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**Gaseous fire-extinguishing systems —  
Physical properties and system  
design —**

**Part 10:  
HFC 23 extinguishant**

*Systèmes d'extinction d'incendie utilisant des agents gazeux —  
Propriétés physiques et conception des systèmes —*

*Partie 10: Agent extincteur HFC 23*



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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](http://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](http://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 on 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 the following URL: [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

The committee responsible for this document is ISO/TC 21, *Equipment for fire protection and fire fighting*, Subcommittee SC 8, *Gaseous media and fire fighting systems using gas*.

This third edition cancels and replaces the second edition (ISO 14520-10:2005), which has been technically revised with the following changes:

- added reference to [Table 8](#) and [Table 9](#) for 41 bar and 70 bar systems in [6.1](#);
- added [Table 9](#) for 70 bar storage container characteristics data;
- added [Figure 2](#), pressure vs temperature chart for 70 bar system;
- added [Clause 7](#).

A list of all parts in the ISO 14520 series can be found on the ISO website.

# Gaseous fire-extinguishing systems — Physical properties and system design —

## Part 10: HFC 23 extinguishant

### 1 Scope

This document contains specific requirements for gaseous fire-extinguishing systems, with respect to the HFC 23 extinguishant. It includes details of physical properties, specification, usage and safety aspects and is applicable to systems operating at a nominal pressure of 41 bar without nitrogen superpressurization and 70 bar superpressurized with nitrogen.

### 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 14520-1:2015, *Gaseous fire-extinguishing systems — Physical properties and system design — Part 1: General requirements*.

### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 14520-1 apply.

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

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

### 4 Characteristics and uses

#### 4.1 General

Extinguishant HFC 23 shall comply with the specification shown in [Table 1](#).

HFC 23 is a colourless, almost odourless, electrically non-conductive gas with a density approximately 2,4 times that of air.

The physical properties are shown in [Table 2](#).

HFC 23 extinguishes fires mainly by physical means, also by some chemical means.

**Table 1 — Specification for HFC 23**

Property	Requirement
Purity	99,6 % (mol/mol), min.
Acidity	$3 \times 10^{-6}$ by mass, max.
Water content	$10 \times 10^{-6}$ by mass, max.
Non-volatile residue	0,01 % by mass, max.
Suspended matter or sediment	None visible

**Table 2 — Physical properties of HFC 23**

Property	Units	Value
Molecular mass	—	70
Boiling point at 1,013 bar (absolute)	°C	-82,0
Freezing point	°C	-155,2
Critical temperature	°C	25,9
Critical pressure	bar abs	48,36
Critical volume	cm <sup>3</sup> /mol	133
Critical density	kg/m <sup>3</sup>	525
Vapour pressure 20 °C	bar abs	41,80
Liquid density 20 °C	kg/m <sup>3</sup>	806,6
Saturated vapour density 20 °C	kg/m <sup>3</sup>	263,0
Specific volume of superheated vapour at 1,013 bar and 20 °C	m <sup>3</sup> /kg	0,340 9
Chemical formula	CHF <sub>3</sub>	
Chemical name	Trifluoromethane	

## 4.2 Use of HFC 23 systems

HFC 23 total flooding systems may be used for extinguishing fires of all classes within the limits specified in ISO 14520-1:2015, Clause 4.

The extinguishant requirements per volume of protected space are shown in [Table 3](#) for various levels of concentration. These are based on methods shown in ISO 14520-1:2015, 7.6.

The extinguishing concentrations and design concentrations for *n*-heptane and surface class A hazards are shown in [Table 4](#). Concentrations for acetone heptane, methanol and toluene are shown in [Table 5](#), and inerting concentrations are shown in [Table 6](#).

