperature
ε_t	%	Elongation at break in tension
σ_f	MPa	Flexural strength
σ_t	MPa	Tensile strength
ShD	—	Shore Hardness D
ρ	g/ml	Density
E_t	MPa	Modulus of elasticity in tension
E_f	MPa	Modulus of elasticity in flexure

4 Thermosetting resins

4.1 General

The resins used for GRP tanks or vessels are liquid or liquefiable, thermosetting in nature and cure by polymerisation (polyaddition or polycondensation) with or without curing agents (initiators, accelerators/promotors).

The production procedure and cure schedule of thermosetting resin laminates shall be in accordance with the resin manufacturer's recommendations. Most thermosetting resins require an elevated temperature post cure to enhance chemical and thermal resistance.

Most unsaturated polyester resins and vinyl ester resins may be classified in accordance with Table 2.

In order that a specific resin may be given a classification according to Table 2 then the resin manufacturer shall state that the specific resin conforms with the property requirements given in Table 2 and meets the chemical resistance requirements given in prEN 13121-2.

When required, flammability and electrical conductivity shall be taken into account.

Table 2 — Classification scheme for UP- and VE-resins

Resin group	Resin type	Type of glycols	Type of acids	Content of styrene mass-% max.	T_g °C min.	HDT °C min.	σ_t MPa min.	ε_t % min.	f MPa min.
1A	UP	Standard glycols[a, b]	Orthophthalic acid Ethylenedicarbonxylic acids	45	85	60	60	2,0	90
1B	UP	Standard glycols[a, b]	Orthophthalic acid Ethylenedicarbonxylic acids	45	120	90	50	1,5	75
2A	UP	Standard glycols[a, b]	Isophthalic acid, HET acid Ethylenedicarbonxylic acids	50	85	60	60	2,0	90
2B	UP	Standard glycols[a]	Isophthalic acid, HET acid Ethylenedicarbonxylic acids	50	120	90	50	1,5	75
3	UP	Standard glycols[a]	Terephthalic acid Ethylenedicarbonxylic acids	50	140	110	75	3,0	120
4	UP	Neopentyl and halogenated neopentyl glycol (min. 80 mol-%)[c] and a diol with at least one secondary OH-group (max. 20 mol-%)[c]	Isophthalic acid Orthophthalic acid Ethylenedicarboxylic acids	55	120	90	65	3,0	110
5	UP	Bis (hydroxymethyl)-tricyclodecan	Orthophthalic acid Ethylenedicarbonxylic acids	45	120	90	50	1,5	100
6	UP	Dipropoxy-Bisphenol A and halogenated Bisphenol A (min. 90 mol-%)	Ethylenedicarbonxylic acids	55	130	110	60	2,0	110
7A	VE	Epoxidised Bisphenol A and halogenated Bisphenol A	Methacrylic-/Acrylic acid	55	110	90	75	4,0	130
7B	VEU	Dialkoxy — Bisphenol A and halogenated Bisphenol A (min. 90 ml-%), Alkoxy (meth)acrylate	Ethylenedicarbonxylic acids	50	120	105	75	3,5	130
8	VE	Epoxidised-Novolak	Methacrylic-/Acrylic acid	50	150	120	75	2,5	130

[a] Ethylene-, 1,2-propylene-, diethylene-, dipropylene-, neopentylglycol, 1,3-butanediol 1,4-butanediol and corresponding halogenated glycols

[b] May also contain cyclic unsaturated hydrocarbons.

[c] Related to the sum of the diol components.

4.2 Unsaturated polyester resins

Unsaturated polyester resins (UP) are thermosetting resins consisting of polyester molecules, dissolved in a reactive monomer (e.g. styrene) capable of copolymerisation with the polyester. The polyester molecules are built from polyhydric alcohols (polyols) and polyvalent carboxylic acids (e.g. ethylene dicarboxylic acids like fumaric acid and/or maleic acid) and cyclic unsaturated hydrocarbons (e.g. dicyclopentadiene) by a polymerisation reaction. At least one of the acids is unsaturated (in UP-resins usually maleic and/or fumaric acid is used).

