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

Part 11: **HFC 236fa extinguishant**

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

Partie 11: Agent extincteur HFC 236fa

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Contents

Page

Foreword ..... **iv**
1 Scope **1**
2 Normative references **1**
3 Terms and definitions **1**
4 Characteristics and uses **1**
4.1 General 1
4.2 Use of HFC 236fa systems 2
5 Safety of personnel **5**
6 System design **6**
6.1 Fill density 6
6.2 Superpressurization 7
6.3 Extinguishant quantity 7
7 Environmental properties **8**

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 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.

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 14520-11:2005), which has been technically revised with the following changes:

— in Table 5, minimum design data was corrected from previous edition; all but values for ethanol and methanol were incorrect;

— 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 11:
HFC 236fa extinguishant

1 Scope

This document contains specific requirements for gaseous fire-extinguishing systems, with respect to the HFC 236fa extinguishant. It includes details of physical properties, specification, usage and safety aspects.

This document covers systems operating at nominal pressures of 25 bar and 42 bar superpressurized with nitrogen. This does not preclude the use of other systems.

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 236fa shall comply with the specification shown in Table 1.

HFC 236fa is a colourless, almost odourless, electrically non-conductive gas with a density approximately five times that of air.

The physical properties are shown in Table 2.

HFC 236fa extinguishes fires mainly by physical means, but also by some chemical means.

Table 1 — Specification for HFC 236fa

Property	Requirement
Purity	99,6% by mass, min.
Acidity	3×10^{-6} by mass, max.
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 236fa

Property	Units	Value
Molecular mass	—	152
Boiling point at 1,013 bar (absolute)	°C	–1,4
Freezing point	°C	–103
Critical temperature	°C	124,9
Critical pressure	bar abs	32,00
Critical volume	cm^3/mol	274,0
Critical density	kg/m^3	551,3
Vapour pressure 20 °C	bar abs	2,296
Liquid density 20 °C	kg/m^3	1 377
Saturated vapour density 20 °C	kg/m^3	15,58
Specific volume of superheated vapour at 1,013 bar and 20 °C	m^3/kg	0,1529
Chemical formula	$CF_3CH_2CF_3$	
Chemical name	Hexafluoropropane	

4.2 Use of HFC 236fa systems

HFC 236fa 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 various types of hazard are shown in Table 4. Concentrations for other fuels are shown in Table 5.

Table 3 — HFC 236fa total flooding quantity

Temperature *T* °C	Specific vapour volume *S*	HFC 236fa mass requirements per unit volume of protected space, m/V (kg/m^3) — Design concentration (by volume)										
	m^3/kg	5 %	6 %	7 %	8 %	9 %	10 %	11 %	12 %	13 %	14 %	15 %
0	0,141 3	0,372 5	0,451 7	0,532 7	0,615 4	0,699 9	0,786 3	0,874 7	0,965 1	1,057 5	1,152 1	1,248 9
5	0,144 2	0,365 0	0,442 7	0,522 0	0,603 1	0,686 0	0,770 6	0,857 2	0,945 8	1,036 4	1,129 1	1,224 0
10	0,147 1	0,357 9	0,434 0	0,511 8	0,591 3	0,672 5	0,755 5	0,840 4	0,927 3	1,016 1	1,107 0	1,200 0
15	0,149 9	0,351 0	0,425 7	0,502 0	0,579 9	0,659 6	0,741 0	0,824 3	0,909 5	0,996 6	1,085 7	1,176 9
20	0,152 8	0,344 4	0,417 7	0,492 5	0,569 0	0,647 2	0,727 1	0,808 8	0,892 3	0,977 8	1,065 2	1,154 8
25	0,155 7	0,338 0	0,410 0	0,483 4	0,558 5	0,635 2	0,713 6	0,793 8	0,875 8	0,959 7	1,045 5	1,133 4
30	0,158 6	0,331 9	0,402 5	0,474 6	0,548 3	0,623 7	0,700 7	0,779 4	0,859 9	0,942 3	1,026 6	1,112 8
35	0,161 5	0,326 0	0,395 3	0,466 2	0,538 6	0,612 5	0,688 2	0,765 5	0,844 6	0,925 5	1,008 2	1,093 0
40	0,164 3	0,320 3	0,388 4	0,458 0	0,529 1	0,601 8	0,676 1	0,752 1	0,829 8	0,909 2	0,990 6	1,073 8
45	0,167 2	0,314 7	0,381 7	0,450 1	0,520 0	0,591 4	0,664 5	0,739 1	0,815 5	0,893 6	0,973 5	1,055 3
50	0,170 1	0,309 4	0,375 2	0,442 5	0,511 2	0,581 4	0,653 2	0,726 6	0,801 7	0,878 5	0,957 0	1,037 5
55	0,173 0	0,304 3	0,369 0	0,435 1	0,502 7	0,571 7	0,642 3	0,714 5	0,788 3	0,863 8	0,941 1	1,020 2
60	0,175 9	0,299 3	0,363 0	0,428 0	0,494 5	0,562 4	0,631 8	0,702 8	0,775 4	0,849 7	0,925 7	1,003 5

