SLOVENSKI STANDARD

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Nadzemni rezervoarji iz armiranega poliestra – 2. del: Kompozitni materiali – Kemijska obstojnost

GRP tanks and vessels for use above ground - Part 2: Composite materials - Chemical resistance

Oberirdische GFK-Tanks und -Behälter - Teil 2: Verbundwerkstoffe - Chemische Widerstandsfähigkeit

Réservoirs et récipients en PRV pour utilisation hors sol - Partie 2: Matériaux composites - Résistance chimique

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

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Contents

Foreword

This document (EN 13121-2:2003) 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of an identical text or by endorsement, at the latest by April 2004, and conflicting national standards shall be withdrawn at the latest by April 2004.

This European Standard 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 97/23/EC.

For relationship with this European Directive see informative Annex ZA, which is an integral part of this standard.

This standard is Part 2 of EN 13121 which in total covers materials, design, manufacture, inspection, delivery, installation and maintenance of GRP tanks and vessels for use above ground. This Part 2 specifies requirements for chemical resistance of composite materials used for GRP tanks and vessels for the storage or processing of fluids, for use above ground. The tanks and vessels may be factory made or site built, with or without lining.

Annexes A and B are normative. Annex C is informative.

This document includes a bibliography.

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

European Standard 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 manufacturer, the materials manufacturers or suppliers and the purchaser.

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

EN 13121-1 gives the requirements necessary to establish that the GRP material and any thermoplastic lining will have the required chemical and thermal resistance to the service conditions. EN 13121-1 specifies the requirements for the specification conditions and acceptance conditions for GRP and thermoplastic materials, which are necessary in order to establish the chemical resistance properties of these materials in accordance with this Part of the standard. EN 13121-2 gives the requirements necessary to establish that the GRP material and any thermoplastic lining willl have sufficient chemical and thermal resistance to service conditions. Part 2 defines the requirements for the protective layer and the structural laminate as well as defining methods for proof of suitability to meet the chemical/thermal effects caused by the fluids and of determination of the partial design factor, A_2, as required for design in accordance with prEN 13121-3. Five methods are described — use of Media Lists, use of resin manufacturers data, use of thermoplastics manufacturers data, service experience and sample testing. The manufacturer of the tank or vessel may choose any one of these methods subject to here being sufficient data available in that method for the particular application.

Together with the requirements and acceptance conditions for the raw materials determined in EN 13121-1, the design and workmanship requirements as determined in prEN 13121-3 and the delivery, handling, installation and maintenance recommendations given in EN 13121-4, EN 13121-2 completes the total standard's requirements.

1 Scope

This European Standard gives requirements for chemical resistance of composite materials used for GRP tanks and vessels for storage or processing of fluids, for use above ground. The tanks or vessels may be factory made or site built, with or without lining.

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.

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

EN 590, *Automotive fuels — Diesel - Requirements and test methods..*

EN 13121-1:2003, *GRP tanks and vessels for use above ground — Part 1: Raw materials — Specification conditions and acceptance conditions.*

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

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

EN ISO 4599, *Plastics — Determination of resistance to environmental stress cracking (ESC) — Bent strip method (ISO 4599:1986).*

EN ISO 6252, *Plastics — Determination of Environmental Stress Cracking (ESC) — Constant-tensile-stress method (ISO 6252:1992).*

EN ISO 14125:1998, *Fibre-reinforced plastic composites — Determination of flexural properties (ISO 14125:1998).*

ISO 1172, *Textile-glass-reinforced plastics. Prepregs, moulding compounds and laminates — Determination of the textile-glass and mineral-filler content — Calcination methods.*

ISO 4433-1, *Thermoplastics pipes — Resistance to liquid chemicals — Classification – Part 1: Immersion test method.*

ISO 4433-2, *Thermoplastics pipes — Resistance to liquid chemicals — Classification — Part 2: Polyolefin pipes.*

ISO 4433-3, *Thermoplastics pipes — Resistance to liquid chemicals — Classification — Part 3: Unplasticized poly(vinyl chloride) (PVC-U), high-impact poly(vinyl chloride) (PVC-HI) and chlorinated poly(vinyl chloride) (PVC-C) pipes.*

ISO 4433-4, *Thermoplastics pipes — Resistance to liquid chemicals — Classification — Part 4: Poly(vinylidene fluoride) (PVDF) pipes.*

3 Definitions

For the purposes of this standard in addition to the definitions given in EN 13121-1:2003, the following definitions apply:

3.1
resin layer (RL)
a layer of resin with or without additives in accordance with clause 7 of EN 13121-1:2003, but without nonwovens or any other fibre

3.2
veil layer (VL)
a layer of resin with or without additives in accordance with clause 7 of EN 13121-1:2003, with one or two surface nonwovens

3.3
single protective layer (SPL)
a protective layer of resin with or without surface nonwovens to meet slight or less significant effects caused by service conditions

3.4
chemical resistant layer (CRL)
a protective layer of resin with or without surface nonwovens to meet more significant or major effects caused by service conditions.

