TECHNICAL REPORT

ISO/TR 10358

Second edition
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Plastics pipes and fittings for industrial applications — Collection of data on combined chemical-resistance

Tubes et raccords en matières plastiques pour applications industrielles — Collecte de données sur la résistance chimique combinée

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 3, *Plastics pipes and fittings for industrial applications*.

This second edition cancels and replaces the first edition (ISO/TR 10358:1993), which has been technically revised.

The main changes compared to the previous edition are as follows:

— Due to the rare use of PE-LD inside industrial applications and the comparability of its chemical behaviour to PE-HD, the reference to PE only has been indicated.

— Considering the ever more frequent use in industrial fields, the following materials have been introduced:

  — ECTFE

  — PA-U

  — PFA

  — PPS

  — PSU

  — PTFE

— Due to the different behaviours of the materials considered in this document, they have been gathered in two separate tables with different temperature ranges.

— A column with CAS (Chemical Abstracts Service) number, where available, has been introduced for the listed substances.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The tables in this document provide a preliminary informative collection of the chemical resistance of thermoplastic materials used to manufacture piping components which are not subjected to pressure or other stresses. They take into account the working conditions used, in particular the temperatures and concentrations of the chemical fluids to which a material may be exposed. To evaluate the behaviour of the different materials against the chemicals, data coming from published literature and industry experience were considered. To obtain numerical values for changes in mass or for mechanical properties, tests can be carried out in accordance with ISO 175, ISO 4433 (all parts) and ISO 22088 (all parts).

Careful consideration is paid by the end user when the fluid being transported is a combination of two or more chemicals. The resulting combination can have the potential to negatively affect the material from which the pipeline is made[12].

Careful consideration is paid by the end user to composite structures. The following data, collected from literature, only address the effect on an individual material. Aspects for composite structure such as layers, reinforcements and/or fillers that are added above a negligible amount, are outside of the scope of this document[12].

Plastics pipes and fittings for industrial applications — Collection of data on combined chemical-resistance

1 Scope

This document collects available data on combined chemical resistance of thermoplastic materials typically used to manufacture piping components for industrial applications, against fluids over a range of temperatures.

The base thermoplastic materials covered by this classification are:

Polyethylene	PE

NOTE 1 The PE considered in this document corresponds to PE-HD, with a minimum density value of 0,935 g/cm^3 (e.g.: PE63, PE80, PE100, PE100-RC, PE-RT).

Polypropylene	PP (PP-R and PP-RCT, PP-H, PP-B)
Polyvinyl chloride, unplasticized	PVC-U
Polyvinyl chloride, chlorinated	PVC-C
Polybutylene	PB
Acrylonitrile/butadiene/styrene	ABS
Polyvinylidene fluoride	PVDF

NOTE 2 This document considers homopolymer PVDF.

Cross-linked polyethylene	PE-X (PE-Xa, PE-Xb, PE-Xc)
Ethylene chloro trifluoro ethylene	ECTFE
Polyamide, unplasticized	PA-U (PA-U11, PA-U12)

NOTE 3 This document focuses on PA-U11 and PA-U12 only, as these long chained PA-U are standardized according to ISO 16486-1; short chained (e.g. PA 66) and plasticized PAs are not used for monolithic plastic piping components.

Polysulfone	PSU
Perfluoralkoxy	PFA

NOTE 4 Temperatures higher than 200°C can be applied after an evaluation with the raw material manufacturer.

Polytetrafluoroethylene	PTFE

NOTE 5 Temperatures higher than 200°C can be applied after an evaluation with the raw material manufacturer.

Polyphenylene sulphide PPS

NOTE 6 PPS is new with regards to industrial application and chemical resistance issues; for this reason, manufacturers and end-users are advised to assess the chemical suitability of the material.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

4 Symbols used to describe the fluids

Column 1:

Identification number of the fluid.

Column 2:

The fluids are listed by their most common names, including trivial and trade names, in English alphabetical order.

With some of the chemicals, synonyms are listed, also in alphabetical order, with a reference to the first or the most widely used name.

