INTERNATIONAL STANDARD

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Second edition
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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

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 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 firefighting systems using gas*.

This second edition cancels and replaces the first edition (ISO 14520-5:2006), which has been technically revised with the following changes:

— corrected the purity specification in Table 1;

— added reference to 34,5 bar and 50 bar systems in 6.1 and 6.2;

— added tables for 34,5 bar and 50 bar systems storage container characteristics data;

— added figures for pressure vs. temperature charts for 34,5 bar and 50 bar systems;

— 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 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, specification, usage and safety aspects.

This document covers only systems operating at nominal pressures of 25 bar, 34,5 bar, 42 bar and 50 bar 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 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 FK-5-1-12 shall comply with the specification shown in 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.

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	99,0 % 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

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	0,3260
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 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	

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 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. Concentrations for other fuels are shown in Table 5 and inerting concentrations in 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/m^3)							
		Design concentration (by volume)							
T	S								
°C	m^3/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

Table 3 *(continued)*

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 %
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

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:

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 FK-5-1-12 vapour at a pressure of 1,013 bar may be approximated by the formula

$$S = k_1 + k_2 T$$

where

$k_1 = 0{,}066\ 4$

$k_2 = 0{,}000\ 274$

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.

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.

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

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) the extinguishant itself;

b) the combustion products of the fire;

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 — 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 Table 8 to 11 for 25 bar, 34,5 bar, 42 bar or 50 bar systems.

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

Property	Unit	Value
Maximum fill density	kg/m^3	1 480
Maximum container working pressure at 50 °C	bar (gauge)	29
Superpressurization at 20 °C	bar (gauge)	25
NOTE Reference should be made to Figure 1 for further data on pressure/temperature relationships.		

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

Property	Unit	Value
Maximum fill density	kg/m^3	1 200
Maximum container pressure at 50 °C	bar (absolute)	48
Superpressurization at 20 °C	bar (absolute)	34,5
NOTE Reference should be made to Figure 2 for further data on pressure/temperature relationships.		

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

Property	Unit	Value
Maximum fill density	kg/m^3	1 440
Maximum container pressure at 50 °C	bar (absolute)	38
Superpressurization at 20 °C	bar (absolute)	42
NOTE Reference should be made to Figure 3 for further data on pressure/temperature relationships.		

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

Property	Unit	Value
Maximum fill density	kg/m^3	1 200
Maximum container pressure at 50 °C	bar (absolute)	57
Superpressurization at 21 °C	bar (absolute)	50
NOTE Reference should be made to Figure 4 for further data on pressure/temperature relationships.		

6.2 Superpressurization

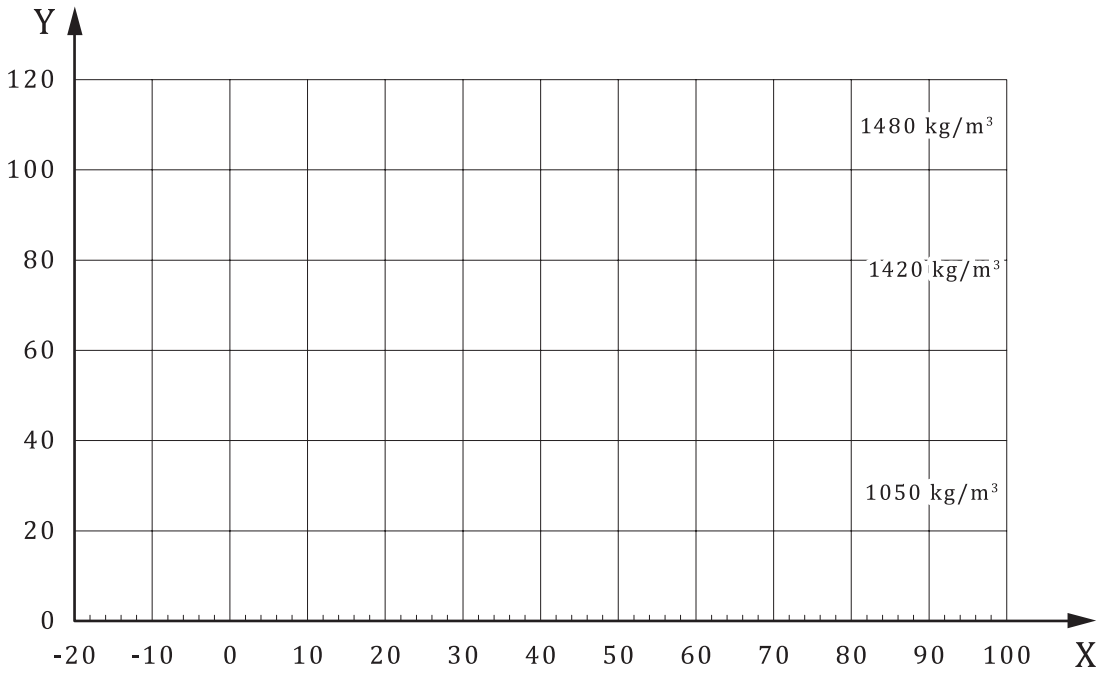
Containers shall be superpressurized with nitrogen with a moisture content of not more than 60×10^{-6} by mass to an equilibrium pressure of 25 bar $^{+5}_{0}$ %, 34,5 bar $^{+5}_{0}$ %, 42 bar $^{+5}_{0}$ % or 50 bar $^{+5}_{0}$ % at a temperature of 20 °C.