4.3 Vinylester resins

Vinylester resins (VE) are thermosetting resins consisting of phenyl- and/or phenylene derivatives (e.g. glycidylether from bisphenol A or novolak) and ester terminated with acrylic- and/or methacrylic acid.

The vinylester molecules are built up by reaction of an epoxide with (meth)acrylic acid.

The vinylester molecules are dissolved in a reactive monomer (e.g. styrene) capable of copolymerisation with the unsaturated vinylester molecules.

4.4 Vinylester urethane resins

Vinylester urethane resins (VEU) are thermosetting resins consisting of phenyl- and/or phenylene derivates (e.g. dialkoxy-bisphenol A), fumaric/maleic acid, diisocyanate derivates and terminated with alkoxy-(meth)acrylate.

The vinylester urethane molecules are built up by the reaction of a diisocyanate derivate with alkoxy-(meth)acrylate and the condensation product of dialkoxy-bisphenol A with fumaric/maleic acid.

The vinylester urethane molecules are dissolved in a reactive monomer (e.g. styrene) capable of copolymerisation with the unsaturated vinylester molecules.

4.5 Epoxy resins

Epoxy resins (EP) are low to medium molecular weight polymers containing the oxirane (epoxide) reactive group. Crosslinking occurs at these sites through addition of amines, Lewis acids/bases and anhydrides.

The epoxy resin system is characterised by the type of epoxy resin (e.g. diglycidyl ether of bisphenol A, diglycidyl ether of bisphenol F), the type of curing agent [e.g. (cyclo)aliphatic or aromatic amine, anhydride] and, if used, the type of viscosity modifier (e.g. "reactive-" or "non-reactive diluent").

4.6 Furane resins

Furane resins (FU) are prepolymers of furfuryl alcohol dissolved in monomeric furfuryl alcohol. They polymerise via a condensation reaction on addition of an acid catalyst (typically para-toluene sulphonic acid or phosphoric acid), water being liberated.

4.7 Phenolic resins

Phenolic resins (PF) are the reaction product of phenol and an aldehyde, typically formaldehyde. They polymerize by a condensation reaction on addition of an acid catalyst (typically para-toluene sulphonic acid or phosphoric acid), water being liberated (analogous to the furane resins).

4.8 Characterisation of thermosetting resins in the uncured state

Thermosetting resins shall be characterised in the uncured state by the resin manufacturer by the properties given in Table 3.

Table 3 — Test methods for determination of uncured resin properties

Property	UP	VE, VEU	EP-resins	EP-hardeners	FU	PF
Density	EN ISO 1675	EN ISO 1675	EN ISO 1675	EN ISO 1675	EN ISO 1675	EN ISO 1675
Colour	ISO 2211	ISO 2211	ISO 6271	ISO 6271	—	—
Refractive index	ISO 5661	ISO 5661	ISO 5661	ISO 5661	—	—
Acid number	EN ISO 2114	EN ISO 2114	—	—	—	—
Viscosity	EN ISO 3219 EN ISO 2555	EN ISO 3219 EN ISO 2555	EN ISO 3219 EN ISO 2555	EN ISO 3219 EN ISO 2555	EN ISO 3219 EN ISO 2555	EN ISO 3219 EN ISO 2555
Non-volatile matter	EN ISO 3251	EN ISO 3251	—	—	—	—
Flash point	EN ISO 2592	ENISO 2592	EN ISO 2592	EN ISO 2592	EN ISO 2592	EN ISO 2592
Hydroxyl eq. weight	—	—	—	EN ISO 2554	—	—
Epoxy eq. weight	—	—	EN ISO 3001	—	—	—
Amine eq. weight	—	—	—	EN ISO 9702	—	—
Anhydride eq. weight	—	—	—	EN ISO 2114	—	—
Gel time	EN ISO 2535	EN ISO 2535	—	—	—	EN ISO 9771

4.9 Characterisation of thermosetting resins in the cured state

Thermosetting resins shall be characterised by the resin manufacturer in the cured state (unreinforced and unfilled) in accordance with the properties and test methods given in Table 4. The curing system and the cure schedule shall be indicated by the resin manufacturer.