NOTE In some cases, further information is given:

Subl. sublimes

Dec. decomposes

Column 3:

CAS nr. or internationally recognized code for the fluid listed in column 2.

Column 4:

Melting points (m.p.) are given where appropriate, the values referring to fluids of technical-grade purity.

Column 5:

Boiling points (b.p.) are given where appropriate, the values referring to fluids of technical-grade purity at standard atmospheric pressure, unless otherwise stated in brackets below. In that case a different pressure in mm Hg height is indicated.

Column 6:

The concentration and/or purity of the fluid is indicated, using the following symbols:

Dil. sol. Dilute aqueous solution at a concentration equal to or less than 10 %.

Sol. Aqueous solution at a concentration higher than 10 %, but not saturated.

Sat. sol. Saturated aqueous solution, prepared at 20 °C.

tg At least technical-grade purity.

tg-l Technical grade, liquid.

tg-g Technical grade, gas

Work. sol. Working solution of the concentration usually used in the industry concerned.

Susp. Suspension of solid in a saturated solution at 20 °C.

The concentrations are expressed as a percentage by mass at 20 °C, unless otherwise stated.

Column 7:

Test temperatures at which chemical resistance determined.

Column 8, etc.:

The chemical resistance of the pipeline materials is given in accordance with the classification system explained in 5.1.

5 Chemical resistance classification

5.1 General

Even if the base thermoplastics show full resistance to a fluid at a defined temperature, their application inside a piping system should be evaluated to verify the resistance of the joints.

The chemical resistance classification is given in Table 1 for polymers with thermal rating up to and including 100 °C, and in Table 2 for polymers with higher thermal rating.

The following chemical resistance information:

S (satisfactory), L (limited) or NS (not satisfactory),

given in Tables 1 and 2, is only suitable for materials which are used to produce piping components without the influence of internal and external mechanical stresses (for example, those caused by internal pressure, flexural stresses).

For different percentages not given in Tables 1 and 2 and mixtures of fluids, the compatibility will be checked with the material supplier.

5.2 Procedure

The procedure used to evaluate the chemical resistances of the table below refers to ISO 175. ISO 4433-1, ISO 4433-2, ISO 4433-3 or ISO 4433-4 may also be used for polymers indicated in the scope.

In order to assess the behaviour of piping components for the conveyance of fluids under pressure, or in the presence of other stresses, the tests performed by the end user will be considered.

To assess the tendency of a material towards environmental stress cracking, tests may be carried out in accordance with all parts of the ISO 22088 series.

5.3 Performances

The material applicability at temperatures close to upper limits could be limited due to thermal aging.

Not all thermoplastic materials are technically suitable for transport of gases under pressure due to risk of explosion when the energy level is locally raised by gas compression

Other properties of the pipeline material (e.g. permeability) or of the conveyed fluid (e.g. toxicity, flammability, etc.) should be considered separately.

Table 1 — Chemical-resistance classification data of thermoplastics materials with thermal rating up to and including 100 °C

No.	Chemical	CAS Nr.	m.p.°C	b.p.°C	Concentration %	*T* °C	PE	PP	PB	PVC-U	PVC-C	ABS	PE-X	PA-U
1	Acetaldehyde	75-07-0	-123	21	40	20	S	S		NS	NS	NS	S	L
						40	L	L		NS	NS	NS	L	L
						60	L	L		NS	NS	NS	L	NS
						80					NS			
						100								
					tg-l	20	S	L	L	NS	NS	NS	S	L
					tg-g	40	L	L	L	NS	NS	NS	L	L
						60	L	L	NS	NS	NS	NS	L	L
						80					NS			NS
						100								
2	Acetamide	60-35-5	82	221	5	20	S	S	S	NS	NS	NS	S	S
						40	S	S	L		NS	NS	S	
						60	S	S	L				S	
						80								
						100								
3	Acetic acid	64-19-7	17	118	Up to 10	20	S	S	S	S	S	L	S	S
						40	S	S	S	S	S	L	S	S
						60	S	S	S	S	S		S	S
						80		L			S		S	L
						100		L						
					10 to 40	20	S	S	S	L	L	NS	S	L
						40	S	S	L	L	L	NS	S	
						60	S	L	L	L	L		S	
						80		L					S	
						100		L						
					50	20	S	S	S	L	L	NS	S	L
						40	S	S	L	L	L	NS	S	
						60	L	L	L	L	L		L	
						80		L					L	
						100		L						
					60	20	S	L	L	L	L	NS	S	L
						40	L	L	L	L	L	NS		
						60	L	L	NS	NS	L			
						80		L						
						100		NS						

