भारतीय मानक

Indian Standard

IS/ISO 11114-2 : 2021

(*Superseding* IS/ISO 11114-2 : 2013)

गैस सिलेंडर — गैस के संघटक से सिलेंडर एंव वाल्व सामग्री की अनुरूपता

भाग 2 गैर-धातु सामग्री

(दूसरा पुनरीक्षण)

Gas Cylinders — Compatibility of Cylinder and Valve Materials with Gas Contents

Part 2 Non-Metallic Materials

(Second Revision)

ICS 23.020.35

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Gas Cylinders Sectional Committee, MED 16

NATIONAL FOREWORD

This Indian Standard (Part 2) (Second Revision) which is identical with ISO 11114-2 : 2021 'Gas cylinders — Compatibility of cylinder and valve materials with gas contents — Part 2: Non-metallic materials' published by the International Organization for Standardization (ISO) was adopted by the Bureau of Indian Standards on recommendation of the Gas Cylinders Sectional Committee and approval of the Mechanical Engineering Division Council.

This standard was first published in 2013 and revised in 2015. The Indian Standard supersedes IS/ISO 11114-2 : 2013 'Transportable gas cylinders — Compatibility of cylinder and valve materials with gas contents: Part 2 Non-metallic materials'. The main changes compared with the previous edition are as follows:

a) New materials were added in Table 1; and

b) Table 2, dedicated to the compatibility for liners, was added.

Under the general title 'Gas cylinders — Compatibility of cylinder and valve materials with gas contents', the standard is in six parts, other parts are as following:

Part 1 Metallic materials

Part 3 Autogenous ignition test for non-metallic materials in oxygen atmosphere

Part 4 Test methods for selecting steels resistant to hydrogen embrittlement

Part 5 Test methods for evaluating plastic liners (*under process*)

Part 6 Oxygen pressure surge testing (*under process*)

The text of ISO standard has been approved as suitable for publication as an Indian Standard without deviations. Certain terminologies and conventions are, however, not identical to those used in Indian Standard. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear, referring to this standard, they should be read as 'Indian Standard'.
b) Comma (,) has been used as a decimal marker, while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to certain International Standard for which Indian Standard also exist. The corresponding Indian Standard, which are to be substituted in their respective places, are listed below along with their degree of equivalence for the editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
ISO 11114-3 Gas cylinders — Compatibility of cylinder and valve materials with gas contents — Part 3: Autogenous ignition test for non-metallic materials in oxygen atmosphere	IS/ISO 11114-3 : 2010 Gas cylinders — Compatibility of cylinder and valve materials with gas contents: Part 3 Autogenous ignition test for non-metallic materials in oxygen atmosphere	Identical
ISO 15001 Anaesthetic and respiratory equipment — Compatibility with oxygen	IS/ISO 15001 : 2010 Anaesthetic and respiratory equipment — Compatibility with oxygen (*first revision*)	Identical

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Introduction

This document provides guidance on the compatibility of non-metallic materials used for gas cylinders and gas cylinder valves with the gas contents of the cylinder. Compatibility of metallic materials is covered in ISO 11114-1.

Non-metallic materials are very often used for the construction of gas cylinder valves as seals, e.g. O-ring, gland packing, seats or as lubrication products to avoid friction. They are also commonly used to ensure sealing of the valve/cylinder connection. For gas cylinders, they are sometimes used as an internal coating or as a liner for composite materials.

Non-metallic materials not in contact with the gas are not covered by this document.

This document is based on current international experience and knowledge. Some data are derived from experience involving a mixture of the gas concerned with a dilutant, where no data for single component gases were available.

This document has been written so that it is suitable to be referenced in the UN Model Regulations[7].

Indian Standard

GAS CYLINDERS-— COMPATIBILITY OF CYLINDER AND VALVE MATERIALS WITH GAS CONTENTS

PART 2 NON-METALLIC MATERIALS

1 Scope

This document gives guidance on the selection and evaluation of compatibility between non-metallic materials for gas cylinders and valves and the gas contents. It is also applicable to tubes, pressure drums and bundles of cylinders.

This document covers composite and laminated materials used for gas cylinders. It does not include ceramics, glasses and adhesives.

This document considers the influence of the gas in changing the material and mechanical properties (e.g. chemical reaction or change in physical state). The basic properties of the materials, such as mechanical properties required for design purposes (normally available from the materials supplier), are not considered. Other aspects, such as quality of delivered gas, are not considered.

The compatibility data given are related to single component gases but can be applicable to gas mixtures.

This document does not apply to cryogenic fluids (this is covered in ISO 21010).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 10286, *Gas cylinders — Vocabulary*

ISO 10297, *Gas cylinders — Cylinder valves — Specification and type testing*

ISO 11114-3, *Gas cylinders — Compatibility of cylinder and valve materials with gas contents — Part 3: Autogenous ignition test for non-metallic materials in oxygen atmosphere*

ISO 15001, *Anaesthetic and respiratory equipment — Compatibility with oxygen*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 10286 and the following apply.

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/

3.1
competent person
person who has the necessary technical knowledge, qualification, experience and authority to assess and approve materials for use with gases and to define any special conditions of use that are necessary

[SOURCE: ISO 11114-1:2020, 3.1, modified — "qualification" has been added to the definition.]

3.2
acceptable
satisfactory material/gas combination, under normal conditions of use, provided that any indicated non-compatibility risks are taken into account

Note 1 to entry: Normal conditions of use are defined in Clause 5.

Note 2 to entry: Non-compatibility risks are provided in Table 1.

3.3
not acceptable
unsafe material/single gas combination, under normal conditions of use

Note 1 to entry: For gas mixtures, special conditions can apply.

Note 2 to entry: Normal conditions of use are defined in Clause 5.

3.4
dynamic sealing
non-metallic material used, in normal operation, to provide a pressure seal between two surfaces that have relative motion to each other

4 Materials

4.1 General

Non-metallic materials shall be suitable for the intended service. They are suitable if their compatibility is stated as acceptable in Table 1, and Table 2 for the cylinder liners, or the necessary properties have been proved by tests or long and safe experience to the satisfaction of a competent person.

NOTE When plastic liner materials are used, it is necessary to use metallic bosses. For compatibility of metallic bosses, see ISO 11114-1.

If coated materials are used, the suitability of the combination shall be assessed and approved if all technical aspects have been considered and validated by a competent person. These technical aspects include, but are not limited to, compatibility of the coating material with the intended gas, durability of the coating during all its intended use and gas permeability through it.

4.2 Type of materials

The most commonly used non-metallic materials for gas cylinders and cylinder valves can be grouped as follows:

— plastics;

— elastomers;

— fluid lubricants.