Table 3 — HFC 23 total flooding quantity

Temperature $T$ °C	Specific vapour volume $S$ m <sup>3</sup> /kg	HFC 23 mass requirements per unit volume of protected space, $m/V$ (kg/m <sup>3</sup> )									
		Design concentration (by volume)									
		10 %	12 %	14 %	15 %	16 %	17 %	18 %	20 %	22 %	24 %
-60	0,2428	0,4576	0,5616	0,6705	0,7268	0,7845	0,8436	0,9041	1,0297	1,1617	1,3006
-55	0,2492	0,4459	0,5472	0,6533	0,7081	0,7644	0,8219	0,8809	1,0032	1,1318	1,2672
-50	0,2555	0,4349	0,5337	0,6371	0,6907	0,7455	0,8016	0,8591	0,9785	1,1039	1,2360
-45	0,2617	0,4246	0,5211	0,6221	0,6743	0,7278	0,7826	0,8388	0,9553	1,0778	1,2067
-40	0,2680	0,4146	0,5088	0,6074	0,6585	0,7107	0,7643	0,8191	0,9328	1,0524	1,1783
-35	0,2742	0,4052	0,4973	0,5937	0,6436	0,6947	0,7470	0,8006	0,9117	1,0286	1,1517
-30	0,2803	0,3964	0,4865	0,5808	0,6296	0,6795	0,7307	0,7831	0,8919	1,0062	1,1266
-25	0,2865	0,3878	0,4760	0,5682	0,6160	0,6648	0,7149	0,7662	0,8726	0,9845	1,1022
-20	0,2926	0,3797	0,4660	0,5564	0,6031	0,6510	0,7000	0,7502	0,8544	0,9639	1,0793
-15	0,2987	0,3720	0,4565	0,5450	0,5908	0,6377	0,6857	0,7349	0,8370	0,9443	1,0572
-10	0,3047	0,3647	0,4475	0,5343	0,5792	0,6251	0,6722	0,7204	0,8205	0,9257	1,0364
-5	0,3108	0,3575	0,4388	0,5238	0,5678	0,6129	0,6590	0,7063	0,8044	0,9075	1,0161
0	0,3168	0,3507	0,4304	0,5139	0,5570	0,6013	0,6465	0,6929	0,7891	0,8903	0,9968
5	0,3229	0,3441	0,4223	0,5042	0,5465	0,5899	0,6343	0,6798	0,7742	0,8735	0,9780
10	0,3289	0,3378	0,4146	0,4950	0,5365	0,5791	0,6227	0,6674	0,7601	0,8576	0,9601
15	0,3349	0,3318	0,4072	0,4861	0,5269	0,5688	0,6116	0,6555	0,7465	0,8422	0,9429
20	0,3409	0,3259	0,4000	0,4775	0,5177	0,5587	0,6008	0,6439	0,7334	0,8274	0,9263
25	0,3468	0,3204	0,3932	0,4694	0,5089	0,5492	0,5906	0,6330	0,7209	0,8133	0,9106
30	0,3528	0,3149	0,3865	0,4614	0,5002	0,5399	0,5806	0,6222	0,7086	0,7995	0,8951
35	0,3588	0,3097	0,3801	0,4537	0,4918	0,5309	0,5708	0,6118	0,6968	0,7861	0,8801
40	0,3647	0,3047	0,3739	0,4464	0,4839	0,5223	0,5616	0,6019	0,6855	0,7734	0,8659
45	0,3707	0,2997	0,3679	0,4391	0,4760	0,5138	0,5525	0,5922	0,6744	0,7609	0,8519
50	0,3766	0,2950	0,3621	0,4323	0,4686	0,5058	0,5439	0,5829	0,6638	0,7489	0,8385

NOTE This information refers only to HFC-23 and does not represent any other products containing trifluoromethane as a component.

Symbols:

$m/V$  is the agent mass requirements (kg/m<sup>3</sup>); i.e. mass,  $m$ , in kilograms of agent required per cubic metre of protected volume,  $V$ , to produce the indicated concentration at the temperature specified;

$V$  is the net volume of hazard (m<sup>3</sup>); i.e. the enclosed volume minus the fixed structures impervious to extinguishant

$$m = \left( \frac{c}{100 - c} \right) \frac{V}{S}$$

$T$  is the temperature (°C); i.e. the design temperature in the hazard area;

$S$  is the specific volume (m<sup>3</sup>/kg); the specific volume of superheated HFC 23 vapour at a pressure of 1,013 bar may be approximated by the formula

$$S = k_1 + k_2 T$$

where

$$k_1 = 0,3164$$

$$k_2 = 0,0012$$

$c$  is the concentration (%); i.e. the volumetric concentration of HFC 23 in air at the temperature indicated and a pressure of 1,013 bar absolute.