This information refers only to the product HFC-236fa and may not represent any other products containing 1,1,1,3,3,3-hexafluoropropane as a component.

Symbols:

m/V is the agent mass requirements (kg/m^3); 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^3); 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^3/kg); the specific volume of superheated HFC 236fa vapour at a pressure of 1,013 bar may be approximated by the formula

$S = k_1 + k_2 T$

where

k_1 = 0,141 3

k_2 = 0,000 6

c is the concentration (%); i.e. the volumetric concentration of HFC 236fa in air at the temperature indicated and a pressure of 1,013 bar absolute.

Table 3 *(continued)*

Temperature T °C	**Specific vapour volume** S m³/kg	**HFC 236fa mass requirements per unit volume of protected space**, m/V (kg/m³) **Design concentration** (by volume) 5 %	6 %	7 %	8 %	9 %	10 %	11 %	12 %	13 %	14 %	15 %
65	0,178 7	0,294 5	0,357 1	0,421 1	0,486 5	0,553 3	0,621 6	0,691 5	0,762 9	0,836 0	0,910 8	0,987 3
70	0,181 6	0,289 8	0,351 4	0,414 4	0,478 8	0,544 5	0,611 8	0,680 5	0,750 8	0,822 7	0,896 3	0,971 6
75	0,184 5	0,285 3	0,346 0	0,408 0	0,471 3	0,536 0	0,602 2	0,669 9	0,739 1	0,809 9	0,882 3	0,956 5
80	0,187 4	0,2809	0,340 6	0,401 7	0,464 1	0,527 8	0,593 0	0,659 6	0,727 7	0,797 4	0,868 8	0,941 8
85	0,190 3	0,276 6	0,335 5	0,395 6	0,457 0	0,519 8	0,584 0	0,649 6	0,716 7	0,785 4	0,855 6	0,927 5
90	0,193 1	0,272 5	0,330 5	0,389 7	0,450 2	0,512 1	0,575 3	0,639 9	0,706 0	0,773 7	0,842 9	0,913 7
95	0,196 0	0,268 5	0,325 6	0,384 0	0,443 6	0,504 5	0,566 8	0,630 5	0,695 7	0,762 3	0,830 5	0,900 3

This information refers only to the product HFC-236fa and may not represent any other products containing 1,1,1,3,3,3-hexafluoropropane 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 236fa vapour at a pressure of 1,013 bar may be approximated by the formula

$S = k_1 + k_2 T$

where

$k_1 = 0{,}141\ 3$

$k_2 = 0{,}000\ 6$

c is the concentration (%); i.e. the volumetric concentration of HFC 236fa in air at the temperature indicated and a pressure of 1,013 bar absolute.

Table 4 — HFC 236fa reference extinguishing and design concentrations

Fuel	Extinguishment % by volume	Minimum design % by volume
Class B		
Heptane (cup burner)	6,5	9,8
Heptane (room test)	7,5	
Surface class A		8,8
Wood Crib	5,0	
PMMA	6,8	
PP	6,8	
ABS	6,8	
Higher Hazard Class A	See Note 4	9,3

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 236fa extinguishing and design concentrations for other fuels

Fuel	**Extinguishment** % by volume	**Minimum design** % by volume
Acetone	6,7	8,7
Ethanol	7,8	10,1
Ethyl acetate	6,8	8,8
Kerosene	6,5	8,5
Methanol	8,4	10,9
Propane	7,2	9,4
Toluene	6,5	8,5

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.