NOTE 1 Solid lubricants are sometimes used, e.g. MoS_2.

Materials considered in this document are as follows:

a) plastics:

— polytetrafluoroethylene (PTFE);

— polychlorotrifluoroethylene (PCTFE);

— polyvinylidenefluoride (PVDF);

— polyamide (PA);

— polypropylene (PP);

— polyethylene (PE);

NOTE 2 PE covers grades such as HDPE (high density polyethylene), MDPE (medium density polyethylene), LDPE (low density polyethylene), PEX (cross-linked), etc.

— polyethylene terephthalate (PET);

— polyetheretherketone (PEEK);

— polypropylene sulfide (PPS);

— polyvinyl chloride (PVC);

— polyimide (PI);

— polyoxymethylene (POM);

b) elastomers (rubber):

— butyl rubber (IIR);

— nitrile butadiene rubber (NBR);

— chloroprene rubber (CR);

— fluorocarbon rubber (FKM);

— methyl-vinyl-silicone rubber (VMQ);

— ethylene propylene diene rubber (EPDM);

— polyacrylate rubber (ACM);

— polyurethane rubber (PUR);

— epichlorohydrin rubber (ECO);

— methyl-fluoro-silicone rubber (FVMQ);

c) fluid lubricants:

— hydrocarbon (HC);

— fluorocarbon (FC).

5 General consideration

It is important to note that these materials are generic types. Within each material type there are variations in the properties of the materials due to polymer differences and formulations used by manufacturers to modify physical and chemical properties of the material. The user of the material should therefore consult the manufacturer and, if necessary, carry out tests before using the material (e.g. for critical services such as oxygen and other oxidizing gases).

Lubricants are often used in valves to reduce friction and wear in the moving parts. For valves used for oxidizing gases or for gases supporting combustion, if lubrication is required, it shall be ensured that the lubricant is compatible for the intended application when the lubricated components are in contact with the oxidizing gas or the gas supporting combustion.

Where the lubricant is listed as "not acceptable" in Table 1 for reasons other than violent reaction (oxidation/burning) (F), it may be used safely and usually satisfactorily in applications which do not involve contact in normal operation with the gas. An example of such an application is the lubrication of the valve actuating mechanism not in contact with the gas.

Where the lubricant is listed as "not acceptable" for the reason of violent reaction (oxidation/burning) (F), it should not be used in any part of the system that can be contacted by the gas, even under abnormal conditions such as in the event of a failure of the gas sealing system. If there is a risk of violent reaction, appropriate safety and suitability tests shall be carried out for the lubricant application before it is used either on the lubricant itself, as specified in ISO 11114-3, or on the lubricated equipment in which it is intended to be used, as specified in ISO 10297.

The properties of plastics and elastomers including compatibility are dependent on temperature. Low temperature can cause hardening and the possibility of embrittlement, whereas high temperature can cause softening and the possibility of material flow. Users of such materials shall check to ensure their suitability over the entire operating temperature range specified by the cylinder and valve manufacturing standards.

Some materials become brittle at low temperatures, especially at temperatures at the lower end of the normal operating range (e.g. fluorocarbon rubber). Temperatures in the refrigerant or cryogenic ranges affect many materials and caution shall be exercised at temperatures below −50 ° C. This risk shall be considered in particular when transfilling by thermal siphoning at low temperature or similar procedures, or for cylinders regularly filled at low temperatures (e.g. carbon dioxide).

6 Specific considerations

6.1 General

The compatibility of gases with non-metallic materials is affected by chemical reactions and physical influences, which can be classified as defined in 6.2.

6.2 Non-compatibility risks

6.2.1 Violent reaction (oxidation/burning) (F)

6.2.1.1 Principle

Historically the majority of serious accidents from rapid oxidation or violent combustion have occurred with oxidizing gas supporting combustion at high pressure. Thorough investigation of all materials and factors should be conducted with great care and all data should be considered before designing or using equipment to handle oxidizing gases or gases supporting combustion.

Compatibility depends mainly on the operating conditions (pressure, temperature, gas velocity, particles, equipment design and application). The risk shall particularly be considered with gases such as oxygen, fluorine, chlorine and nitrogen trifluoride. Most of the non-metallic materials can be ignited relatively easily when in contact with oxidizing gases (see ISO 10156) and even when in contact with gases not classified as oxidizing but still supporting combustion.

The selection of a material for use with oxygen or an oxygen enriched atmosphere, or both, is primarily a matter of understanding the circumstances that cause the material to react with oxygen. Most materials in contact with oxygen will not ignite without a source of ignition energy (friction, heat of compression, particle impacts, etc.). When an energy input rate, as converted to heat, is greater than the rate of heat dissipation, and the resulting heat increase is continued for sufficient time, ignition and combustion will occur.

Thus, two general factors shall be considered:

a) the materials compatibility properties (ease of ignition and energy of combustion);

b) the different energy sources that will produce a sufficient increase in the temperature of the material.

These general factors should be viewed in the context of the entire system design so that the following specific factors will assume the proper relative significance:

— the properties of the materials, which include the factors affecting ease of ignition and the conditions affecting potential resulting damage (heat of reaction);

— the operating conditions [e.g. pressure, temperature, oxygen or oxidizing gas concentrations in a gas mixture, or both, influence of dilutant (e.g. helium), surface contamination];

— the potential sources of ignition (e.g. friction, heat of compression, heat from mass impact, heat from particle impact, static electricity, electrical arc, resonance, internal flexing);

— the possible consequence (e.g. effects on the surroundings such as propagation of fire);

— the additional factors (e.g. performance requirements, prior experience, availability).

In conclusion, the evaluation of compatibility of non-metallic materials is more critical than that of metallic materials, which generally perform well when in contact with oxygen.

6.2.1.2 Specifications for oxidizing gases

In accordance with 6.2.1.1, it is not possible to make a simple statement concerning the compatibility of non-metallic materials with oxidizing gases such as oxygen, chlorine, nitric oxide, nitrous oxide, nitrogen dioxide, nitrogen trifluoride, etc. (see ISO 10156).

For fluorine, which is the most oxidizing gas, all non-metallic materials would historically fall into the classification "not acceptable".

For fluorine mixtures, the gases industry now has evidence of successful testing and safe history of use of PTFE and PCTFE under controlled conditions (e.g. low concentration and low pressure). Therefore, following an assessment and authorization by a competent person, these materials are acceptable in similar conditions.