Table 3 (continued)

Temperature <i>T</i> °C	Specific vapour volume <i>S</i> m <sup>3</sup> /kg	HFC 23 mass requirements per unit volume of protected space, <i>m/V</i> (kg/m <sup>3</sup> )									
		Design concentration (by volume)									
		10 %	12 %	14 %	15 %	16 %	17 %	18 %	20 %	22 %	24 %
55	0,3826	0,2904	0,3564	0,4255	0,4612	0,4978	0,5353	0,5737	0,6534	0,7372	0,8254
60	0,3885	0,2860	0,3510	0,4190	0,4542	0,4903	0,5272	0,5650	0,6435	0,7260	0,8128
65	0,3944	0,2817	0,3457	0,4128	0,4474	0,4830	0,5193	0,5566	0,6339	0,7151	0,8007
70	0,4004	0,2775	0,3406	0,4066	0,4407	0,4757	0,5115	0,5482	0,6244	0,7044	0,7887

NOTE This information refers only to HFC-23 and does not represent any other products containing trifluoromethane as a component.

Symbols:

*m/V* is the agent mass requirements (kg/m<sup>3</sup>); i.e. mass, *m*, in kilograms of agent required per cubic metre of protected volume, *V*, to produce the indicated concentration at the temperature specified;

*V* is the net volume of hazard (m<sup>3</sup>); i.e the enclosed volume minus the fixed structures impervious to extinguishant

$$m = \left( \frac{c}{100 - c} \right) \frac{V}{S}$$

*T* is the temperature (°C); i.e. the design temperature in the hazard area;

*S* is the specific volume (m<sup>3</sup>/kg); the specific volume of superheated HFC 23 vapour at a pressure of 1,013 bar may be approximated by the formula

$$S = k_1 + k_2 T$$

where

$$k_1 = 0,316 4$$

$$k_2 = 0,001 2$$

*c* is the concentration (%); i.e. the volumetric concentration of HFC 23 in air at the temperature indicated and a pressure of 1,013 bar absolute.



**Table 4 — HFC 23 reference extinguishing and design concentrations**

<b>Fuel</b>	<b>Extinguishment</b> % by volume	<b>Minimum design</b> % by volume
<b>Class B</b>		
Heptane (cup burner)	12,6	16,4
Heptane (room test)	12,3	
<b>Surface Class A</b>		
Wood Crib	10,5	16,3
PMMA	12,5	
PP	12,5	
ABS	12,4	
<b>Higher Hazard Class A</b>	See Note 4	16,3
NOTE 1 The extinguishment values for the Class B and the Surface Class A fuels are determined by testing in accordance with ISO 14520-1:2015, Annexes B and C.		
NOTE 2 The minimum design concentration for the Class B fuel is the higher value of the heptane cup burner or room test heptane extinguishment concentration multiplied by 1,3.		
NOTE 3 The minimum design concentration for Surface Class A fuel is the highest value of the wood crib, PMMA, PP or ABS extinguishment concentrations multiplied by 1,3. In the absence of any of the four extinguishment values, the minimum design concentration for Surface Class A is that of Higher Hazard Class A.		
NOTE 4 The minimum design concentration for Higher Hazard Class A fuels is the higher of the Surface Class A or 95 % of the Class B minimum design concentration.		
NOTE 5 See ISO 14520-1:2015, 7.5.1.3 for guidance on Class A fuels.		

In [Table 4](#), the extinguishing and design concentrations for room-scale test fires are for informational purposes only. Lower and higher extinguishing concentrations than those shown for room-scale test fires may be achieved and allowed when validated by test reports from internationally recognized laboratories.