3.5
thermoplastic lining (TPL)
a protective using thermoplastic materials as a lining to meet effects caused by service conditions

3.6
sample
a piece of laminate or thermoplastic sheet for purposes of testing

3.7
specimen
a piece of a sample prepared for purposes of testing

3.8
test piece
a piece of a specimen for purposes of mechanical testing only

3.9
maximum temperature T_m
temperature given by the resin manufacturer or the thermoplastics manufacturer referring to a specified fluid

3.10
maximum design temperature T_d
maximum temperature for determination of the partial design factor, A_2, by different methods of this standard.

4 Protective layers

4.1 General requirements

The inner surface of all laminates shall consist of a protective layer. The protective layer shall be either a single protective layer (SPL) or a chemical resistant layer (CRL) or a thermoplastic lining (TPL).

The type of protective layer shall be selected on the basis of the ability to prevent, or limit to an acceptable level, chemical attack on the laminate. In order to do this, it shall be chemically resistant to the service conditions, allow limited diffusion of service fluids and shall not suffer environmental stress cracking. The TPL may require stress relief to prevent environmental stress cracking, see prEN 13121-3.

The required thickness of the protective layer shall be in accordance with Table 1.

When required, flammability and/or electrical conductivity shall be taken into account and/or the protective layer shall be selected on the basis of its ability to maintain the purity of the service fluids.

The requirements for workmanship of the protective layer are defined in prEN 13121-3.

For application in contact with foodstuffs the relevant regulations shall be considered.

Table 1 — Required thicknesses of protective layers

Protective layer	Required thickness mm
SPL	0,4 to 0,6
CRL	2,5 to 4,0
PVC-U	3,0 to 4,5
PP-H, -B, -R	3,0 to 6,0
PVDF	2,4 to 4,0
E-CTFE, FEP, PFA	1,7 to 4,0

4.2 Single protective layer (SPL)

The single protective layer SPL) shall be either a veil layer (VL) or a resin layer (RL).

4.3 Chemical resistant layer (CRL)

The chemical resistant layer (CRL) shall be a single or double veil layer (VL) followed by a layer or layers of either chopped strand mat or sprayed fibres with a total mass per unit area greater than or equal to 900 g/m^2. The fibre content shall be between 25 % and 35 % by mass.

Following the veil layer (VL), the subsequent chopped strand mats or sprayed fibres shall be applied before cure.

4.4 Thermoplastic lining (TPL)

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

Linings of PVC-U are to be treated initially using a solvent based primer or the initial contact layer shall be applied using a specific bonding resin. Linings of PP, PVDF, E-CTFE, FEP or PFA shall have a glass or synthetic fibre fabric backing — branches up to 100 mm diameter may use chemically etched E-CTFE or PVDF linings.

The initial contact layer applied directly to the thermoplastic lining shall be reinforced with chopped strand mat with 300 g/m^2 to 450 g/m^2. The minimum bond strength of the reinforcement to the lining shall be in accordance with prEN 13121-3.

Subsequent to any forming or machining, the specified thickness shall be maintained. This may require initial use of a thicker lining material.

5 Determination of partial design factor, A_2

5.1 General

This clause defines the methods for determining the partial design factor, A_2, used for establishing the design factor K and the design factor F in accordance with prEN 13121-3.

Five methods are described and are summarised in Table 2; together with the maximum design temperature, T_d, applicable to each particular method.

The methods listed provide for situations where there are common material-/media lists given in annex A or manufacturers' data for resins or thermoplastics are available, and where there is documented service experience available in annex B or testing is required. Testing may be carried out in a laboratory and/or in-situ in an existing plant item by procedures given in annex C.

An overall view of handling these methods is given in figure 1.