Oxygen and other oxidizing gases can react violently when tested with all non-metallic materials listed in 4.2 a), 4.2 b) and 4.2 c). Some materials such as PTFE and FKM are more resistant to ignition than other plastics and elastomers. HC lubricants are normally not acceptable. Under certain conditions other plastics and elastomers listed can be safely used in oxidizing service without presenting some of the disadvantages of PTFE, i.e. poor mechanical properties and risk of release of toxic products for breathing gas applications (see ISO 15001), or FKM, i.e. swelling, poor mechanical properties at low temperature, risk of release of toxic products in breathing gas applications, etc.

Consequently, non-metallic materials may only be used if it has been proven by tests (or long and safe service experience), taking into account all the operating conditions and especially the design of the equipment, that their use is safe. ISO 11114-3 and ISO 21010 give test methods for polymeric materials and fluid lubricants that result in conservative value. Some non-metallic materials can be safely used at higher pressure if they are satisfactorily tested in the final design configuration, e.g. in gas cylinder valves and regulators. Cylinder valves intended to be used for oxidizing gas service shall be tested in accordance with ISO 10297.

6.2.2 Mass loss (W)

6.2.2.1 Extraction

Solvent extraction of plasticizers from elastomers can cause shrinkage, especially in highly plasticized products.

Some solvents, e.g. acetone or DMF (dimethylformamide) used for dissolved gases such as acetylene, can damage non-metallic materials.

Liquefied gases can act as solvents.

6.2.2.2 Chemical attack

Some non-metallic materials can be chemically attacked by gases, e.g. the chemical attack of silicone elastomers by ammonia.

NOTE This attack can sometimes lead to the complete destruction of the material.

6.2.3 Swelling of material (S)

Elastomers and plastics can be subject to swelling due to gas (or liquid) absorption. This can lead to an unacceptable increase of dimensions (especially for O-rings) or the cracking due to sudden out-gassing when the partial pressure is decreased, e.g. carbon dioxide with fluorocarbon.

Initial swelling can be masked by subsequent extraction of plasticizers and fillers while in service. Other important effects such as changes in mechanical strength and hardness should also be considered.

Differences in the compounding, formulation and curing of a given elastomer can cause significant differences in the swelling of the material in service.

Regardless of the above compatibility evaluation, the design configuration (e.g. static or dynamic sealing) shall be taken into account before deciding to use elastomers or plastics. In this document, a swelling of more than approximately 15 % in normal service conditions is marked N (in particular not acceptable for dynamic sealing); a swelling less than this is marked A (acceptable) provided other risks are also acceptable.

NOTE There is also a risk of cross bonding between sulfur vulcanised rubbers and copper alloys.

6.2.4 Change in mechanical properties (M)

Gases can lead to an unacceptable change of mechanical properties in some non-metallic materials. This can result, for example, in an increase in hardness or a decrease in elasticity (i.e. an increase in compression set). ISO 1817 gives testing methods to check the influence of the gas on the mechanical properties.

6.2.5 Other compatibility considerations

6.2.5.1 Impurities in the gas (I)

Some gases contain typical impurities which it is possible will not be compatible with the intended materials (e.g. acetone in acetylene, hydrogen sulfide in methane).

6.2.5.2 Contamination of the material (C)

Some materials become contaminated in toxic gas use by the toxic gas and become hazardous themselves (e.g. during maintenance of equipment).

6.2.5.3 Release of dangerous products (D)

Many materials when subjected to extreme conditions (such as elevated temperature) can release dangerous products (e.g. toxic products). This risk shall be considered in particular for breathing gases as specified in ISO 15001.

6.2.5.4 Ageing (G)

Ageing is a gradual change in the mechanical and physical properties of the material due to the environment in which it is used or stored (e.g. exposure to UV light). Many elastomer and plastic materials are particularly subject to ageing; some gases like oxygen and in general exposure to high temperatures can accelerate the ageing process, leading to degradation such as cracking, brittleness, etc.

6.2.5.5 Permeation (P)

Permeation is a slow process by which gas passes through materials.

The permeation of some gases (e.g. helium, hydrogen, carbon dioxide) through non-metallic materials can be significant. For a given material, the permeation rate mainly depends on the temperature, pressure, thickness and surface area of the material in contact with the gas. The molecular radius of the gas and the specific formulation of plasticizers and other additives can cause a wide range of permeation rates for a particular type of plastic or elastomer.

This risk shall be considered for effects to the surroundings (e.g. toxicity, fire potential).

Permeation through the liner can lead to gas pressure between the liner and the composite, thus potentially causing liner collapse and/or blistering.

7 Compatibility data

7.1 Table of compatibility

Table 1 lists the gases in alphabetic order with their UN number. The compatibility data are given using the symbols and abbreviated terms defined in 7.2.1 and 7.2.2. When a gas/material combination is not acceptable, the main reason is given, using the appropriate abbreviation for the non-compatibility risk (see 6.2). The abbreviated terms are also sometimes used for acceptable combinations to show a limited risk.

If no UN number is listed in Table 1 for a gas (or a liquid), this means that this gas has no official UN number but it can be transported using a generic NOS (not otherwise specified) number (e.g. compressed gas, flammable, NOS, UN 1954).

Compatibility evaluations are based on the following documents:

— literature data;

— operational experiences;

— laboratory tests.

The material resistance to gases can be estimated by simple immersion tests in the respective gas with approximately the same or intensified exposure conditions (increase of temperature, pressure or flow rate). Time- and equipment-consuming test methods to evaluate the permeation and the absorption as well as the resistance to stress cracking are required in many cases.

Apart from the visual evaluation of detectable changes, changes in mass and dimension as well as the course of mechanical and other physical characteristics, depending on the immersion time, are the parameters of immersion tests. They are consulted as classification characteristics.

Testing procedures described in ISO 1817 and in ISO 9539 can be adapted to check the resistance of materials.

7.2 Symbols and abbreviated terms

7.2.1 Symbols for compatibility

A acceptable

NOTE There can be a secondary risk associated (see 7.2.4).

N not acceptable for use under normal service conditions

n no reliable recommendation can be made due to a lack of definitive information

u the compatibility depends on the conditions of use (e.g. oxygen), and the material may be used where it has been assessed and authorized by a competent person who specifies the conditions of use

7.2.2 Abbreviated terms for materials

PTFE polytetrafluoroethylene

PCTFE polychlorotrifluoroethylene

PVDF polyvinylidenefluoride

PA polyamide

PP polypropylene

PE polyethylene

PET polyethylene terephthalate

PEEK polyetheretherketone

PPS polypropylene sulfide

PVC polyvinyl chloride

PI polyimide

POM polyoxymethylene

IIR butyl rubber

NBR nitrile rubber

CR chloroprene rubber

FKM fluorocarbon rubber

VMQ methyl-vinyl-silicone rubber

EPDM ethylene propylene diene monomer

ACM polyacrylate rubber

PUR	polyurethane rubber
ECO	epichlorohydrin rubber
FVMQ	methyl-fluoro-silicone rubber
HC	hydrocarbon
FC	fluorocarbon

7.2.3 Symbols for compatibility risks

n	no reliable recommendation can be made due to a lack of definitive information
A	acceptable
C	contamination of material
u	compatibility depends on the conditions of use
D	dangerous product release
F	violent reaction (oxidation/burning)
G	ageing
I	impurities in the gas
M	change of mechanical properties
N	not acceptable for use under all normal service conditions
P	permeation
S	swelling
W	mass loss

7.2.4 Examples

EXAMPLE 1

AP

Symbol for compatibility = A.

