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Fluorocarbon refrigerants — Specifications and test methods

Fluides frigorigènes fluorocarbonés — Spécifications et méthodes d'essai

Please see the administrative notes on page iii

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 12810 was prepared by Technical Committee ISO/TC 86, *Refrigeration and air-conditioning*, Subcommittee SC 8, *Refrigerants and refrigeration lubricants*.

Introduction

Imperial (English) units (I-P) are used in these annexes to describe certain equipment and apparatus which are generally described commercially only in Imperial (English) dimensions (inch-pounds).

The lengths and diameters of the packed columns used with the gas chromatograph are given in Imperial dimensions in most annexes because they are designated commercially in Imperial (English) units. If other sizes of packed columns are used, differences in the test results will be experienced as the retention times will change. If other sizes of packed columns are employed, it will be necessary for the user to demonstrate that they produce results that are equivalent in terms of sensitivity, precision and accuracy to those specified in this International Standard.

Fluorocarbon refrigerants — Specifications and test methods

1 Scope

This International Standard defines the maximum levels of contaminants for various commercially available fluorocarbon refrigerants and blends containing fluorocarbon refrigerants regardless of their source (new, reclaimed or repackaged). This International Standard also establishes test methods for determining the levels of these contaminants.

The fluorocarbon refrigerants included in this International Standard are those identified in ANSI/ASHRAE 34 as R 11, R 12, R 13, R 22, R 23, R 32, R 113, R 114, R 123, R 124, R 125, R 134a, R 143a, R 401A, R 401B, R 402A, R 402B, R 500, R 502, and R 503.

NOTE Only those fluorocarbon refrigerants listed in ANSI/ASHRAE 34 are addressed in this International Standard.

2 Conformance

Refrigerants reported as conforming to this International Standard shall meet all of the requirements established therein and shall be accompanied by a certificate of conformity indicating that the refrigerant does not exceed the maximum contaminant levels specified in this International Standard.

3 Normative references

The following referenced documents are indispensable for the application 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.

ANSI/ASHRAE 34, *Number designation and safety classification of refrigerants*

4 Terms, definitions, symbols and abbreviated terms

4.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

4.1.1
contaminant
any substance foreign to the chemical and physical composition of the refrigerant (such as an impurity)

4.1.2
fluorocarbon
halogenated hydrocarbon containing fluorine

4.1.3
non-condensable
gas in a refrigerant that does not condense at the temperature and partial pressure at which it exists in the condenser

4.1.4
reclaimed refrigerant
refrigerant that has been processed to the requirements of this International Standard for reuse, by means which may include distillation, at a reprocessing or manufacturing facility

NOTE Chemical analysis is required to determine that the appropriate product specifications have been met.

4.1.5
refrigerant
medium of heat transfer in a refrigerating system which absorbs heat on evaporating at a low temperature and a low pressure and gives up heat on condensing at a higher temperature and higher pressure

4.1.6
repackaged refrigerant
refrigerant that has been relabelled or placed in another container for resale

4.2 Symbols and abbreviated terms

A_i Chromatographic peak area of component i

$K_{abs,i}$ Absolute response factor of the detector for component i

$K_{rel,i}$ Relative response factor for component i

m_i Mass of component i

p_s Vapour pressure of the refrigerant at the sampling temperature T_s

s Standard deviation

t Temperature expressed in Celsius

T_s Sampling temperature expressed in kelvins (t + 273,15)

w_i Mass fraction of component i

α_i Temperature-to-pressure correlation factor for component i

φ_i Volume fraction of component i

φ_s Volume fraction determined at the sampling temperature T_s

CL Confidence limit

ECN Effective carbon number

FID Flame ionization detector

FPT Female pipe thread

GC Gas chromatograph

ID Inner diameter

KF Karl Fischer

MEK	Methyl ethyl ketone
N/A	Not applicable
NCG	Non-condensable gas
NPT	National pipe thread
OD	Outer diameter
PTFE	Polytetrafluoroethylene (Teflon)
RT	Retention time
TCD	Thermal conductivity detector
TCE	Trichloroethylene

5 Characterization of refrigerants and requirements for contaminants

Refrigerant contaminants shall be characterized by measuring non-condensable components, water content, and the presence of other impurities including other refrigerants, high boiling residues, particulates/solids, acidity, and the presence of excessive chloride concentration. Requirements for the maximum contaminant levels are specified in Tables 1 and 2. The tests or determining contaminants are specified in Clause 8.

