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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

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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 document 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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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-~~25~~:2019), which has been technically revised.

The main changes are as follows:

— ~~—~~new specifications for dimers have been added to ~~Table 1.~~Table 1.

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 5:
FK-5-1-12 extinguishant

1 Scope

This document contains specific requirements for gaseous fire-extinguishing systems, with respect to FK-5-1-12 extinguishant. It includes details of physical properties, specifications, usage and safety aspects.

This document is applicable only to systems operating at nominal pressures of 25 bar, 34,5 bar, 42 bar and 50 bar[1] with nitrogen propellant. 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, *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~~terminology databases for use in standardization at the following addresses:

~~— IEC Electropedia: available at https://www.electropedia.org/~~

— ~~—~~ISO Online browsing platform: available at ~~https://www.iso.org/obp~~https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

4 Characteristics and uses

4.1 General

Extinguishant FK-5-1-12 shall conform to the specifications shown in ~~Table 1.~~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 shown in ~~Table 2.~~Table 2.

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

Table 1 — Specifications for FK-5-1-12

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

Property	Requirement
Purity	99,0 % 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
Kinetic dimers of HFP[a]	<2 850 mg/kg
Thermodynamic dimer of HFP + HF adduct[b]	<95 mg/kg

[a] Kinetic dimers of HFP (CAS Registry Number® 2070-70-4). (Chemical Abstracts Service (CAS) Registry Number® is a trademark of the American Chemical Society (ACS). This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of the product named. Equivalent products may be used if they can be shown to lead to the same results).

[b] Thermodynamic dimer of HFP (CAS 1584-03-8) and its adduct (CAS 30320-28-6).

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

Property	Units	Value
Molecular mass	n/a	316,04
Boiling point at 1 013 bar (absolute)	°C	49,2
Freezing point	°C	–108,0
Critical temperature	°C	168,66
Critical pressure	bar	18,646
Critical volume	cc/mole	494,5
Critical density	kg/m^3	639,1
Vapour pressure 20 °C	bar abs	0,326 0
Liquid density 20 °C	g/ml	1,616
Saturated vapour density 20 °C	kg/m^3	4,330 5
Specific volume of superheated vapour at 1 013 bar and 20 °C	m^3/kg	0,071 9
Heat of vapourization at boiling point	KJ/kg	88,0
Chemical formula	$CF_3CF_2C(O)CF(CF_3)_2$	
Chemical name	Dodecafluoro-2-methylpentan-3-one	
NOTE 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 14520-1:2015, Clause 4.

The extinguishant requirements per volume of protected space are shown in ~~Table 3~~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 heptane and Surface Class A hazards are shown in Table 4.Table 4. Concentrations for other fuels are shown in Table 5Table 5 and inerting concentrations in Table 6.Table 6.

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

Temperature	Specific volume	FK-5-1-12 mass requirements per unit volume of protected space, m/V (kg/m³)							
		Design concentration (by volume)							
T	S								
°C	m³/kg	3 %	4 %	5 %	6 %	7 %	8 %	9 %	10 %
–20	0,060 9	0,507 7	0,684 0	0,864 0	1,040 7	1,235 7	1,427 5	1,623 6	1,824 1
–15	0,062 3	0,496 5	0,669 0	0,845 0	1,024 8	1,208 4	1,396 1	1,587 9	1,783 9
–10	0,063 7	0,485 9	0,654 5	0,826 8	1,002 7	1,182 4	1,366 0	1,553 7	1,745 5
–5	0,065 0	0,475 6	0,640 7	0,809 4	0,981 6	1,157 5	1,337 2	1,520 9	1,708 7
0	0,066 4	0,465 8	0,627 5	0,792 6	0,961 3	1,133 6	1,309 6	1,489 5	1,673 4
5	0,067 8	0,456 4	0,614 8	0,776 6	0,941 8	1,110 6	1,283 1	1,459 3	1,639 5
10	0,069 1	0,447 3	0,602 6	0,761 2	0,923 2	1,088 6	1,257 6	1,430 4	1,607 0
15	0,070 5	0,438 6	0,590 9	0,746 4	0,905 2	1,067 4	1,233 2	1,402 6	1,575 7
20	0,071 9	0,430 2	0,579 6	0,732 2	0,887 9	1,047 1	1,209 6	1,375 8	1,545 7
25	0,073 3	0,422 2	0,568 8	0,718 4	0,871 3	1,027 5	1,187 0	1,350 0	1,516 7
30	0,074 6	0,414 4	0,558 3	0,705 2	0,855 3	1,008 6	1,165 2	1,325 2	1,488 8
35	0,076 0	0,406 9	0,548 2	0,692 5	0,839 9	0,990 4	1,144 2	1,301 3	1,462 0
40	0,077 4	0,399 7	0,538 5	0,680 2	0,825 0	0,972 8	1,123 9	1,278 3	1,436 1
45	0,078 7	0,392 8	0,529 1	0,668 4	0,810 6	0,955 9	1,104 3	1,256 0	1,411 1
50	0,080 1	0,386 0	0,520 1	0,657 0	0,796 7	0,939 5	1,085 4	1,234 5	1,386 9
55	0,081 5	0,379 5	0,511 3	0,645 9	0,783 3	0,923 7	1,067 1	1,213 7	1,363 6
60	0,082 9	0,373 3	0,502 9	0,635 2	0,770 4	0,908 4	1,049 5	1,193 6	1,341 0
65	0,084 2	0,367 2	0,494 7	0,624 7	0,757 8	0,893 6	1,032 4	1,174 2	1,319 1
70	0,085 6	0,361 3	0,486 8	0,614 8	0,745 7	0,879 3	1,015 8	1,155 4	1,298 0
75	0,0870087 0	0,355 6	0,479 1	0,605 2	0,733 9	0,865 4	0,999 8	1,137 2	1,277 5
80	0,088 3	0,350 1	0,471 6	0,595 8	0,722 5	0,852 0	0,984 3	1,119 5	1,257 7
85	0,089 7	0,344 7	0,464 4	0,586 6	0,711 5	0,839 0	0,969 2	1,102 4	1,238 5
90	0,091 1	0,339 5	0,457 4	0,577 8	0,700 8	0,826 3	0,954 7	1,085 8	1,219 8
95	0,092 5	0,334 5	0,450 7	0,569 2	0,690 4	0,814 1	0,940 5	1,069 7	1,201 4
100	0,093 8	0,329 6	0,444 1	0,560 9	0,680 3	0,802 2	0,926 7	1,054 0	1,184 2

