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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

Reference number
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Foreword

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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).

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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 21, *Equipment for fire protection and fire fighting*, Subcommittee SC 8, *Gaseous media and firefighting systems using gas*.

This fourth edition cancels and replaces the third edition (ISO 14520-10:2016), which has been technically revised. The main changes compared to the previous edition are as follows

— a new subclause 6.4 on fill density and superpressurization levels has been added.

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

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.

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, specifications, usage and safety aspects. It 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	3×10^{-6} by mass, max.

Table 1 *(continued)*

Property	Requirement
Water content	10×10^{-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^3/mol	133
Critical density	kg/m^3	525
Vapour pressure 20 °C	bar abs	41,80
Liquid density 20 °C	kg/m^3	806,6
Saturated vapour density 20 °C	kg/m^3	263,0
Specific volume of superheated vapour at 1,013 bar and 20 °C	m^3/kg	0,340 9
Chemical formula	CHF_3	
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	HFC 23 mass requirements per unit volume of protected space, m/V (kg/m^3)									
		Design concentration (by volume)									
	m^3/kg	10 %	12 %	14 %	15 %	16 %	17 %	18 %	20 %	22 %	24 %
−60	0,242 8	0,457 6	0,561 6	0,670 5	0,726 8	0,784 5	0,843 6	0,904 1	1,029 7	1,161 7	1,300 6
−55	0,249 2	0,445 9	0,547 2	0,653 3	0,708 1	0,764 4	0,821 9	0,880 9	1,003 2	1,131 8	1,267 2
−50	0,255 5	0,434 9	0,533 7	0,637 1	0,690 7	0,745 5	0,801 6	0,859 1	0,978 5	1,103 9	1,236 0
−45	0,261 7	0,424 6	0,521 1	0,622 1	0,674 3	0,727 8	0,782 6	0,838 8	0,955 3	1,077 8	1,206 7
−40	0,268 0	0,414 6	0,508 8	0,607 4	0,658 5	0,710 7	0,764 3	0,819 1	0,932 8	1,052 4	1,178 3
−35	0,274 2	0,405 2	0,497 3	0,593 7	0,643 6	0,694 7	0,747 0	0,800 6	0,911 7	1,028 6	1,151 7
−30	0,280 3	0,396 4	0,486 5	0,580 8	0,629 6	0,679 5	0,730 7	0,783 1	0,891 9	1,006 2	1,126 6
−25	0,286 5	0,387 8	0,476 0	0,568 2	0,616 0	0,664 8	0,714 9	0,766 2	0,872 6	0,984 5	1,102 2

Table 3 *(continued)*

Temperature T °C	Specific vapour volume S	**HFC 23 mass requirements per unit volume of protected space**, m/V (kg/m³)									
		Design concentration (by volume)									
	m³/kg	10 %	12 %	14 %	15 %	16 %	17 %	18 %	20 %	22 %	24 %
–20	0,292 6	0,379 7	0,466 0	0,556 4	0,603 1	0,651 0	0,700 0	0,750 2	0,854 4	0,963 9	1,079 3
–15	0,298 7	0,372 0	0,456 5	0,545 0	0,590 8	0,637 7	0,685 7	0,734 9	0,837 0	0,944 3	1,057 2
–10	0,304 7	0,364 7	0,447 5	0,534 3	0,579 2	0,625 1	0,672 2	0,720 4	0,820 5	0,925 7	1,036 4
–5	0,310 8	0,357 5	0,438 8	0,523 8	0,567 8	0,612 9	0,659 0	0,706 3	0,804 4	0,907 5	1,016 1
0	0,316 8	0,350 7	0,430 4	0,513 9	0,557 0	0,601 3	0,646 5	0,692 9	0,789 1	0,890 3	0,996 8
5	0,322 9	0,344 1	0,422 3	0,504 2	0,546 5	0,589 9	0,634 3	0,679 8	0,774 2	0,873 5	0,978 0
10	0,328 9	0,337 8	0,414 6	0,495 0	0,536 5	0,579 1	0,622 7	0,667 4	0,760 1	0,857 6	0,960 1
15	0,334 9	0,331 8	0,407 2	0,486 1	0,526 9	0,568 8	0,611 6	0,655 5	0,746 5	0,842 2	0,942 9
20	0,340 9	0,325 9	0,400 0	0,477 5	0,517 7	0,558 7	0,600 8	0,643 9	0,733 4	0,827 4	0,926 3
25	0,346 8	0,320 4	0,393 2	0,469 4	0,508 9	0,549 2	0,590 6	0,633 0	0,720 9	0,813 3	0,910 6
30	0,352 8	0,314 9	0,386 5	0,461 4	0,500 2	0,539 9	0,580 6	0,622 2	0,708 6	0,799 5	0,895 1
35	0,358 8	0,309 7	0,380 1	0,453 7	0,491 8	0,530 9	0,570 8	0,611 8	0,696 8	0,786 1	0,880 1
40	0,364 7	0,304 7	0,373 9	0,446 4	0,483 9	0,522 3	0,561 6	0,601 9	0,685 5	0,773 4	0,865 9
45	0,370 7	0,299 7	0,367 9	0,439 1	0,476 0	0,513 8	0,552 5	0,592 2	0,674 4	0,760 9	0,851 9
50	0,376 6	0,295 0	0,362 1	0,432 3	0,468 6	0,505 8	0,543 9	0,582 9	0,663 8	0,748 9	0,838 5
55	0,382 6	0,290 4	0,356 4	0,425 5	0,461 2	0,497 8	0,535 3	0,573 7	0,653 4	0,737 2	0,825 4
60	0,388 5	0,286 0	0,351 0	0,419 0	0,454 2	0,490 3	0,527 2	0,565 0	0,643 5	0,726 0	0,812 8
65	0,394 4	0,281 7	0,345 7	0,412 8	0,447 4	0,483 0	0,519 3	0,556 6	0,633 9	0,715 1	0,800 7
70	0,400 4	0,277 5	0,340 6	0,406 6	0,440 7	0,475 7	0,511 5	0,548 2	0,624 4	0,704 4	0,788 7

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/m³), 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 (m³), 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 (m³/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

Fuel	Extinguishment % by volume	Minimum design % by volume
Class B		
Heptane (cup burner) Heptane (room test)	12,6 12,3	16,4
Surface Class A		
Wood Crib PMMA PP ABS	10,5 12,5 12,5 12,4	16,3
Higher Hazard Class A	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

Fuel	Extinguishment % by volume	Minimum design % by volume
Acetone	13,2	17,2
Ethanol Ethyl acetate Kerosene	16,1 13,4 13,2	20,9 17,4 17,2
Methanol Propane	18,2 14,2	23,7 18,5
Toluene	12,6	16,4

NOTE 1 Extinguishing concentrations for all Class B fuels listed were derived in accordance with ISO 14520-1:2015, Annex B.

NOTE 2 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

Fuel	Inertion % by volume	Minimum design % 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^3	890
Maximum container working pressure at 50 °C	bar	148
Pressure at 20 °C	bar	41
NOTE Figure 1 shows further data on pressure/temperature relationships.		

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

Property	Unit	Value
Maximum fill density	kg/m^3	850
Maximum container working pressure at 50 °C	bar	163
NOTE Figure 2 shows further data on pressure/temperature relationships.		