**Table 5 — HFC 23 extinguishing and design concentrations for other fuels**

<b>Fuel</b>	<b>Extinguishment</b> % by volume	<b>Minimum design</b> % by volume
Acetone	13,2	17,2
Ethanol	16,1	20,9
Ethyl acetate	13,4	17,4
Kerosene	13,2	17,2
Methanol	18,2	23,7
Propane	14,2	18,5
Toluene	12,6	16,4
NOTE Extinguishing concentrations for all Class B fuels listed were derived in accordance with ISO 14520-1:2015, Annex B.		
Minimum design values have been increased to the minimum design concentration established for heptane in accordance with ISO 14520-1:2015, 7.5.1.		

**Table 6 — HFC 23 inerting and design concentrations**

<b>Fuel</b>	<b>Inertion</b> % by volume	<b>Minimum design</b> % by volume
Methane	20,2	22,2
Propane	20,2	22,2
NOTE Inerting concentrations were derived in accordance with the requirements of ISO 14520-1:2015, Annex D and 7.5.2.		

## 5 Safety of personnel

Any hazard to personnel created by the discharge of HFC 23 shall be considered in the design of the system.

Potential hazards can arise from the following:

- a) the extinguishant itself;
- b) the combustion products of the fire;
- c) breakdown products of the extinguishant resulting from exposure to fire.

For minimum safety requirements, see ISO 14520-1:2015, Clause 5.

Toxicological information for HFC 23 is shown in [Table 7](#).

**Table 7 — Toxicological information for HFC 23**

Property	Value % by volume
ALC	>65
No observed adverse effect level (NOAEL)	30
Lowest observed adverse effect level (LOAEL)	>30
NOTE ALC is the approximate lethal concentration for a rat population during a 4-h exposure.	

## 6 System design

### 6.1 Fill density

The fill density of the container shall not result in pressures exceeding the container specifications at the maximum design temperature. For examples, see [Tables 8](#) and [9](#).

Exceeding the maximum fill density may result in the container becoming “liquid full”, with the effect that an extremely high rise in pressure occurs with small increases in temperature, which could adversely affect the integrity of the container assembly.

The relationships between pressure and temperature are shown in [Figure 1](#) for various levels of fill density.

**Table 8 — Storage container characteristics for HFC 23 - 41 bar**

Property	Unit	Value
Maximum fill density	kg/m <sup>3</sup>	890
Maximum container working pressure at 50 °C	bar	148
Pressure at 20 °C	bar	41
NOTE Reference should be made to <a href="#">Figure 1</a> for further data on pressure/temperature relationships.		

**Table 9 — Storage container characteristics for HFC 23 – 70 bar**

Property	Unit	Value
Maximum fill density	kg/m <sup>3</sup>	850
Maximum container working pressure at 50 °C	bar	163
Superpressurization at 20 °C	bar	70
NOTE Reference should be made to <a href="#">Figure 2</a> for further data on pressure/temperature relationships.		