Table 1 — Characteristics of fluorocarbon refrigerants and maximum contaminant levels

Characteristics and contaminants	Reporting units	Reference subclause	R 11	R 12	R 13	R 22	R 23	R 32	R 113	R 114	R 123	R 124	R 125	R 134a	R 143a
CHARACTERISTICS [a]															
Boiling point [a]	°C at 101 325 Pa [d]	—	23,8	– 29,8	– 81,4	– 40,8	– 82,1	– 51,7	47,6	3,8	27,9	–12,1	– 48,1	– 26,2	– 47,0
Boiling point range [a]	°C	—	0,3	0,3	0,5	0,3	0,5	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3
Typical isomer content	mass fraction	—	N/A	N/A	N/A	N/A	N/A	N/A	0 % to 1 % R 113a	0 % to 30 % R 114a	0 % to 8 % R 123a	0 % to 5 % R 124a	N/A	0 µg/g to 5000 µg/g R 134	0 µg/g to 100 µg/g R 143
VAPOUR-PHASE CONTAMINANTS															
Air and other non-condensable	volume fraction, % at 25 °C	8.2.1	N/A [b]	1,5	1,5	1,5	1,5	1,5	N/A [b]	1,5	N/A [b]	1,5	1,5	1,5	1,5
LIQUID-PHASE CONTAMINANTS															
Water	µg/g	8.2.2	20	10	10	10	10	10	20	10	20	10	10	10	10
All other impurities including refrigerants	mass fraction, %	8.2.3	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50
High boiling residue	volume fraction, %	8.2.4	0,01	0,01	0,05	0,01	0,01	0,01	0,03	0,01	0,01	0,01	0,01	0,01	0,01
Particulates/solids	visually clean to pass	8.2.5	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass
Acidity	µg/g	8.2.6	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0
Chlorides [c]	no visible turbidity	8.2.7	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass

[a] Boiling points and boiling point ranges, although not required, are provided for informational purposes.

[b] Since R 11, R 113 and R 123 have normal boiling points at or above room temperature, non-condensable determinations are not required for these refrigerants.

[c] Recognized chloride level for pass/fail is 3 µg/g.

[d] 101 325 Pa = 1 atm. The use of atmosphere is deprecated.

Table 2 — Characteristics of fluorocarbon refrigerant mixtures and maximum contaminant levels

Characteristics and contaminants	Reporting units	Reference subclause	R 401A	R 401B	R 402A	R 402B	R 500	R 502	R 503
CHARACTERISTICS [a]									
Refrigerant components			R 22/R 152a/ R 124	R 22/R 152a/ R 124	R 125/R 290/R 22	R 125/R 290/ R 22	R 12/R 152a	R 22/R 115	R 23/R 13
Nominal component	mass fraction, %		53/13/34	61/11/28	60/2/38	38/2/60	73,8/26,2	48,8/51,2	40,1/59,9
Allowable component	mass fraction, %		51 to 55/ 11,5 to 13,5/ 33 to 35	59 to 63/ 9,5 to 11,5/ 27 to 29	58 to 62/ 1 to 3/ 36 to 40	36 to 40/ 1 to 3/ 58 to 62	72,8 to 74,8/ 25,2 to 27,2	44,8 to 52,8/ 47,2 to 55,2	39 to 41/ 59 to 61
Boiling point [a]	°C at 101 325 Pa [c]		– 33,0 to – 26,7	– 34,6 to – 28,6	– 48,9 to – 47,0	– 47,1 to – 44,9	– 33,5	– 45,4	– 88,7
Boiling point range [a]	°C	—	N/A	N/A	N/A	N/A	0,5	0,5	0,5
VAPOUR-PHASE CONTAMINANTS Air and other non-condensable components	volume fraction, % at 25 °C	8.2.1	1,5	1,5	1,5	1,5	1,5	1,5	1,5
LIQUID-PHASE CONTAMINANTS Water	µg/g	8.2.2	10	10	10	10	10	10	10
All other impurities including refrigerants	mass fraction, %	8.2.3	0,50	0,50	0,50	0,50	0,50	0,50	0,50
High boiling residue	volume fraction, %	8.2.4	0,01	0,01	0,01	0,01	0,05	0,01	0,01
Particulates/solids	visually clean to pass	8.2.5	pass	pass	pass	pass	pass	pass	pass
Acidity	µg/g	8.2.6	1,0	1,0	1,0	1,0	1,0	1,0	1,0
Chlorides [b]	no visible turbidity	8.2.7	pass	pass	pass	pass	pass	pass	pass