NOTE – This information refers only to FK-5-1-12 and does not represent any other product containing dodecafluoromethylpentan-3-one as a component.

Symbols:

Key

m/V is the agent mass requirements (kg/m³), i.e. mass, m, in kilogramskg of agent required per cubic metrem³ of protected volume, V, to produce the indicated concentration at the temperature specified;

Temperature	Specific volume	FK-5-1-12 mass requirements per unit volume of protected space, m/V (kg/m³)							
T	S	Design concentration (by volume)							
°C	m³/kg	3 %	4 %	5 %	6 %	7 %	8 %	9 %	10 %

V is the net volume of hazard (m³), i.e. the enclosed volume minus the fixed structures impervious to extinguishant.

m is calculated using the following formula:

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

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

where

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

S is the specific volume (m³/kg).

The specific volume, S, of superheated FK-5-1-12 vapour at a pressure of 1,013 bar can be approximated by the following formula:

$S = k_1 + k_2 T$

where

k_1 = 0,066 4;

k_2 = 0,000 274;

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

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	See NOTE 4	5,6

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.

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	4,5	5,9
n-heptane	4,5	5,9
Technical heptane	4,5	5,9
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 — FK-5-1-12 inerting and design concentrations

Fuel	Inertion %	Minimum design %
Methane	8,8	9,7
Propane	8,1	8,9
NOTE 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) ~~a)~~ the extinguishant itself;

b) ~~b)~~ the combustion products of the fire;

c) ~~c)~~ the breakdown products of the extinguishant resulting from exposure to fire.

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

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

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

Property	Value %
4 h LC_{50}	>10 %
No observed adverse effect level (NOAEL)	10 %
Lowest observed adverse effect level (LOAEL)	>10 %
NOTE LC_{50} is the concentration lethal to 50 % of the 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 shown in ~~Tables 8 to 11~~Tables 8 to 11 for 25 bar, 34,5 bar, 42 bar or 50 bar systems.

Exceeding the maximum fill density can 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~~Figure 1 for various levels of fill density.

Table 8 — 25 bar storage container characteristics for FK-5-1-12

Property	Unit	Value
Maximum fill density	kg/m³	1 480
Maximum container working pressure at 50 °C	bar	29
Superpressurization at 20 °C	bar	25
NOTE 1 ~~Figure 1~~Figure 1 shows further data on pressure/temperature relationships. NOTE 2 1 bar = 0,1 MPa = 10^5 Pa; 1 MPa = 1 N/mm².		

Table 9 — 34,5 bar storage container characteristics for FK-5-1-12

Property	Unit	Value
Maximum fill density	kg/m³	1 200
Maximum container pressure at 50 °C	bar	38
Superpressurization at 20 °C	bar	34,5
NOTE 1 ~~Figure 2~~Figure 2 shows further data on pressure/temperature relationships. NOTE 2 1 bar = 0,1 MPa = 10^5 Pa; 1 MPa = 1 N/mm².		

Table 10 — 42 bar storage container characteristics for FK-5-1-12

Property	Unit	Value
Maximum fill density	kg/m³	1 440
Maximum container pressure at 50 °C	bar	48
Superpressurization at 20 °C	bar	42
NOTE 1 ~~Figure 3~~Figure 3 shows further data on pressure/temperature relationships. NOTE 2 1 bar = 0,1 MPa = 10^5 Pa; 1 MPa = 1 N/mm².		

Table 11 — 50 bar storage container characteristics for FK-5-1-12