No.	Chemical	CAS Nr.	m.p.°C	b.p.°C	Concentration %	*T* °C	PE	PP	PB	PVC-U	PVC-C	ABS	PE-X	PA-U
3	Acetic acid (cont'd)	64-19-7	17	118	80	20	L	L	L	NS	L	NS	S	L
						40	L	L	L	NS	L	NS		
						60	L	NS	L	NS	L			
						80		NS						
						100		NS						
					95	20	L	S	NS	NS	L		L	L
						40	L	L	NS	NS	NS		L	NS
						60	L	L		NS	NS		L	
						80		L						
						100		NS						
	Acetic acid, glacial				> 96	20	S	S	L	NS	NS	NS	S	NS
						40	L	L	NS	NS	NS	NS		
						60	L	L	NS	NS	NS	NS		
						80		L	NS		NS			
						100		NS						
4	Acetic anhydride	108-24-7	-73	140	tg-l	20	S	S	S	NS	NS	NS	S	L
						40	L	L	S	NS	NS	NS		NS
						60	L	L	S	NS	NS			
						80								
						100								
5	Acetone	67-64-1	-95	56	Up to 10	20	S	S	S	NS	NS	NS	S	S
						40	S	L		NS	NS	NS	S	S
						60	L	L		NS	NS	NS	L	L
						80		L						
						100		NS						
					tg-l	20	L	S	S	NS	NS	NS	L	S
						40	L	L		NS	NS	NS	L	L
					tg-g	60	L	L		NS	NS		L	L
						80		NS						NS
						100		NS						
6	Acetophenone	98-86-2	20	202	tg-l	20	S	S		NS	NS	NS	S	L
						40	L	L		NS	NS	NS		L
						60	L	L		NS	NS			L
						80								
						100								
7	Acetyl chloride	75-36-5	-112	51	tg-l	20	L	L		NS	NS	NS	L	
						40	NS	NS		NS	NS	NS	NS	
					tg-g	60								
						80								
						100								

No.	Chemical	CAS Nr.	m.p.°C	b.p.°C	Concentration %	*T* °C	PE	PP	PB	PVC-U	PVC-C	ABS	PE-X	PA-U
8	Acetylene, gas	74-86-2	-84		tg-g	20	S	S	L	NS	NS	NS	S	S
						40	S	S	NS	NS			S	S
						60	S	L	NS				S	S
						80								
						100								
9	Acrylonitrile	107-13-1	-82	77	tg-l	20	S	S		NS	NS	NS	S	L
						40	S	L			NS	NS	S	L
						60	L	L					L	L
					tg-g	80								
						100								
10	Adipic acid	124-04-9	151	265	Sat. sol. (1,4%)	20	S	S	S	S	S	NS	S	L
				(100 mm)		40	S	S	L	S	S		S	L
						60	S	S	L	L	S		S	L
						80					S			L
						100								
						80								
11	Air	132259-10-0	-213	193	tg-g	20	S	S	S	S	S	S	S	
		ZVG nr. 80000				40	S	S	S	S	S	S	S	
						60	S	S	S	S	S		S	
						80					S			
						100								
12	Allyl alcohol	107-18-6	-129	97	tg-l	20	S	L	S	L	NS	NS	S	L
						40	S	L	S	NS			S	
						60	L	L	S	NS			L	
						80								
					tg-g	100								
13	Allyl chloride	107-05-1	-136	45	Sat. sol.	20	L	L	L	NS	NS	NS	L	
						40	NS	L	L	NS	NS	NS	NS	
						60	NS	NS	L	NS	NS		NS	
						80								
						100								
14	Almond oil				tg-l	20	S	S		S	L		S	
						40	L	S		L	L		L	
						60	L	L		L	L		L	
						80		L						
						100		NS						
15	Alum (see 21)													