Table 4 — Test methods for determination of cured resin properties

Property	Test method
Barcol hardness	EN 59
Density	ISO 1183
Tensile strength	EN ISO 527-2
Tensile strain at break	EN ISO 527-2
Modulus of elasticity in tension	EN ISO 527-2
Flexural strength	EN ISO 178
Modulus of elasticity in flexure	EN ISO 178
Heat deflection temperature	EN ISO 75-2 Method A
Glass transition temperature[a]	EN ISO 6721-2
[a] Optional	

5 Curing agents for unsaturated polyester and vinylester resins

5.1 General

Both unsaturated polyester and vinylester resins cure by a free radical polymerisation mechanism. To start the process, radicals are generated by the addition of an initiator (e.g. organic peroxide) and an accelerator or promotor, to liberate, at a sufficient rate, a supply of free radicals to allow the polymerisation to initiate.

The resin and/or cure system manufacturer shall state the compatibility of the curing system with the resins, shall give recommendations on the quantities and conditions of use and shall state any limitations on use in service.

5.2 Initiators

Initiators generally are organic peroxides which break down liberating radicals which initiate the radical polymerisation process. The grade of initiator to be used (e.g. Methyl ethyl ketone peroxide (MEKP), Cumene hydroperoxide (CuHP), Dibenzoyl peroxide (BPO), acetyl acetone peroxide (AAP), Cyclohexanone peroxide (CHP) etc.) shall be compatible with the resin system used and with the service conditions. The amount of active initiator to be added depends upon the cure requirements.

5.3 Accelerators, organometallic

Organometallic accelerators (e.g. cobalt naphthenate, cobalt octoate) are the primary agents which accelerate the break down of the initiator to achieve a sufficient rate of generation of radicals to start the polymerisation of the unsaturated resin.

5.4 Promotors

Promotors [e.g. Dimethylaniline (DMA), Diethylaniline (DEA), dimethylacetoacetamide (DMAA)] improve the reaction efficiency of the accelerators. When used with BPO, promotors can act on the peroxide without the need for organometallic accelerators.

5.5 Inhibitors

Inhibitors are chemical agents which react on the curing system in such a way as to slow up the hardening of the resin. They are normally alkylated phenols (e.g. tertiary butyl catechol — TBC) which react with the free radicals to form more stable and less reactive species. With certain resin grades (e.g. VE) chelating agents (e.g. acetyl acetone) are also used. They act by temporarily complexing the organometallic accelerator out of the reaction medium.

6 Reinforcing materials

6.1 General

Reinforcing materials shall be made from textile glass-types in accordance with Table 5. Special structures of reinforcing material shall be specified taking into account requirements as defined in 6.2 to 6.6. Test methods shall be in accordance with Table 7.

Table 5 — Textile glass types

Glass type	Chemical characterisation
E	Alumina-borosilicate glass, ≤ 1 % alkali content
E-CR	Alumina-limesilicate glass, ≤ 1 % alkali content
AR	Zirconium-lime glass, ≈ 15 % zirconium content
A	Alkali-lime glass ≈ 15 % Alkali content
C	Alkali-lime glass, ≈ 8 % Alkali content

6.2 Surface nonwovens

The surface nonwoven manufacturer shall state the material filament structure, binder, sizing and mass per unit area and shall state the compatibility with the resin system and the laminating process.

Surface nonwovens shall be made from filaments of textile glass or textile of synthetics, e.g. polyacrylonitrile, polyamide or polyester or of carbon, with or without orientation, and with mass per unit area 20 to 50 g/m^2.

Surface nonwovens shall be in accordance with the specification of the supplier (see clause 9).

6.3 Chopped strand mats

The chopped strand mat manufacturer shall state the strand, structure, binder and mass per unit area and shall state the compatibility with the resin system, the laminating process and the laminate design.