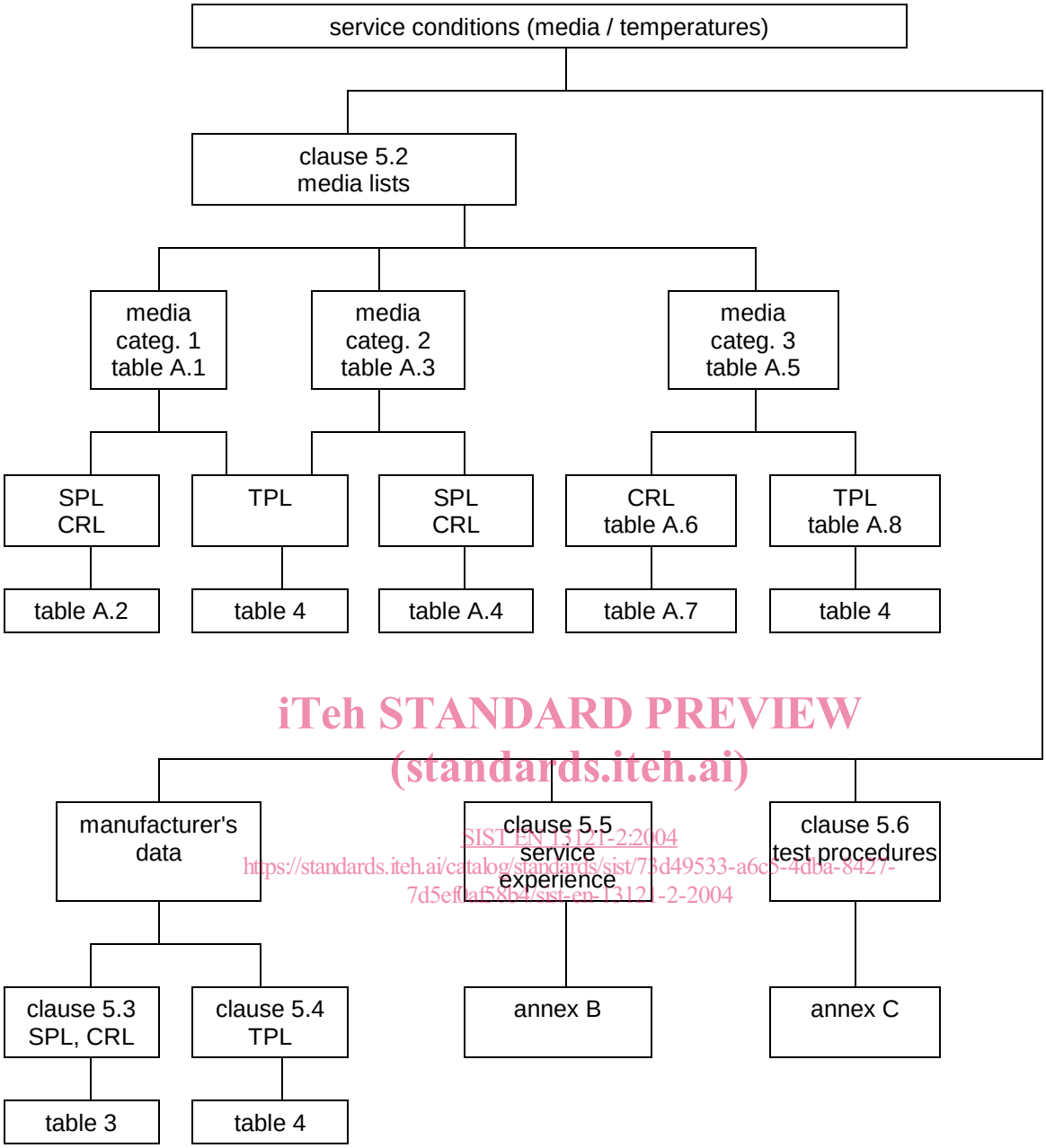

Figure 1 — Determination of partial design factor, A_2

It will often be possible to specify the partial design factor, A_2, by more than one of the above methods. In such cases it is permissible to choose the method which gives the lowest value of A_2.

The absence of data for a particular method is not indicative that a resin or TPL is unsuitable, it usually implies only that the service condition has not been studied using that particular method. This is especially so for the media lists which only give data for temperatures as shown in Table 2, for higher service temperatures, other methods may be used.