Symbol for potential compatibility risk = P.

This example shows an acceptable material/gas combination, suitable for use in normal service conditions, provided the risk of permeation has been evaluated and found acceptable.

EXAMPLE 2

NF,C

Symbol for compatibility = N.

Symbol for non-compatibility risk:

— first risk = F;

— second risk = C.

This example shows a material/gas combination, not acceptable for general use with non-compatibility risks of violent reaction (first risk) and contamination of material (second risk).

7.2.5 Tables 1 and 2

Table 1 — Compatibility of non-metallic materials with gases when other than used with liner

No.	UN number	Name of the gas	Plastics												Elastomers										Fluid lubricants		MoS_2
			Formula	R#	PTFE	PI	PCT FE	PV DF	PA[a]	PP	POM	PEEK	PPS	PVC	IIR	NBR	CR	FKM	VMQ	EPDM	FVMQ	ACM	PUR	ECO[b]	HC	FC	
98	2035	1,1,1-TRIFLUO-ROETHANE	$C_2H_3F_3$	R 143a	A	n	AS	A	A	NS	A	A	A	NS	NS	NS	NS	A	NS	NS	NS	NS	NS	NS	NW	NW	A
39	1030	1,1-DIFLUOROETHANE	$C_2H_4F_2$	R 152a	A	A	AS	A	A	NS	NS	NS	NS	NS	AS	A	A	NS	NS	A	NS	A	NS	NS	NW	NW	A
40	1959	1,1-DIFLUOROETH-YLENE	$C_2H_2F_2$	R 1132a	A	n	AS	A	A	NS	NS	NS	A	NS	NS	A	A	NS	NS	NS	NS	NS	NS	NS	NW	NW	A
97	3082	2-TRICHLORO-1,2,2-TRI-FLUOROETHANE	$C_2Cl_3F_3$	R 113	A	n	AS	A	AW	A	AS	A	A	NW	NS	AS	AS	AS	NS	NS	NS	NS	NS	NS	NW	NW	A
36	1958	1,2-DICHLORO-1,1,2,2-TETRA-FLUOROETHANE	$C_2Cl_2F_4$	R 114	A	A	AS	A	A	NS	NS	NS	A	NS	AS	A	A	AS	NS	A	NS	A	A	NS	NW	NW	A
38	2517	1-CHLORO-1,1-DIFLUO-ROETHANE	$C_2H_3ClF_2$	R 142b	A	A	AS	A	A	NS	NS	NS	NS	NS	AS	AS	AS	NS	NS	A	NS	A	NS	NS	NW	NW	A
24	1021	1-CHLORO-1,2,2,2-TETRAFLUO-ROETHANE	C_2HClF_4	R 124	A	n	A	A	A	NS	NS	NS	NS	NS	NS	NS	NS	A	NS	NS	NS	NS	NS	NS	NW	NW	A
113	3161	1-CHLORO-1,2-DIFLUO-ROETHANE	$C_2H_3ClF_2$		A	n	A	A	A	NS	NS	NS	NS	NS	NS	NS	NS	A	NS	NS	NS	NS	NS	NS	n	n	A
25	1983	1-CHLORO-2,2,2-TRIF-LUOROETHANE	$C_2H_2ClF_3$	R 133a	A	A	AS	A	A	NS	NS	NS	NS	NS	n	n	n	A	NS	NS	NS	NS	NS	NS	NW	NW	A
117	2044	2,2-DIMETHYLPRO-PANE	C_5H_{12}		A	n	A	A	A	NS	A	A	A	A	NS	A	A	A	NS	NS	A	NS	n	A	n	n	A
1	1001	ACETYLENE[c]	C_2H_2		A	n	A	A	AW, I	A	A	A	A	A	A	NW, I	NW,I	NW, I	NW, I	A	A	NW, I	NW, I	A	NW,I	NW,I	A
105	1002	AIR[d]			AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	AF	A	AF	AF	A
2	1005	AMMONIA	NH_3		A	NW	A	NG, W	A	A	A	A	A	A	A	NW	A	NW	NW	A	NW	NW	NW	A	NW	A	A
3	1006	ARGON	Ar		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
4	2188	ARSINE	AsH_3		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	NW	A	NC,D	NC,D	A
5	1741	BORON TRICHLORIDE	BCl_3		A	n	A	A	NW	A	NW	A	A	A	NW	NW	NW	A	NW	NW	A	NW	NW	NW	NW	A	A
6	1008	BORON TRIFLUORIDE	BF_3		A	n	A	A	NW	A	NW	A	A	A	NW	NW	NW	A	NW	NW	A	NW	NW	NW	NW	A	A
9	2419	BROMOTRIF-LUORO-ETHYLENE	C_2BrF_3	R 123B1	A	n	AS	A	NS	NS	NS	NS	NS	NS	NS	NS	NS	A	NS	NS	NS	NS	NS	NS	AW	AW	A

[a] The compatibility information for PA given in this table is mainly based on PA 6.6 and does not necessarily cover all other types of PA.

[b] This material is only used for low pressure refrigerant gases.

[c] Some materials are not compatible because of the solvent used.

[d] At high pressure risk of violent reaction due to oxygen.