5 Safety of personnel

Any hazard to personnel created by the discharge of HFC 236fa 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 236fa is shown in Table 6.

Table 6 — Toxicological information for HFC 236fa

Property	Value % by volume
ALC	>47,5
No observed adverse effect level (NOAEL)	10
Lowest observed adverse effect level (LOAEL)	15
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 container specifications at the maximum design temperature. For an example, see Table 7.

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 7 — 25 bar storage container characteristics for HFC 236fa

Property	Unit	Value
Maximum fill density	kg/m^3	1 202
Maximum container working pressure at 50 °C	bar	34
Superpressurization at 22 °C	bar	25
NOTE Reference should be made to Figure 1 for further data on pressure/temperature relationships.		

Table 8 — 42 bar storage container characteristics for HFC-236fa

Property	Unit	Value
Maximum fill density	kg/m^3	1 202
Maximum container working pressure at 50 °C	bar	79
Superpressurization at 22 °C	bar	42
NOTE Reference should be made to Figure 2 for further data on pressure/temperature relationships.		

6.2 Superpressurization

Containers shall be superpressurized with nitrogen with a moisture content of not more than 60 × 10^{-6} by mass to an equilibrium pressure of 25 bar $^{+5}_{0}$ % or 42 bar $^{+5}_{0}$ % at a temperature of 22 °C (see Clause 1 for exception).

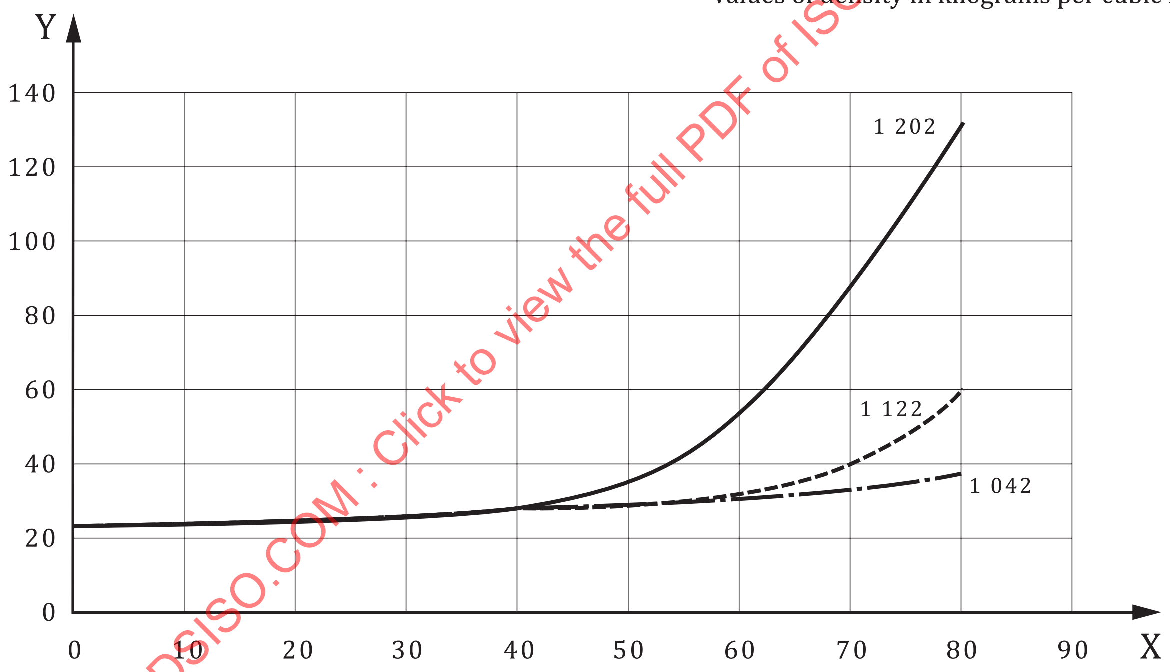
6.3 Extinguishant quantity

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 and the method specified in ISO 14520-1:2015; 7.6.

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

Figure 1 — Temperature/pressure graph for HFC 236fa pressurized with nitrogen to 25 bar at 22 °C