INTERNATIONAL STANDARD

ISO 14520-5

First edition
2006-02-15

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

Part 5: FK-5-1-12 extinguishant

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

Partie 5: Agent extincteur FK-5-1-12

Reference number
ISO 14520-5:2006(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

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 14520-5 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*.

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

— *Part 1: General requirements*

— *Part 2: CF_3I extinguishant*

— *Part 5: FK-5-1-12 extinguishant*

— *Part 6: HCFC Blend A extinguishant*

— *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*

Part 3, 4 and 7, which dealt with FC-2-1-8, FC-3-1-10 and HCFC 124 extinguishants, respectively, have been withdrawn, as these types are no longer manufactured.

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

Part 5: **FK-5-1-12 extinguishant**

1 Scope

This part of ISO 14520 gives specific requirements for gaseous fire-extinguishing systems, with respect to the FK-5-1-12 extinguishant. It includes details of physical properties, specification, usage and safety aspects and is applicable to systems operating at nominal pressures of 25 bar and 42 bar with nitrogen propellant. This does not preclude the use of other systems.

2 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.

ISO 14520-1:2006, *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.

4 Characteristics and uses

4.1 General

Extinguishant FK-5-1-12 shall comply with the specification according to Table 1.

FK-5-1-12 is a clear, colourless, almost odourless, electrically non-conductive gas with a density approximately 11 times that of air.

The physical properties are given in Table 2.

FK-5-1-12 extinguishes fires mainly by physical means, but also by some chemical means.

Table 1 — Specification for FK-5-1-12

Property	Requirement
Purity	99,9 % by mol/mol, min.
Acidity	3×10^{-6} by mass, max.
Water content	0,001 % by mass, max.
Non-volatile residue	0,03 % by mass, max.
Suspended matter or sediment	None visible

Table 2 — Physical properties of FK-5-1-12

Property	Unit	Value
Molecular mass	—	316,04
Boiling point at 1,013 bar (absolute)[a]	°C	49,2
Freezing point	°C	−108,0
Critical temperature	°C	168,66
Critical pressure	bar [a]	18,646
Critical volume	cc/mol	494,5
Critical density	kg/m^3	639,1
Vapour pressure 20 °C	bar abs [a]	0,3260
Liquid density 20 °C	g/ml	1,616
Saturated vapour density 20 °C	kg/m^3	4,3305
Specific volume of superheated vapour at 1,013 bar and 20 °C	m^3/kg	0,0719
Heat of vaporization at boiling point	kJ/kg	88,0
Chemical formula	$CF_3CF_2C(O)CF(CF_3)_2$	
Chemical name	Dodecafluoro-2-methylpentan-3-one	

[a] 1 bar = 0,1 MPa = 10^5 Pa; 1 MPa = 1 N/mm^2.

4.2 Use of FK-5-1-12 systems

FK-5-1-12 total flooding systems may be used for extinguishing fires of all classes within the limits specified in ISO 14520-1:2006, Clause 4.

The extinguishant requirements per volume of protected space are given in Table 3 for various levels of concentration. These are based on methods given in ISO 14520-1:2006, 7.6.

The extinguishing concentrations and design concentrations for heptane and Surface class A hazards are given in Table 4, those for other fuels in Table 5 and inerting concentrations in Table 6.