[a] Boiling points and boiling point ranges, although not required, are provided for informational purposes.

[b] Recognized chloride level for pass/fail is 3 µg/g.

[c] 101 325 Pa = 1 atm. The use of atmosphere is deprecated.

6 Principle

The test methods for quantifying the various contaminants are specified in the following subclauses and shall be the reference test methods. Alternate test methods specified in this International Standard are also acceptable. If other test methods are employed, the user shall be able to demonstrate that they produce results that are equivalent in terms of sensitivity, precision and accuracy as those specified in this International Standard.

The recommended order for conducting these tests is to determine the quantity of the contaminants as follows:

a) non-condensable components;

b) water content;

c) purity;

d) high-boiling residue;

e) particulates/solids;

f) acidity;

g) chloride.

7 Sampling

7.1 Precautions

Take special precautions to assure that representative samples are obtained for analysis. Sampling shall be accomplished by trained personnel following accepted sampling and safety procedures.

7.2 Procedure

7.2.1 General

To assure accurate results, two separate refrigerant samples shall be obtained, i.e. one liquid-phase sample and one vapour-phase sample, from the original packaged container, unless the final packaged cylinder is provided.

7.2.2 Liquid-phase test samples

A liquid-phase sample is required for all tests listed in this International Standard except for the test for non-condensable where a gaseous-phase test sample is required.

7.2.3 Vapour-phase test samples

A vapour-phase test sample shall be used for the determination of non-condensable. Non-condensable gases consist primarily of air accumulated in the vapour phase of refrigerants. The solubility of air in the refrigerant liquid phase is extremely low and air is not significant as a liquid-phase contaminant. The presence of non-condensable gases may reflect poor quality control in transferring refrigerants to storage tanks and cylinders.

8 Procedure

8.1 Product hazards

Avoid breathing refrigerant vapours. Volatile refrigerants shall be handled in a well-ventilated area to avoid inhalation of refrigerant vapours. Compressed liquefied refrigerants can cause frostbite on contact. Liquefied refrigerants will readily dissolve body oils. Consult the supplier's material safety data sheets (MSDS) for additional safety information for each individual refrigerant as well as for each of the reagents associated with the individual test methods.

8.2 Determination

8.2.1 Non-condensable contaminants

8.2.1.1 Test method

Determine the quantity of non-condensable contaminants using gas chromatography (GC) with a thermal conductivity detector (TCD) as described in Annex A.

8.2.1.2 Requirements

The maximum level of non-condensable contaminants in the vapour phase of a refrigerant at 25 °C in a container shall not exceed 1,5 % by volume, as indicated in Tables 1 and 2.

8.2.2 Water content

8.2.2.1 Reference test method

Determine the water content of refrigerants using coulometric Karl Fischer titration as the reference test method as described in Annex B. Proper operation of the analytical method requires special equipment and an experienced operator. Refrigerants containing a dye can be successfully analysed for water using this method.

8.2.2.2 Alternative test method

The volumetric Karl Fischer titration is an acceptable alternative test method to the coulometric Karl Fischer titration for determining the water content of refrigerants.

8.2.2.3 Requirements

The refrigerants covered in this International Standard shall have a maximum water content as indicated in Tables 1 and 2.

8.2.3 Impurities including other refrigerants

8.2.3.1 Test method

Determine the amount of impurities, including other refrigerants, in the subject refrigerant using gas chromatography as described in Annexes C to T.

NOTE A single gas chromatograph equipped with a thermal conductivity detector, a flame ionization detector and packed and capillary columns can be used to conduct a number of test methods.