Chopped strand mats shall be made of textile glass strand, cut to 25 to 50 mm of length without orientation of strands and mass per unit area shall be within 225 to 600 g/m^2.

Chopped strand mats shall be in accordance with ISO 2559.

6.4 Continuous strand mats

The continuous strand mat manufacturer shall state the strand, structure, binder and mass per unit area and shall state the compatibility with the resin system, the laminating process and the laminate design.

Continuous strand mats shall be made of textile glass strand without orientation of strands and mass per unit area shall be within 225 to 600 g/m^2.

Continuous strand mats shall be in accordance with ISO 2559.

6.5 Woven fabrics/Woven roving fabrics

Fabrics shall be made of textile glass yarns or rovings. The fabric manufacturer shall state the grade of yarns or roving, structure, finish and mass per unit area and shall state the compatibility with the resin system, the laminating process and laminate design.

The fabrics manufacturer shall state the linear density of yarns or rovings, by ratio of mass of warp to weft, bidirectional or unidirectional. Mass per unit area shall be within 240 to 1 200 g/m^2.

Fabrics shall be in accordance with ISO 2113.

Special fabrics, e.g. combined chopped strand mat/woven fabrics or multi axial fabrics, may be used in accordance with the requirements of this European Standard.

6.6 Rovings for winding and for chopping applications

Rovings shall be made of textile glass. The rovings manufacturer shall state the grade of filament, linear density and sizing and shall state the compatibility with the resin system, radial or helical winding process and laminate design.

Rovings for filament winding or for chopping applications shall be specified by their linear density and sizing.

Rovings for filament winding or for chopping applications shall be in accordance with ISO 2797.

7 Additives

7.1 General

The typical properties of any additive used shall be stated.

If any additives are incorporated into the resin system by the manufacturer of the tank or vessel, the manufacturer shall inform the purchaser of the inclusion of any such additives before manufacture commences.

The additives shall be used in accordance with the resin and/or additive manufacturer's recommendations.

7.2 Thixotropic agents

Thixotopic agents such as fumed silica may be added to the resin up to 5 % by mass, using a high shear stirrer, for viscosity control, provided it does not interfere with visual inspection and taking specific note of 7.1.

7.3 Conductive fillers

Conductive fillers such as graphite or carbon black may be added to the resin in order to meet any requirements for electrical conductivity of the laminates. Such fillers may be used also in conductive pastes used to facilitate spark testing of welds in thermoplastics linings.

7.4 Fire retardants

Fire retardants such as aluminium trihydrate, halogen-containing compounds or antimony oxides may be added to specified laminate layers to meet any requirements for fire resistance.

7.5 Paraffin wax

The final layer may contain paraffin wax in order to meet requirements for surface cure (see Part 3 of this European Standard).

The wax should have a melting point of 40 to 60°C and should be added to the resin in the form of a 10 % solution in styrene so as to achieve a wax content of 0,2 to 0,8 % by mass.

7.6 Aggregates and fillers

Neither aggregates (inert granular material) nor other inert fillers shall be incorporated into the laminate structure. Fillers may be used to formulate resin pastes.

7.7 Ultra-violet absorbers

When required, ultra-violet absorbers may be incorporated into the laminate or outer layers, in accordance with the supplier's recommendations (usually at a level of less than 0,5 % by mass).

7.8 Pigments

Pigments are permissible only in the outer resin surface and — if required — shall be applied after visual inspection has been carried out.

7.9 Surface active agents

Surface active agents may be added to the resin to improve its processability. Examples of this type of additive are air release agents, wetting agents, activators for thixotropic agents and monomer emission suppressants.

8 Thermoplastic lining materials

8.1 General

Lining materials shall be selected from following thermoplastics:

a)	Polyvinylchloride in accordance with EN ISO 1163-1:1999 class PVC-U-E-078-T33, unplasticised, pressed or extruded (Cl ≥ 48 %)	PVC-U
b)	Polypropylene (homopolymer, block polymer, random polymer)	PP-H, PP-B, PP-R

c)	Polyvinylidene fluoride	PVDF
d)	Ethylene-chlorotrifluoroethylene copolymer	E-CTFE
e)	Fluorinated ethylene-propylene copolymer	FEP
f)	Perfluoro-alkoxy copolymer	PFA

The lining shall be selected on the basis of its ability to meet the requirements for service conditions including permeability, environmental stress cracking, mechanical properties, bond strength to laminate and fabricability (forming, welding) stated in prEN 13121-2 and prEN 13121-3.