Table 3 — FK-5-1-12 total flooding quantity

Temperature T	**Specific vapour volume** S	**FK-5-1-12 mass requirements per unit volume of protected space,** m/V (kg/m^3) This information refers only to FK-5-1-12, and may not represent any other products containing Dodecafluoromethylpentan-3-one as a component.							
		Design concentration (by volume)							
°C	m3/kg	3 %	4 %	5 %	6 %	7 %	8 %	9 %	10 %
−20	0,0609	0,5077	0,6840	0,8640	1,0407	1,2357	1,4275	1,6236	1,8241
−15	0,0623	0,4965	0,6690	0,8450	1,0248	1,2084	1,3961	1,5879	1,7839
−10	0,0637	0,4859	0,6545	0,8268	1,0027	1,1824	1,3660	1,5537	1,7455
−5	0,0650	0,4756	0,6407	0,8094	0,9816	1,1575	1,3372	1,5209	1,7087
0	0,0664	0,4658	0,6275	0,7926	0,9613	1,1336	1,3096	1,4895	1,6734
5	0,0678	0,4564	0,6148	0,7766	0,9418	1,1106	1,2831	1,4593	1,6395
10	0,0691	0,4473	0,6026	0,7612	0,9232	1,0886	1,2576	1,4304	1,6070
15	0,0705	0,4386	0,5909	0,7464	0,9052	1,0674	1,2332	1,4026	1,5757
20	0,0719	0,4302	0,5796	0,7322	0,8879	1,0471	1,2096	1,3758	1,5457
25	0,0733	0,4222	0,5688	0,7184	0,8713	1,0275	1,1870	1,3500	1,5167
30	0,0746	0,4144	0,5583	0,7052	0,8553	1,0086	1,1652	1,3252	1,4888
35	0,0760	0,4069	0,5482	0,6925	0,8399	0,9904	1,1442	1,3013	1,4620
40	0,0774	0,3997	0,5385	0,6802	0,8250	0,9728	1,1239	1,2783	1,4361
45	0,0787	0,3928	0,5291	0,6684	0,8106	0,9559	1,1043	1,2560	1,4111
50	0,0801	0,3860	0,5201	0,6570	0,7967	0,9395	1,0854	1,2345	1,3869
55	0,0815	0,3795	0,5113	0,6459	0,7833	0,9237	1,0671	1,2137	1,3636
60	0,0829	0,3733	0,5029	0,6352	0,7704	0,9084	1,0495	1,1936	1,3410
65	0,0842	0,3672	0,4947	0,6247	0,7578	0,8936	1,0324	1,1742	1,3191
70	0,0856	0,3613	0,4868	0,6148	0,7457	0,8793	1,0158	1,1554	1,2980
75	0,0870	0,3556	0,4791	0,6052	0,7339	0,8654	0,9998	1,1372	1,2775
80	0,0883	0,3501	0,4716	0,5958	0,7225	0,8520	0,9843	1,1195	1,2577
85	0,0897	0,3447	0,4644	0,5866	0,7115	0,8390	0,9692	1,1024	1,2385
90	0,0911	0,3395	0,4574	0,5778	0,7008	0,8263	0,9547	1,0858	1,2198
95	0,0925	0,3345	0,4507	0,5692	0,6904	0,8141	0,9405	1,0697	1,2014
100	0,0938	0,3296	0,4441	0,5609	0,6803	0,8022	0,9267	1,0540	1,1842

m/V is the agent mass requirement (in kilograms per cubic metre); 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 (in cubic metres); 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 (in degrees Celsius); i.e. the design temperature in the hazard area;

S is the specific volume (in cubic metres per kilogram); the specific volume of superheated FK-5-1-12 vapour at a pressure of 1,013 bar may be approximated by

$$S = k_1 + k_2 T$$

where k_1 = 0,066 4; k_2 = 0,000 274

c is the concentration (in percent); i.e. the volumetric concentration of FK-5-1-12 in air at the temperature indicated, and a pressure of 1,013 bar absolute.

Table 4 — FK-5-1-12 reference extinguishing and design concentrations

Fuel	Extinguishment % by volume	Minimum design % by volume
Class B		
Heptane (cup burner)	4,5	5,9
Heptane (room test)	4,4	
Surface Class A		
Wood crib	3,4	
PMMA	4,1	5,3
PP	4,0	
ABS	4,0	
Higher Hazard Class A	[a]	5,6

The extinguishment values for the Class B and the Surface Class A fuels are determined by testing in accordance with ISO 14520-1:2006, Annexes B and C.

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.

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.

See ISO 14520-1:2006, 7.5.1.3, for guidance on Class A fuels.

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.

[a] The minimum design concentration for Higher Hazard Class A fuels shall be the higher of the surface Class A or95 % of the Class B minimum design concentration.

Table 5 — FK-5-1-12 concentrations for other fuels

Fuel	Extinguishment % by volume	Minimum design % by volume
Acetone	4,5	5,9
Ethyl alcohol	5,5	7,2
Marine diesel	4,5	5,9
Methyl alcohol	6,5	8,5
Methyl ethyl ketone		
n-heptane	4,5	5,9
Technical heptane		

Extinguishing concentrations for Class B fuels derived in accordance with ISO 14520-1:2006, Annex B. Minimum design values have been increased to the minimum design concentration established for heptane in accordance with ISO 14520-1:2006, 7.5.1.

Table 6 — FK-5-1-12 inerting and design concentrations

Fuel	Inertion % by volume	Minimum design % by volume
Methane	8,8	9,7
Propane	8,1	8,9
Inerting concentrations determined in accordance with ISO 14520-1.		

5 Safety of personnel

Any hazard to personnel created by the discharge of FK-5-1-12 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 14520-1:2006, Clause 5.

Toxicological information for FK-5-1-12 is given in Table 7.

Table 7 — Toxicological information for FK-5-1-12

Property	Value % by volume
4 h LC_{50}	$>$ 10
No observed adverse effect level (NOAEL)	10
Lowest observed adverse effect level (LOAEL)	$>$ 10
4 h LC_{50} is the concentration lethal to 50 % of a rat population during a 4 h exposure.	

6 System design

6.1 Fill density

The fill density of the container shall not exceed the values given in Tables 8 and 9 for 25 bar and 42 bar systems, respectively.

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 Figures 1 and 2 for various levels of fill density.

