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

Part 9: HFC 227ea extinguishant

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

Partie 9: Agent extincteur HFC 227ea

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Foreword

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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 14520-9 was prepared by Technical Committee ISO/TC 21, *Equipment for fire protection and fire fighting*, Subcommittee SC 8, *Gaseous media fire fighting systems using gas*.

This second/third/... edition cancels and replaces the first/second/... edition (), [clause(s) / subclause(s) / table(s) / figure(s) / annex(es)] of which [has / have] been technically revised.

ISO 14520 consists of the following parts, under the general title *Gaseous fire-extinguishing systems — Physical and system design*:

- Part 1: General requirements
- Part 2: CF₃I extinguishant
- Part 3: Withdrawn
- Part 4: Withdrawn
- Part 5: FK-5-1-12 extinguishant
- Part 6: HCFC Blend A extinguishant
- Part 7: Withdrawn
- Part 8: HFC 125 extinguishant
- Part 9: HFC 227ea extinguishant
- Part 10: HFC 23 extinguishant
- Part 11: HFC 236fa extinguishant
- Part 12: IG-01 extinguishant
- Part 13: IG-100 extinguishant
- Part 14: IG-55 extinguishant
- Part 15: IG-541 extinguishant

Gaseous fire-extinguishing systems — Physical and system design — Part 9: HFC 227ea extinguishant

1 Scope

1.1 This part of ISO 14520 contains specific requirements for gaseous fire-extinguishing systems, with respect to the HFC 227ea extinguishant. It includes details of physical properties, specification, usage and safety aspects.

1.2 This part of ISO 14520 covers systems operating at nominal pressures of 25 bar, 42 bar and 50 bar with nitrogen propellant. This does not preclude the use of other systems.

2 Normative reference

The following normative document contains provisions which, through reference in this text, constitute provisions of this part of ISO 14520. For dated references, subsequent amendments to, or revisions of, this publication do not apply. However, parties to agreements based on this part of ISO 14520 are encouraged to investigate the possibility of applying the most recent edition of the normative document indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

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

3 Terms and definitions

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

4 Characteristics and uses

4.1 General

Extinguishant HFC 227ea shall comply with the specification shown in Table 1.

HFC 227ea is a colourless, almost odourless, electrically non-conductive gas, with a density approximately six times that of air.

The physical properties are shown in Table 2.

HFC 227ea extinguishes fires mainly by physical means but by some chemical means.

Table 1 — Specification for HFC 227ea

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 227ea

Property	Units	Value
Molecular mass	—	170
Boiling point at 1,013 bar (absolute)	°C	-16,4
Freezing point	°C	-127
Critical temperature	°C	101,7
Critical pressure	bar abs	29,26
Critical volume	cm ³ /mol	274
Critical density	kg/m ³	573
Vapour pressure 20 °C	bar abs	3,90
Liquid density 20 °C	kg/m ³	1410
Saturated vapour density 20 °C	kg/m ³	31,035
Specific volume of superheated vapour at 1,013 bar and 20 °C	m ³ /kg	0,1374
Chemical formula	CF ₃ CHFCF ₃	
Chemical name	Heptafluoropropane	

4.2 Use of HFC 227ea systems

HFC 227ea total flooding systems may be used for extinguishing fires of all classes within the limits specified in clause 4 of ISO 14520-1.

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 7.6 of ISO 14520-1.

The extinguishing concentrations and design concentrations for *n*-heptane and surface class A hazards are shown in Table 4. Concentrations for other fuels are shown in Table 5 and inerting concentrations are shown in Table 6.