All parts of the lining shall be manufactured from the same or compatible grade of material.

The thermoplastic lining manufacturer shall state that specific linings meet the chemical resistance requirements given in prEN 13121-2.

When required, flammability and electrical conductivity shall be taken into account.

8.2 Mechanical and thermal properties

The lining materials properties shall conform to the values given in Table 6.

Actual values shall be stated by the manufacturer of the lining material.

Table 6 — Properties of thermoplastic lining materials

Material type	Density ISO 1183 g/ml	Melt flow rate[a] EN ISO 1133 g/10 min	Vicat[b] softening temp. EN ISO 306 °C	Tensile strength EN ISO 527-2 MPa	Tensile strain at break EN ISO 527-2 %	Modulus of elasticity in tension EN ISO 527-2 MPa	Shore D Hardness EN ISO 868	Heat deflection temperature EN ISO 75-2[c] °C	Linear thermal expansion ISO 11359-2 °C
PVC-U	1,45	—	75	55	15	3 000	80	75	75
PP-H	0,91	0,4 — 0,8	—	30	> 50	1 200	65	50	180
PP-B	0,91	0,4 — 0,8	—	20	> 50	700	60	45	180
PP-R	0,91	0,4 — 0,8	—	20	> 50	700	60	45	180
PVDF	1,78	—	145	50	80	2 000	80	90	130
E-CTFE	1,69	—	115	45	200	1 700	75	75	80
FEP	2,15	—	70	25	300	350	55	50	100
PFA	2,15	—	75	30	300	300	60	60	140

[a] method MFR 190/5

[b] method VST/B

[c] method A

8.3 Welding consumables

All welding rods and granules used shall be of the same or compatible grade of material as the lining and shall not impair the performance of the lining.

8.4 Dimensional stability

In order for the lining to retain its dimensional stability during heat forming and welding, the thermoplastic lining material shall conform to requirements for heat reversion as stated by the material manufacturer.

9 Material conformance documentation

9.1 General

Materials for manufacture of tanks and vessels to this standard shall only be made by material manufacturers who are competent and experienced and suitably equipped to fulfil the requirements for quality control and quality assurance.

Conformance shall be supported by documentation.

The material manufacturer shall maintain, for 5 years, records, that the materials supplied are in accordance with this European Standard. When required by the manufacturer, confirmation shall be established by certificates EN 10204 of material testing by the material manufacturer.

The material manufacturer shall state the requirements for storage (e.g. temperature, humidity, sunlight and shelf life).

9.2 Unsaturated polyester, vinylester and vinylester urethane resins

9.2.1 In the individual material data sheet the material manufacturer shall state the name, type of resin, resin group if applicable (see Table 2) and typical properties as required by 4.8 and 4.9.

9.2.2 Specific test reports EN 10204:1991 — 2.3 or inspection certificates EN 10204:1991 — 3.1B shall confirm values of

colour

viscosity

non volatile content

gel time

in accordance with the test methods given in Table 3.

9.3 Epoxy resins and hardeners

9.3.1 In the individual material data sheet(s), the material manufacturer shall state the name and type of resin or hardener and, if used, the name and type of viscosity modifier, and typical properties as required by 4.8 and 4.9.

9.3.2 Specific test reports EN 10204:1991 — 2.3 or inspection certificates EN 10204:1991 — 3.1B shall confirm values of

colour

viscosity

gel time

epoxy equivalent

amine/anhydride equivalent

in accordance with test methods given in Table 3.

9.4 Furane and phenolic resins

9.4.1 In the individual material data sheet, the material manufacturer shall state the name and type of resin and typical properties as required by 4.8 and 4.9.