Table 1 *(continued)*

No.	UN number	Name of the gas	Plastics												Elastomers										Fluid lubricants		MoS_2
			Formula	R#	PTFE	PI	PCTFE	PVDF	PA[a]	PP	POM	PEEK	PPS	PVC	IIR	NBR	CR	FKM	VMQ	EPDM	FVMQ	ACM	PUR	ECO[b]	HC	FC	
8	1009	BROMOTRIF-LUORO-METHANE	$CBrF_3$	R 13B1	A	A	AS	A	A	AS, W	A	NS	NS	NS	AS	AS	AS	NS	NR	AS	NS	A	A	NS	AW	AW	A
10	1010	BUTADIENES	C_4H_6		A	A	A	A	A	A	A	A	A	A	NS, M	NS, M	NS, M	A	NS, M	NS,M	A	NS, M	NS, M	NS	NW	A	A
12	1011	BUTANE	C_4H_{10}		A	A	A	A	A	A	A	A	A	A	NS	A	A	A	NS, M	NS,M	A	A	A	A	NW	A	A
13	1012	BUTYLENE	C_4H_8		A	A	A	A	A	A	A	A	A	NS, M	NS, M	A	NS	A	NS, M	NS,M	A	NS, M	NS, M	A	NW	A	A
16	1013	CARBON DIOXIDE	CO_2		A	A	A	A	A	A	NS, M	A	A	A	NS	NS, M	NS, M	NS, M	AP	AS,W	A	A	A	A	A	A	A
17	1016	CARBON MONOXIDE	CO		A	A	A	A	A	A	A	A	A	A	AG	A	A	AS	A	A	A	A	A	A	A	A	A
109	2417	CARBONYL FLUORIDE	COF_2		A	NW	A	NW	NW	NW	NW	NW	NW	NW	A	A	NW	A	NW	A	A	NW	NW	n	NC,D	NC,D	A
19	2204	CARBONYL SULFIDE	COS		A	NW	A	A	A	NW	NW	NW	NW	A	NW	NW	NW	A	A	NW	A	NW	NW	n	NC	NC	A
20	1017	CHLORINE	Cl_2			See 6.2.1.2. WARNING — There is a risk of violent reactions.																					N
					A	NF	A	A	NF	NF	NF	NF	NF	NF	NF	NF	NF	A	NW	NF	NF	NF	NF	NF	NF	A	A
110	1589	CHLORINE CYANIDE	ClCN		A	n	A	A			A	A	A	A				A		n	n	n	n	N	n	n	A
111	2548	CHLORINE PENTAFLU-ORIDE	ClF_5		A	NW	A	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	n	n	A
112	1749	CHLORINE TRIFLUO-RIDE	ClF_3		A	NW	A	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	n	n	A
7	1974	BROMOCHLORO-DI-FLUOROMETHANE	$CBrClF_2$	R 12B1	A	A	AS	A	A	A	NS	NS	NS	NS	NS	NS	A	A	NS	NS	A	NS	NS	NS	NW	AW	A
21	1018	CHLORODIF-LUORO-METHANE	$CHClF_2$	R 22	AP	A	AS	A	A	AP	A	AS	AS	NS	AS	NS	AS	NS	NS	A	NS	NS	NS	A	NW	NW	A
23	1020	CHLOROPEN-TAFLUORO-ETHANE	C_2ClF_5	R 115	A	A	AS	A	A	NS	NS	NS	NS	NS	A	A	A	A	NS	A	NS	A	A	A	NW	NW	A
27	1022	CHLOROTRIF-LUORO-METHANE	$CClF_3$	R 13	A	A	AS	A	A	NS	NS	NS	NS	NS	A	A	AS	A	NS	A	NS	A	NS	A	NW	NW	A
37	1026	CYANOGEN	C_2N_2		A	n	A	A	n	A	n	n	n	n	NS, W	NS, W	NR	A	A	A	A	n	n	A	NC	NC	A
28	1027	CYCLOPROPANE	C_3H_6		A	A	A	A	A	A	A	A	A	A	NS	A	NS	A	NS	NS	A	A	A	A	NW	A	A
29	1957	DEUTERIUM	^2H or D		AP	A	A	A	A	AP	A	A	A	A	A	A	A	A	AP	A	A	A	A	A	A	A	A

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Table 1 *(continued)*

No.	UN number	Name of the gas	Plastics												Elastomers										Fluid lubricants		MoS_2
			Formula	R#	PTFE	PI	PCTFE	PVDF	PA[a]	PP	POM	PEEK	PPS	PVC	IIR	NBR	CR	FKM	VMQ	EPDM	FVMQ	ACM	PUR	ECO[b]	HC	FC	
32	1911	DIBORANE	B_2H_6		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	n	NC	NC	A
30	1941	DIBROMODIF-LUORO-METHANE	CBr_2F_2	R 12B2	AP	n	AS	A	A	NS	NS	NS	NS	NS	NS	NS	A	A	NS	NS	NS	NS	NS	NS	NW	AW	A
31	no UN number yet as-signed	DIBROMO-TETRAFLUORO-ETHANE	$C_2Br_2F_4$	R 114B2	A	n	AS	A	A	NS	NS	NS	NS	NS	NS	NS	AS	NS	NS	NS	NS	NS	NS	NS	NW	NW	A
33	1028	DICHLORODIF-LUORO-METHANE	CCl_2F_2	R 12	AP	A	AS	A	A	NS	A	NS	NS	A	NS	AS	A	AS	NS, P	NS	NS	A	A	NS	NW	NW	A
34	1029	DICHLORO-FLUORO-METHANE	$CHCl_2F$	R 21	A	A	AS	A	A	AP	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NW	NW	A
35	218	DICHLOROSILANE	SiH_2Cl_2		A	n	A	A	NW	NW	NW	NW	NW	NW	NW	NW	NW	A	A	NW	A	NW	NW	NS	NC	NC	A
116	3252	DIFLUOROMETHANE	CH_2F_2	R 32	A	A	NS	A	A	NS	NS	NS	NS	NS	A	A	A	NS	NS	A	NS	NS	NS	n	n	n	A
41	1032	DIMETHYLAMINE	C_2H_7N		A	A	A	NG, W	A	A	A	A	NW	NW	A	NW	NW	NW	NW	A	NW	NW	NW	NW	NW	A	A
42	1033	DIMETHYLETHER	C_2H_6O		A	n	A	A	NS	NS	A	A	A	NS	NS	NS	NS	NS	A	NS	A	NS	NS	NS	NW	NW	A
118	3161	DIMETHYLSILANE	C_2H_8Si		A	n	A	A	NW	NW	A	A	A	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW			A
76	1067	DINITROGEN TE-TROXIDE (NITROGEN DIOXIDE)[c]	NO_2/H_2O_4			See 6.2.1.2. WARNING — There is a risk of violent reactions.																					A
					A	NF	A	A	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	n	NF,C	NC	A
43	3161	DISILANE	Si_2H_6		A	n	A	A	a	a	A	A	A	a	A	a	A	A	A	A	A	A	A	n	NC	NC	A
44	1035	ETHANE	C_2H_6		A	A	A	A	A	A	A	A	A	A	NS	A	NS	A	NS, W	NS	NS	A	A	A	A	A	A
46	1037	ETHYL CHLORIDE	C_2H_5Cl	R 160	A	n	AS	A	A	NS	NS	NS	NS	NS	A	A	A	A	NS, W	A	A	NW	NW	NS	NW	NW	A
50	2453	ETHYL FLUORIDE	C_2H_5F	R 161	A	n	AS	A	A	AP	A	A	A	NS	NS	A	NS	A	NS	NS	A	NS	NS	n	NW	NW	A
121	1039	ETHYL METHYL ETHER	C_3H_8O	R 227	A	n	A	A	NS	NS	A	A	A	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	n	n	n	A
120	2452	ETHYLACETYLENE	C_4H_6		A	A	A	A	A	A	A	A	A	A	A	A	A	A	n	n	A	A	A	n	n	n	A
45	1036	ETHYLAMINE	C_2H_7N		A	n	A	A	NW	A	A	A	NW	NW	NW	NW	NW	NW	NW	A	NW	NW	NW	NW	NW	NW	A
47	1962	ETHYLENE	C_2H_4		A	A	A	A	A	A	A	A	A	A	A	A	NS	A	NS	NS	A	A	A	A	A	A	A
48	1040	ETHYLENE OXIDE	C_2H_4O		A	A	A	A	NS, W	NS, W	NS, W	NS, W	NS, W	NS, W	NS, W	NS, W	NS, W	NS, W	NS, W	NS,W	NS,W	NS, W	NS, W	NS, W	NW	NR	A