With regard to the service conditions, three possible situations can arise:

a) The service conditions can be considered identical to those for which data already exists. In this case the methods listed can be used directly.

b) The service conditions are sufficiently similar to those for which data already exists to allow direct use of the existing data. In this case a judgement on degree of similarity and use of existing data is required.

c) The service conditions are significantly different to any previously encountered and only those methods pertaining to the evaluation of test laminates shall be used.

It is particularly important that the chemical resistance is verified for the full range of service conditions, including any trace impurities e. g. organics or fluorides, and transient temperatures. In some cases there will be a need to take into account that the protective layer may be exposed to different phases of the service fluids, e. g. gas and liquid, and the phase boundary between them.

Table 2 — Maximum design temperature, T_d, used for determination of the partial design factor, A_2

Method of determination by	Maximum design temperature, T_d				
	SPL	CRL	PVC-U	PP-H PP-B PP-R	PVDF E-CTFE FEP PFA
lists of media					
— of category 1 (see Table A.1)	40 °C	100 °C	60 °C	100 °C	100 °C
— of category 2 (see Table A.4)	40 °C	80 °C	60 °C	80 °C	80 °C
— of category 3 (see Tables A.5 and A.8)	n. a.	60 °C	60 °C	60 °C	60 °C
resin manufacturer's data	40 °C	120 °C	n. a.	n. a.	n. a.
thermoplastics manufacturer's data	n. a.	n. a.	60 °C	100 °C	120 °C
service experience	40 °C	120 °C	80 °C	100 °C	120 °C
testing in laboratory/in-situ	40 °C	120 °C	80 °C	100 °C	120 °C
n. a. = not applicable					

5.2 Determination of partial design factor, A_2 by using media lists

The media lists when used with protective layers in accordance with clause 4, at different temperatures and concentrations, are given in annex A.

Use of media lists is only applicable when considering use of a resin described in the resin groups in accordance with EN 13121-1. For other polyester, vinyl ester, furance and phenolic resins which are not in a resin group in accordance with EN 13121-1, then methods 5.3, 5.5 or 5.6 shall be used.

The list of media given in Annex A is not a comprehensive list of all media for which this Standard may be used. Additional data may be found using methods 5.3, 5.4 or 5.5

The lists do not apply for temperatures above 100 °C for category 1 media, not above 80 °C for category 2 media, not above 60 °C for category 3 media and for mixtures of media.

The lists apply to parts which have been either post-cured or not post cured in accordance with the recommendations of the resin manufacturer. By post cure is meant that the laminate shall be maintained for a minimum of 4 h at a minimum temperature of 80 °C or the *HDT* of the resin or in accordance with the recommendation of the resin manufacturer.

The partial design factor, A_2, is determined by taking account of the category of media, temperature, type of protective layer and resin group in accordance with the Table 2 of EN 13121-1:2003, type of fibre and post curing.

5.3 Determination of partial design factor, A_2 using resin manufacturer's data

5.3.1 Chemical resistance information supplied by resin manufacturers

The chemical resistance information supplied by resin manufacturers shall include details related to the cure of the material from which maximum temperatures, T_m, for different service conditions were determined; for example time and temperature of cure including post cure and heat deflection temperature (*HDT*).

5.3.2 Minimum *HDT*

The *HDT* of the cured resin of the tank or vessel shall be at least 20 °C higher than the maximum design temperature, T_d.

The maximum temperature, T_m, shall only be used by the manufacturer if the resin manufacturer's recommended conditions of cure and post cure will be followed during manufacture.

5.3.3 Partial design factor A_2

The partial design factor, A_2, using SPL or CRL, shall be determined in relation to the resin manufacturer's maximum temperature, T_m, for the service conditions and the maximum design temperature, T_d.

The interpretation of resin manufacturer's maximum temperature, T_m, data in terms of A_2, is given in Table 3.

Table 3 — Partial design factor, A_2, relating to the maximum design temperature, T_d, and the maximum temperature, T_m

Maximum design temperature, T_d °C	A_2 post cured[a]
$T_d = T_m$	1,4
$T_d = T_m - 10$	1,4
$T_d = T_m - 20$	1,3
$T_d = T_m - 30$	1,3
$T_d = T_m - 40$	1,2
$T_d = T_m - 50$	1,2
$T_d = T_m - 60$	1,1
$T_d = T_m - 70$	1,1

[a] Conditions as given in 5.2 or subject to agreement with the resin manufacturer.