Table 3 — HFC 227ea total flooding quantity

Temperature <i>T</i> °C	Specific vapour volume <i>S</i> m ³ /kg	HFC 227ea mass requirements per unit volume of protected space, <i>m/V</i> (kg/m ³)									
		Design concentration (by volume)									
		6 %	7 %	8 %	9 %	10 %	11 %	12 %	13 %	14 %	15 %
−10	0,1215	0,5254	0,6196	0,7158	0,8142	0,9147	1,0174	1,1225	1,2301	1,3401	1,4527
−5	0,1241	0,5142	0,6064	0,7005	0,7967	0,8951	0,9957	1,0985	1,2038	1,3114	1,4216
0	0,1268	0,5034	0,5936	0,6858	0,7800	0,8763	0,9748	1,0755	1,1785	1,2839	1,3918
5	0,1294	0,4932	0,5816	0,6719	0,7642	0,8586	0,9550	1,0537	1,1546	1,2579	1,3636
10	0,1320	0,4834	0,5700	0,6585	0,7490	0,8414	0,9360	1,0327	1,1316	1,2328	1,3364
15	0,1347	0,4740	0,5589	0,6457	0,7344	0,8251	0,9178	1,0126	1,1096	1,2089	1,3105
20	0,1373	0,4650	0,5483	0,6335	0,7205	0,8094	0,9004	0,9934	1,0886	1,1859	1,2856
25	0,1399	0,4564	0,5382	0,6217	0,7071	0,7944	0,8837	0,9750	1,0684	1,1640	1,2618
30	0,1425	0,4481	0,5284	0,6104	0,6943	0,7800	0,8676	0,9573	1,0490	1,1428	1,2388
35	0,1450	0,4401	0,5190	0,5996	0,6819	0,7661	0,8522	0,9402	1,0303	1,1224	1,2168
40	0,1476	0,4324	0,5099	0,5891	0,6701	0,7528	0,8374	0,9239	1,0124	1,1029	1,1956
45	0,1502	0,4250	0,5012	0,5790	0,6586	0,7399	0,8230	0,9080	0,9950	1,0840	1,1751
50	0,1527	0,4180	0,4929	0,5694	0,6476	0,7276	0,8093	0,8929	0,9784	1,0660	1,1555
55	0,1553	0,4111	0,4847	0,5600	0,6369	0,7156	0,7960	0,8782	0,9623	1,0484	1,1365
60	0,1578	0,4045	0,4770	0,5510	0,6267	0,7041	0,7832	0,8641	0,9469	1,0316	1,1183
65	0,1604	0,3980	0,4694	0,5423	0,6167	0,6929	0,7707	0,8504	0,9318	1,0152	1,1005
70	0,1629	0,3919	0,4621	0,5338	0,6072	0,6821	0,7588	0,8371	0,9173	0,9994	1,0834
75	0,1654	0,3859	0,4550	0,5257	0,5979	0,6717	0,7471	0,8243	0,9033	0,9841	1,0668
80	0,1679	0,3801	0,4482	0,5178	0,5890	0,6617	0,7360	0,8120	0,8898	0,9694	1,0509
85	0,1704	0,3745	0,4416	0,5102	0,5803	0,6519	0,7251	0,8000	0,8767	0,9551	1,0354
90	0,1730	0,3690	0,4351	0,5027	0,5717	0,6423	0,7145	0,7883	0,8638	0,9411	1,0202
95	0,1755	0,3638	0,4290	0,4956	0,5636	0,6332	0,7044	0,7771	0,8516	0,9277	1,0057
100	0,1780	0,3587	0,4229	0,4886	0,5557	0,6243	0,6945	0,7662	0,8396	0,9147	0,9916

NOTE This information refers only to the product HFC-227ea, and does not represent any other products containing 1,1,1,2,3,3,3-heptafluoropropane 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 227ea vapour at a pressure of 1,013 bar may be approximated by the formula:

$$S = k_1 + k_2 T$$

where

$$k_1 = 0,1269$$

$$k_2 = 0,000513$$

c is the concentration (%); i.e. the volumetric concentration of HFC 227ea in air at the temperature indicated, and a pressure of 1,013 bar absolute.

Table 4 — HFC 227ea reference extinguishing and design concentrations

Fuel	Extinguishment % by volume	Minimum design % by volume
Class B		
Heptane (cup burner)	6,7	9,0
Heptane (room test)	6,9	
Surface Class A		
Wood Crib	4,9	7,9
PMMA	6,1	
PP	6,1	
ABS	6,1	
Higher Hazard Class A	See Note 4	8,5
<p>NOTE 1 The extinguishment values for the Class B and the Surface Class A fuels are determined by testing in accordance with Annexes B and C of ISO 14520-1.</p> <p>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.</p> <p>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 4 extinguishment values, the minimum design concentration for Surface Class A shall be that of Higher Hazard Class A.</p> <p>NOTE 4 The minimum design concentration for Higher Hazard Class A fuels shall be the higher of the Surface Class A or 95% of the Class B minimum design concentration.</p> <p>NOTE 5 See 7.5.1.3 of ISO 14520-1 for guidance on Class A fuels.</p> <p>NOTE 6 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.</p>		

Table 5 — HFC 227ea extinguishing and design concentrations for other fuels

Fuel	Extinguishment % by volume	Minimum design % by volume
Acetone	6,7	8,7
Ethanol	8,4	10,9
Ethyl acetate	6,7	8,7
Ethylene glycol	7,8	10,1
Kerosene	6,1	7,9
Methanol	9,5	12,4
Propane	7,4	9,6
Toluene	4,9	6,4
<p>NOTE Extinguishing concentrations for all Class B fuels listed were derived in accordance with ISO 14520-1, Annex B.</p> <p>Minimum design values have been increased to the minimum design concentration established for heptane in accordance with ISO 14520-1, section 7.5.1.</p>		

Table 6 — HFC 227ea inerting and design concentrations

Fuel	Inertion % by volume	Minimum design % by volume
Isobutane	11,3	12,4
1-Chloro-1,1-difluoroethane (HCFC 1416)	6,7	8,7
1,1-Difluoroethane (HCFC 152a)	8,6	9,5
Difluoromethane (HCFC 32)	6,7	8,7
Ethylene oxide	13,6	15,0
Methane	8,0	8,8
Pentane	11,6	12,8
Propane	11,6	12,8
NOTE Inerting concentrations were derived in accordance with the requirements of ISO 14520-1, Annex D and 7.5.2.		

5 Safety of personnel

Any hazard to personnel created by the discharge of HFC 227ea shall be considered in the design of the system.

Potential hazards can arise from the following:

- the extinguishant itself;
- the combustion products of the fire; and
- breakdown products of the extinguishant resulting from exposure to fire.

For minimum safety requirements, see ISO/DIS 14520-1, clause 5.

Toxicological information for HFC 227ea is shown in Table 7.

Table 7 — Toxicological information for HFC 227ea

Property	Value % by volume
ALC	>80 at 20 % O ₂
No observed adverse effect level (NOAEL)	9,0
Lowest observed adverse effect level (LOAEL)	10,5
NOTE ALC is the approximate lethal concentration for a rat population during a 4-h exposure.	