No.	Chemical	CAS Nr.	m.p.°C	b.p.°C	Concentration %	*T* °C	PE	PP	PB	PVC-U	PVC-C	ABS	PE-X	PA-U
16	Aluminium chloride	7446-70-0			Sat. sol.	20	S	S	S	S	S	L	S	NS
						40	S	S	S	S	S	L	S	
						60	S	S	S	L	S		S	
						80		S			L			
						100		L						
17	Aluminium fluoride	7784-18-1	250		Susp.	20	S	S	S	S	S	L	S	NS
						40	S	S	S	S	S	L	S	
						60	S	S	S	S	S		S	
						80		S			L			
						100		NS						
18	Aluminium hydroxide	21645-51-2			Susp.	20	S	S	S	S	S	L	S	
						40	S	S	S	S	S	L	S	
						60	S	S	S	S	S		S	
						80		S			S			
						100								
19	Aluminium nitrate	13473-90-0			Sat. sol.	20	S	S	S	S	S	L	S	NS
						40	S	S	S	S	S	L	S	
						60	S	S	S	S	S		S	
						80		S			L			
						100								
20	Aluminium chloride oxyde	13596-11-7			Susp.	20	S	S	S	S	S	L	S	NS
						40	S	S	S	S	S	L	S	
						60	S	S	S	L	S		S	
						80		S			L			
						100								
21	Aluminium potassium sulphate	10043-67-1	92,5		Sat. sol.	20	S	S	S	S	S	L	S	S
						40	S	S	S	S	S	L	S	
						60	S	S	S	S	S		S	
						80		S			S			
						100		S						
22	Aluminium sulphate	10043-01-3			Sat. sol.	20	S	S	L	S	S	L	S	S
						40	S	S	NS	S	S	L	S	S
						60	S	S	NS	S	S		S	L
						80		S			L			L
						100		L						

No.	Chemical	CAS Nr.	m.p.°C	b.p.°C	Concentration %	*T* °C	PE	PP	PB	PVC-U	PVC-C	ABS	PE-X	PA-U
23	Ammonia, aqueous	1336-21-6			Sat. sol.	20	S	S	S	S	NS	L	S	S
						40	S	S	S	L	NS	L	S	S
						60	S	S	S	L	NS		S	S
						80					NS			S
						100								
24	Ammonia, dry gas	7664-41-7	-78	-34	tg-g	20	S	S	S	S	NS	NS	S	S
						40	S	S	S	S	NS	NS	S	S
						60	S	L	S	S	NS		S	S
						80		L			NS			
						100		NS						
25	Ammonia, wet gas	7664-41-7	-78	-34	tg-g	20	S	S	S	S	L	NS	S	S
						40	S	S	L	L	NS	NS	S	S
						60	S	L	L	L	NS		S	
						80		L			NS			
						100		NS						
26	Ammonium acetate	631-61-8	114		Sat. sol.	20	S	S		S	S	L	S	S
						40	S	S		S	S	NS	S	S
						60	S	S		L	S		S	S
						80		S			L			
						100		S						
27	Ammonium bifluoride	1341-49-7	125		Sat. sol.	20	S	S	S	S	NS	NS	S	
						40	S	S	S	L			S	
						60	S	S	S	L			S	
						80		S						
						100								
28	Ammonium carbonate	506-87-6			Sat. sol.	20	S	S	S	S	S	L	S	S
						40	S	S	S	S	S	L	S	S
						60	S	S	S	S	S		S	S
						80		S						
						100		L						
29	Ammonium chloride	12125-02-9			Sat. sol.	20	S	S	S	S	S	L	S	S
						40	S	S	S	S	S	L	S	
						60	S	S	S	L	S		S	
						80		S			L			
						100		L						
30	Ammonium fluoride	12125-01-8			Up to 20	20	S	S	S	S	S	L	S	
						40	S	S	S	L	S	NS	S	
						60	S	S	S	NS	S		S	
						80								
						100								