9.4.2 Specific test reports EN 10204:1991 — 2.3 or inspection certificates, EN 10204:1991 — 3.1B shall confirm values of

viscosity

gel time

in accordance with test methods given in Table 3.

9.5 Curing agents and additives

9.5.1 In the individual material data sheet the material manufacturer shall state the name, chemical type and characteristic properties of curing agent and additives.

9.5.2 Test reports EN 10204:1991 — 2.2 shall confirm the specified properties.

9.6 Surface nonwovens

9.6.1 In the individual material data sheets the material manufacturer shall state the name, identity mark, material, type of filament, binding and properties in accordance with Table 7.

9.6.2 Specific test reports EN 10204:1991 — 2.3 or inspection certificates EN 10204:1991 — 3.1B shall confirm mass per unit area, thickness and tensile strength in accordance with the test methods given in Table 7.

9.7 Chopped strand mats

9.7.1 In the individual material data sheets the material manufacturer shall state the name, identity mark and properties in accordance with ISO 2559.

9.7.2 Specific test reports EN 10204:1991 — 2.3 or inspection certificates EN 10204:1991 — 3.1B shall confirm mass per unit area, loss of ignition, content of moisture in accordance with test methods given in Table 7.

9.8 Woven fabrics/Woven roving fabrics

9.8.1 In the individual material data sheets the material manufacturer shall state the name and properties in accordance with ISO 2113.

9.8.2 Specific test reports EN 10204:1991 — 2.3 or inspection certificates EN 10204:1991 — 3.1B shall confirm mass per unit area, loss on ignition, content of moisture in accordance with test methods given in Table 7.

9.9 Rovings for winding and for chopping applications

9.9.1 In the individual material data sheets the material manufacturer shall state the name, identity mark and properties in accordance with ISO 2797.

9.9.2 Specific test reports 10204:1991 – 2.3 or inspection certificates EN 10204:1991 – 3.1B shall confirm, linear density, loss on ignition, content of moisture in accordance with test methods given in Table 7 and the filament diameter and type of sizing.

Table 7 — Test methods for reinforcing materials

Property	Nonwovens EN 29092	Chopped strand mats ISO 2559	Wovens Fabrics ISO 2113	Rovings ISO 2797
Mass per unit area	EN ISO 9073-1	ISO 3374	ISO 3374	–
Linear density	–	–	–	EN ISO 1889
Thickness	EN 29073-2	–	–	–
Loss on ignition	–	ISO 1887	ISO 1887	ISO 1887
Tensile strength	EN ISO 9073-3			
Moisture	–	EN ISO 3344	EN ISO 3344	EN ISO 3344

9.10 Thermoplastic linings

9.10.1 In the individual material data sheet the material manufacturer shall state the name, type, colour, the material and the structure used for any fibrous backing and the relevant properties given in Table 6.

9.10.2 Specific test reports EN 10204:1991 — 2.3 or inspection certificates EN 10204:1991 — 3.1.B shall confirm values of density and melt flow rate or vicat softening temperature in accordance with the test methods given in table 6 and heat reversion value in accordance with the test method stated by the lining manufacturer (see 8.4).

Annex ZA
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 97/23/EC

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the New Approach Directive 97/23/EC.

Once this standard is cited in the Official Journal of the European Communities under that Directive and has been implemented as a national standard in at least one Member State, compliance with the clauses of this standard given in table ZA confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding Essential Requirements of that Directive and associated EFTA regulations.

Table ZA – Correspondence between this European Standard and Directive 97/23/EC

Clause(s)/sub-clause(s) of this EN	Essential Requirements (ERs) of Directive 97/23/EC	Qualifying remarks/Notes
9.2; 9.3; 9,4; 9,5; 9.6; 9.7; 9.8; 9.9; 9.10; 9.11; 9.12	Annex I, 4.3	
4, 5, 6, 7 and 8	Annex I, 4.1	

WARNING: Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

Bibliography

prEN 13121-4, GRP tanks and vessels for use above ground — Part 4: Delivery, installation and maintenance.

BS EN
13121-1:2003

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