## 6.2 Superpressurization

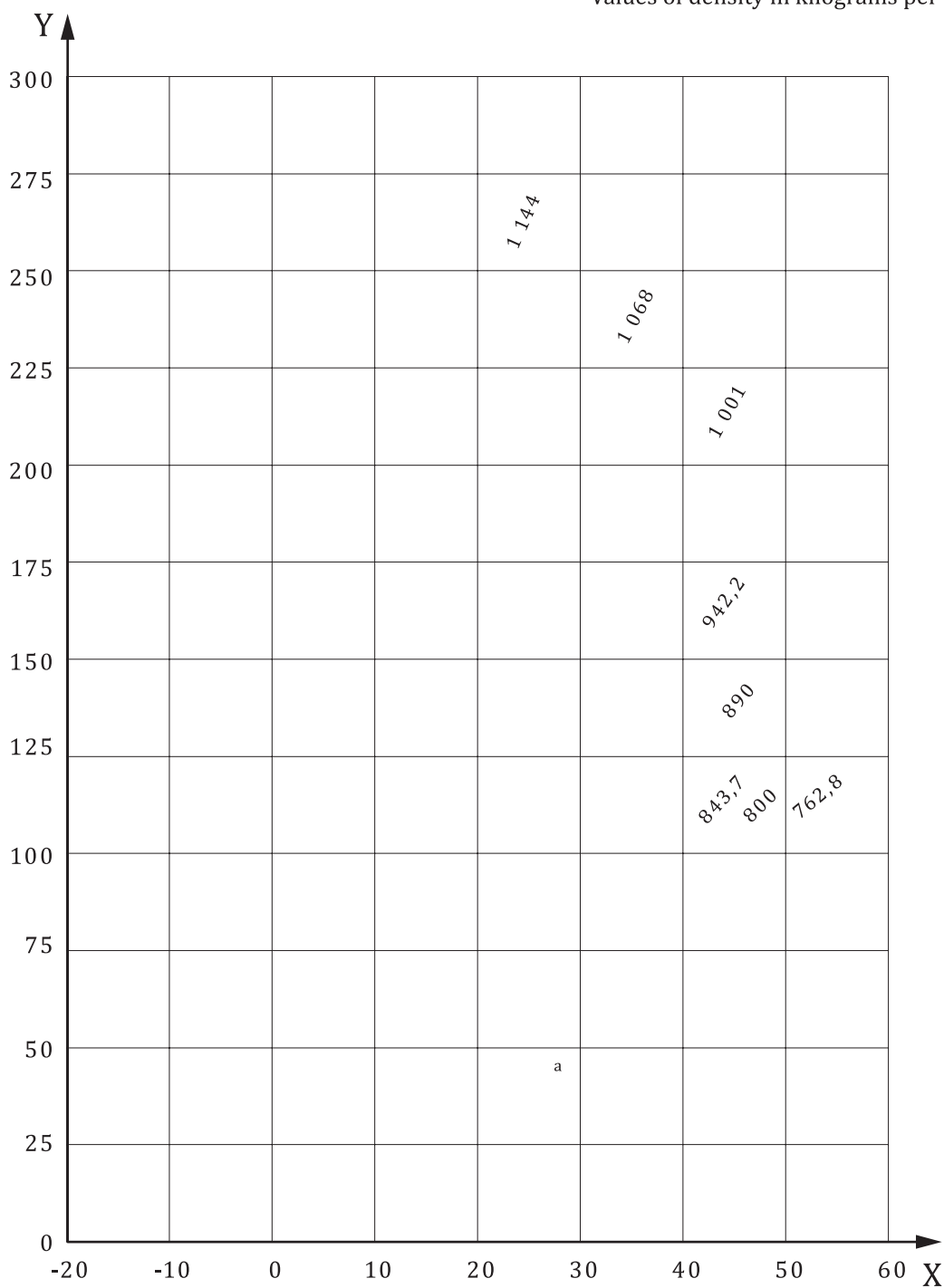
Containers designed for use with HFC 23 are typically not superpressurized. However, when applicable, containers shall be pressurized with nitrogen with a moisture content of not more than  $60 \times 10^{-6}$  by mass to an equilibrium pressure of 70 (+3,5/-0) bar at a temperature of 20 °C.

## 6.3 Extinguishant quantity

The quantity of extinguishant shall be the minimum required to achieve the design concentration within the hazard volume at the minimum expected temperature, determined using [Table 3](#). In addition, a factor shall be included in agent quantity calculations to compensate for any residual agent in the storage containers at the end of 10 s. The design concentrations shall be that specified for relevant hazards shown in [Table 4](#). This includes a 1,3 safety factor on the extinguishing concentration.

Consideration should be given to increasing this for particular hazards and seeking advice from the relevant authority.