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Table 1 *(continued)*

No.	UN number	Name of the gas	Plastics												Elastomers										Fluid lubricants		MoS_2
			Formula	R#	PTFE	PI	PCTFE	PVDF	PA[a]	PP	POM	PEEK	PPS	PVC	IIR	NBR	CR	FKM	VMQ	EPDM	FVMQ	ACM	PUR	ECO[b]	HC	FC	
49	1045	FLUORINE	F_2			See 6.2.1.2. WARNING — There is a risk of violent reactions.																					
					NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	n	NF	NF	NF
53	2192	GERMANE	GeH_4		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	NC,D	NC,D	A
54	1046	HELIUM	He		AP	A	A	A	A	AP	A	A	A	A	A	A	A	A	AP	A	A	A	A	A	A	A	A
122	3296	HEPTAFLUOROPRO-PANE	C_3HF_7		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A		A	A	A
123	2420	HEXAFLUOROACE-TONE	C_3F_6O		A	NS	A	A	n	NS, W	NS, W	NS, W	NS, W	NS, W	NS, W	NS, W	NS, W	A	NS, W	NS,W	NS,W	NS, W	NS, W	NS, W	n	n	A
55	2193	HEXAFLUOROETHANE	C_2F_6	R 116	A	A	AS,W	A	A	NS, W	NS, W	NS, W	NS, W	NS, W	NS, W	NS, W	NS, W	A	NS, W	NS,W	NS,W	NS, W	NS, W	NS, W	NW	NW	A
56	1858	HEXAFLUOROPRO-PYLENE	C_3F_6		A	A	AS	A	A	NS, W	NS, W	NS, W	NS, W	NS, W	NS, W	NS, W	NS, W	A	NS, W	NS,W	NS,W	NS, W	NS, W	NS, W	NW	NW	A
57	1049	HYDROGEN	H_2		AP	A	A	A	A	AP	A	A	A	A	A	A	A	A	AP	A	AP	AP	A	A	A	A	A
58	1048	HYDROGEN BROMIDE	HBr		A	n	A	A	NW	A	NW	NW	NW	A	NW	NW	NW	A	NW	A	NW	NW	NW	n	NC	NC	A
59	1050	HYDROGEN CHLORIDE	HCl		A	A	A	A	NW	A	NW	NW	NW	A	NW	NW	NW	A	NW	A	NW	NW	NW	n	NC	NC	A
60	1051	HYDROGEN CYANIDE	HCN		A	n	A	A	NW	A	NW	NW	NW	A	NW	NW	NW	A	NW	A	NW	NW	NW	n	NC	NC	A
61	1052	HYDROGEN FLUORIDE	HF		A	n	A	A	NW	A	NW	NW	NW	A	NW	NW	NW	A	NW	A	NW	NW	NW	n	NC	NC	A
62	2197	HYDROGEN IODIDE	HI		A	n	A	A	NW	A	NW	NW	NW	A	NW	NW	NW	A	NW	A	NW	NW	NW	n	NC	NC	A
124	2202	HYDROGEN SELENIDE	H_2Se		A	A	A	A	A	A	A	A	A	n	n	NW	n	A	n	n	n	n	n	n	n	n	A
63	1053	HYDROGEN SULFIDE	H_2S		AP	A	A	A	A	A	NW	A	A	A	AW	NW	NW	NW	NW	A	NW	NW	NW	n	NC	NC	A
64	1969	ISOBUTANE	C_4H_{10}		A	A	A	A	A	A	A	A	A	A	NS	A	A	A	NS, M	NS,M	A	A	A	A	NW	A	A
65	1055	ISOBUTYLENE	C_4H_8		A	A	A	A	A	A	A	A	A	A	NS, M	A	NS	A	NS, M	NS,M	A	NS	NS	A	NW	A	A
66	1056	KRYPTON	Kr		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
67	1971	METHANE	CH_4		A	A	A	A	A	A	A	A	A	A	NS	A	A	A	NR	NS	NS	A	NS	A	A	A	A
69	1062	METHYL BROMIDE	CH_3Br	R 40B1	A	A	A	A	A	NS	A	A	NS	NS	NS	NS	NS	A	NS	NS	A	NS	NS	NS	NW	NW	A
51	2454	METHYL FLUORIDE	CH_3F	R 41	A	A	AS	A	A	NS	A	A	A	NS	NS	NS	NS	A	NS	NS	A	NS	NS	NS	NW	NW	A
70	1064	METHYL MERCAPTAN	CH_4S		A	n	A	A	A	n	A	A	A	A	NW	NW	NW	NW	A	A	NW	n	n	NS	NC	NC	A