Values of density in kilograms per cubic metre



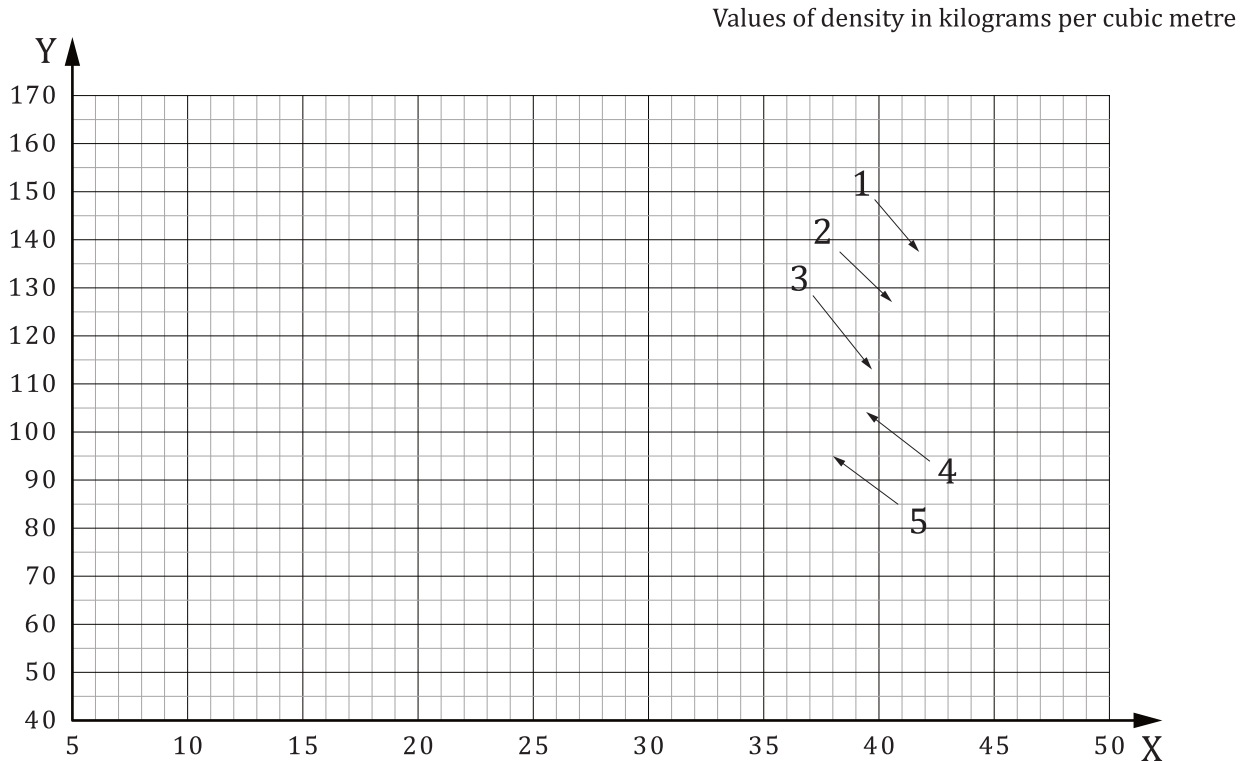
**Key**

X temperature, °C

Y pressure, bar

a Critical point.

**Figure 1 — Temperature/pressure graph for HFC 23**

**Key**

- 1 850 kg/m<sup>3</sup>
- 2 800 kg/m<sup>3</sup>
- 3 700 kg/m<sup>3</sup>
- 4 600 kg/m<sup>3</sup>
- 5 500 kg/m<sup>3</sup>
- X temperature, °C
- Y pressure, bar

**Figure 2 — Temperature/pressure graph for HFC 23 superpressurized to 70 bar at 20 °C**

## 7 Environmental properties

For information purposes, environmental properties of HFC 23 extinguishant are provided:

GWP (100 years)	14 800
ODP	0 <sup>1)</sup>

NOTE 1 See ISO 14520-1:2015, 4.2.1 for a discussion of GWP values and their relation to the impact of a gas on climate change/global warming.

NOTE 2 Environmental properties derived from the following:

- 2005 IPCC/TEAP Special Report Safeguarding the Ozone Layer and the Global Climate System: Issues Related to Hydrofluorocarbons and Perfluorocarbons;
- 2007 Fourth Assessment Report of the Intergovernmental Panel on Climate Change;
- U.S. EPA.

1) Extinguishant HFC 23 has zero ODP because it contains no chlorine, bromine, or iodine, the primary kinetically active species for ozone depletion.