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Table 1 *(continued)*

No.	UN number	Name of the gas	Formula	R#	PTFE	PI	PCTFE	PVDF	PA[a]	PP	POM	PEEK	PPS	PVC	IIR	NBR	CR	FKM	VMQ	EPDM	FVMQ	ACM	PUR	ECO[b]	HC	FC	MoS₂
					Plastics										Elastomers										Fluid lubricants		
126	2455	METHYL NITRITE	CH_3NO_2		A	n	A	A	n	n	n	n	n	n	n	NW	n	A	n	n	n	n	n	n	n	n	A
68	3161	METHYLACETYLENE	C_3H_4		A	A	A	A	AW	A	A	A	A	A	A	n	n	n	n	n	n	n	n	n	NW,I	A	A
72	1061	METHYLAMINE	CH_5N		A	A	A	NG, W	A	A	A	A	NW	NW	A	NW	NW	NW	NW	A	NW	NW	NW	n	NW	A	A
22	1063	METHYL CHLORIDE	CH_3Cl	R 40	A	A	A	A	A	NS	NS	A	NS	NS	NS	NS	NS	A	NS	NS	NS	NS	NS	NS	NW	NW	A
125	2534	METHYLCHLOROSI-LANE	CH_5SiCl		A	n	A	A	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	n	n	A
71	3161	METHYLSILANE	CH_6Si		A	n	A	A	n	n	A	A	A	A	A	n	A	A	A	A	A	A	A	n	NC	NC	A
73	1065	NEON	Ne		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
74	1660	NITRIC OXIDE	NO			See 6.2.1.2. WARNING — There is a risk of violent reactions.																					
					AD	NF	AD	AD	NF, W	NF	NF	NF	NF	NF	NF, W	NF, W	NF,W, D	AD	NF	NF,W	NF	NF	AD	n	NF,C	NC,D	A
75	1066	NITROGEN	N_2		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
78	2451	NITROGEN TRIFLUO-RIDE	NF_3			See 6.2.1.2. WARNING — There is a risk of violent reactions.																					
					A	F	A	A	F	F	F	F	F	F	F	F	F	A	F	F	F	F	F	n	F	A	A
119	2421	NITROGEN TRIOXIDE	N_2O_3			See 6.2.1.2. WARNING — There is a risk of violent reactions.																					A
						NF	A	A	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	n	NF	F	A
77	1070	NITROUS OXIDE	N_2O		A	See 6.2.1.2. WARNING — There is a risk of violent reactions.																					A
					A	N	A	AF	A	NF	NF	AF	NF	NF	NF, S	NF, S	NF, S	NS	A	AF,S	A	A	A	n	NF	A	A
81	2424	OCTAFLUORO PRO-PANE	C_3F_8	R 218	A	A	AS	A	A	NS	A	A	A	NS	A	A	A	A	AS	A	AS	NS	NS	A	NW	NW	A
79	2422	OCTAFLUORO-BUT-2-ENE	C_4F_8	R 1318	A	N	AS	A	A	NS	A	A	A	NS	A	A	A	AS	AS	A	AS	NS	NS	A	NW	NW	A
80	1976	OCTAFLUORO-CY-CLOBUTANE	C_4F_8	R C318		A	AS	A	A	NS	A	A	A	NS	A	A	A	AS	AS	A	AS	NS	NS	A	NW	NW	A
82	1072	OXYGEN	O_2		F.D	See 6.2.1.2. WARNING — There is a risk of violent reactions.																					A
					A	F	F,D	F,D	F	F	F	F	F	F	F	F	F,D	F,S, D	F	F	F	F	F	n	NF	F,D	A
127	3220	PENTAFLUO-ROETHANE	C_2HF_5	R 125	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	n	A	A	A

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Table 1 *(continued)*

No.	UN number	Name of the gas	Plastics											Elastomers										Fluid lubricants		MoS_2
			Formula	R#	PTFE	PI	PCTFE	PVDF	PA[a]	PP	POM	PEEK	PPS	PVC	IIR	NBR	CR	FKM	VMQ	EPDM	FVMQ	ACM	PUR	ECO[b]	HC	FC	
128	3083	PERCHLORYL FLUORIDE	ClO_3F		A	n	A	n	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	n	n	n	A
129	3154	PERFLUORO (ETHYL VINYL ETHER)	C_4F_8O		A	NS	A	n	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	n	n	A
130	3153	PERFLUORO (METHYL VINYL ETHER)	C_3F_6O		A	NS	A	n	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	n	n	A
131	2198	PHOSPHORUS PENTAFLUORIDE	PF_5		A	n	A	A	n	n	A	A	A	A	n	n	n	A	n	n	A	n	n	n	n	n	A
86	2200	PROPADIENE	C_3H_4		A	A	A	A	AW	A	A	A	A	A	A	NS	NS	A	VS	NS	A	NS	NS	NS	NW,I	A	A
85	1978	PROPANE	C_3H_8		A	A	A	A	A	A	A	A	A	NS	NS	A	NS	A	NS, M	NS,M	NS	A	NS	A	NW	A	A
87	1077	PROPYLENE	C_3H_6		A	A	A	A	A	A	A	A	A	NS	NS	NS	NS	A	NS	NS	NS	NS	NS	A	NW	A	A
88	1280	PROPYLENE OXIDE	C_3H_6O		A	n	A	NS, W	NS, W	NS, W	NS, W	NS, W	NS, W	NS, W	NS, W	NS, W	NS, W	NS, W	NS, W	NS,W	NS,W	NS, W	NS, W	NS, W	NW	NW	A
132	2194	SELENIUM HEXAFLUORIDE	SeF_6		A	n	A	A	NW	A	A	A	A	A	NW	NW	NW	A	NW	NW	NW	NW	NW	n	n	n	A
89	2203	SILANE	SiH_4		A	A	A	A	n	n	A	A	A	n	n	n	n	n	n	A	A	A	A	n	NC	NC	A
90	1818	SILICON TETRACHLORIDE	$SiCl_4$		A	n	A	A	NW	A	NW	NW	NW	NW	NW	NW	NW	A	NW	A	NW	NW	NW	n	NC	NC	A
91	1859	SILICON TETRAFLUORIDE	SiF_4		A	n	A	A	NW	A	NW	NW	NW	NW	NW	NW	NW	NW	NW	A	NW	NW	NW	n	NC	NC	A
106	2676	STIBINE	SbH_3		A	A	A	A	A	A	A	A	A	A	A	NW	A	A	A	A	A	A	n	n	n	n	A
133	2191	SULFURYL FLUORIDE	SO_2F_2		A	n	A	NW	NW	NW	NW	NW	NW	NW	NW	NW	n	A	NW	A	NW	NW	NW	n	n	n	A
92	1079	SULFUR DIOXIDE	SO_2		A	A	A	A	NW	A	NW	A	n	NW	A	NW	NW	NW	NW	A	NW	NW	A	NW	NW, C	NC	A
93	1080	SULFUR HEXAFLUORIDE	SF_6		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	NW	A	A	A	A	A
94	2418	SULFUR TETRAFLUORIDE	SF_4		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	NW	A	A	A	A	A
134	2195	TELLURIUM HEXAFLUORIDE	TeF_6		A	A	A	A	NW	A	A	A	A	A	NW	NW	NW	A	NW	NW	NW	NW	NW	A	n	n	A
95	1081	TETRAFLUOROETHYLENE	C_2F_4	R 114	A	n	A	A	A	NS	A	A	A	NS	A	A	A	A	NS	A	AS	NS	A	n	NW	NW	A

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No.	UN number	Name of the gas	Plastics												Elastomers										Fluid lubricants		MoS_2
			Formula	R#	PTFE	PI	PCTFE	PVDF	PA[a]	PP	POM	PEEK	PPS	PVC	IIR	NBR	CR	FKM	VMQ	EPDM	FVMQ	ACM	PUR	ECO[b]	HC	FC	
18	1982	TETRAFLUOROMETHANE	CF_4	R 14	A	A	AS,W	A	A	A	NS, W	NS, W	NS, W	NS, W	NS, W	NS, W	NS, W	A	NS, W	NS,W	NS,W	NS, W	NS, W	n	NW	A	A
96	1295	TRICHLOROSILANE	$SiHCl_3$		A	n	A	A	NW	NW	NW	NW	NW	NW	NW	NW	NW	A	NW	A	NW	NW	NW	NW	NC	NC	A
26	1082	TRIFLUOROCHLOROETHYLENE	C_2ClF_3	R 1113	A	n	NS	A	A	NS	NS	NS	NS	NS	n	n	n	A	NS	NS	NS	n	NS	NS	NW	NW	A
52	1984	TRIFLUOROMETHANE	CHF_3	R 23	A	n	NS,W	A	A	A	A	A	A	NS, W	A	A	A	A	A	A	A	NS	NS	n	NW	A	A
99	1083	TRIMETHYLAMINE	C_3H_9N		A	n	NG	NG, W	NW	A	A	A	NW	A	A	AW	NW	NW	NW	A	NW	NW	NW	NW	NW	NRA	A
100	2196	TUNGSTEN HEXAFLUORIDE	WF_6		A	A	A	A	n	A	A	A	A	A	NW	NW	NW	A	NW	A	NW	NW	NW	n	NC	NC	A
101	1085	VINYL BROMIDE	C_2H_3Br	R 140B1	A	n	AS	A	n	NS	NS	NS	NS	NS	NS	NS	NS	A	NS	NS	NS	NS	NS	NS	NW	NW	A
102	1086	VINYL CHLORIDE	C_2H_3Cl	R 140	A	n	AS	A	n	NS	NS	NS	NS	NS	NS	NS	NS	A	NS	NS	NS	NS	NS	NS	NW	NW	A
103	1860	VINYL FLUORIDE	C_2H_3F	R 141	A	n	AS	A	n	NS	NS	NS	NS	NS	NS	NS	NS	A	NS	NS	NS	NS	NS	NS	NW	NW	A
135	1087	VINYL METHYL ETHER	C_3H_6O		A	n	A	A	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	n	n	A
104	2036	XENON	Xe			A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A

[a] The compatibility information for PA given in this table is mainly based on PA 6.6 and does not necessarily cover all other types of PA.

[b] This material is only used for low pressure refrigerant gases.

[c] Some materials are not compatible because of the solvent used.

[d] At high pressure risk of violent reaction due to oxygen.

Table 2 — Compatibility of non-metallic materials with gases when used as gas cylinders liners material

No.	UN number	Name of the gas	Formula	Key compatibility characteristics[a,b]	Material Liner	
					Acceptable	Not acceptable
57	UN 1049	HYDROGEN	H_2	The main risk is permeability and liner collapse, see 6.2.5, so it is possible that the design will need to be adapted to pass, depending on the requirements of use.	PA PE PET	
54	UN 1046	HELIUM	He	The main risk is permeability and liner collapse, see 6.2.5, so it is possible that the design will need to be adapted to pass depending on the requirements of use.	PA PE PET	
67	UN 1971	METHANE or NATURAL GAS	CH_4	No reaction with any common liner materials.	PA PE PET	
		REFRIGERANT GASES (R 7, R 8, R 9, R 18, R 21, R 22, R 23, R 24, R 25, R 26, R 27, R 30, R 31, R 33, R 34, R 36, R 38, R 39, R 40, R 46, R 50, R 51, R 52, R 55, R 69, R 79, R 80, R 81, R 97, R 95, R 98, R 101, R 102, R 103, R 116, R 121, R 127)		No reaction with any common liner materials.	PA PE PET	
105	1002	AIR		Risk of violent reaction between the oxygen (contain in the air) and the plastic materials during rapid compression. Consequently, special care shall be taken to avoid excessive temperature when filling the cylinder.	PA PE PET	
	1011 1978 1965	BUTANE PROPANE LPG		No reaction with any common liner materials.	PA PE PET	

[a] When plastic liner materials are used, it is necessary to use metallic bosses. For compatibility of metallic bosses, see ISO 11114-1.

[b] When cylinders are fitted with plastic liners, see ISO 11114-5.

Table 2 *(continued)*

No.	UN number	Name of the gas	Formula	Key compatibility characteristics[a,b]	Material Liner	
					Acceptable	Not acceptable
82	1072	OXYGEN	O_2	Risk of violent reaction in contact with the plastic materials. Consequently, special care shall be taken to avoid excessive temperature in any circumstances, e.g. when filling the cylinder.		PA PE PET

[a] When plastic liner materials are used, it is necessary to use metallic bosses. For compatibility of metallic bosses, see ISO 11114-1.

[b] When cylinders are fitted with plastic liners, see ISO 11114-5.

Bibliography

[1] ISO 1817, *Rubber, vulcanized or thermoplastic — Determination of the effect of liquids*

[2] ISO 9539, *Gas welding equipment — Materials for equipment used in gas welding, cutting and allied processes*

[3] ISO 10156, *Gas cylinders — Gases and gas mixtures — Determination of fire potential and oxidizing ability for the selection of cylinder valve outlets*

[4] ISO 11114-1:2020, *Gas cylinders — Compatibility of cylinder and valve materials with gas contents — Part 1: Metallic materials*

[5] ISO 11114-5,[1)] *Gas cylinders — Compatibility of cylinder and valve materials with gas contents — Part 5: Test methods for evaluating plastic liners*

[6] ISO 21010, *Cryogenic vessels — Gas/material compatibility*

[7] United Nations. *Recommendations on the Transport of Dangerous Goods – Model Regulations*

1) Under preparation. Stage at the time of publication: ISO/FDIS 11114-5:2021.

(*Continued from second cover*)

The Committee has reviewed the provisions of the following International Standard referred in this adopted standard and has decided that it is acceptable for use in conjunction with this standard:

International Standard	*Title*
ISO 10286	Gas cylinders — Vocabulary
ISO 10297	Gas cylinders — Cylinder valves — Specification and type testing

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 ‘Rules for rounding off numerical values (*second revision*)’. The number of significant places retained in the rounded-off value should be the same as that of the specified value in this standard.

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Amendments Issued Since Publication

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