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 in ISO 14520-1:2015, 7.6.

The design concentrations shall be that specified for relevant hazards shown in Table 4. This includes at least 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.

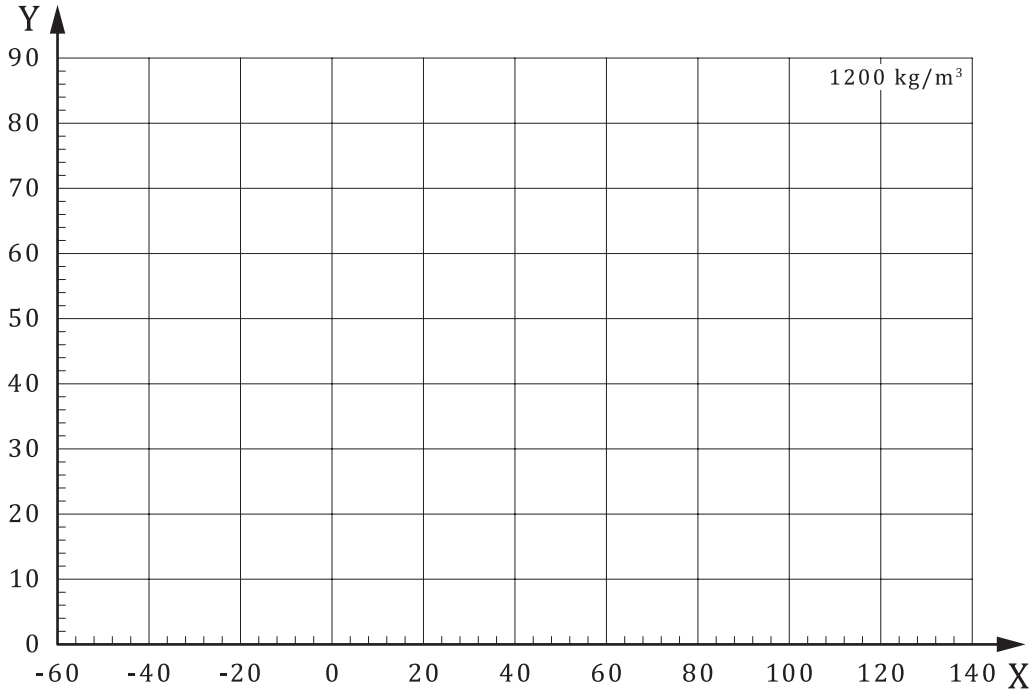


Key

X temperature, °C

Y pressure, bar

Figure 1 — Temperature/pressure graph for FK- 5-1-12 superpressurized with nitrogen 25 bar at 20 °C

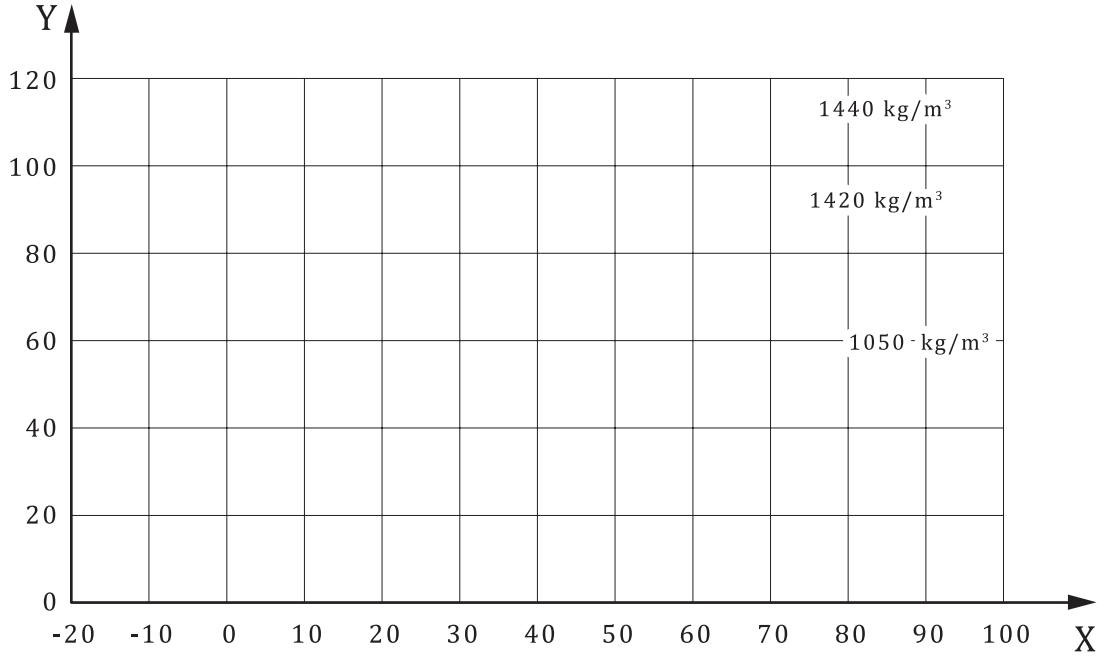


Key

X temperature, °C

Y pressure, bar

Figure 2 — Temperature/pressure graph for FK- 5-1-12 superpressurized with nitrogen to 34,5 bar at 20 °C

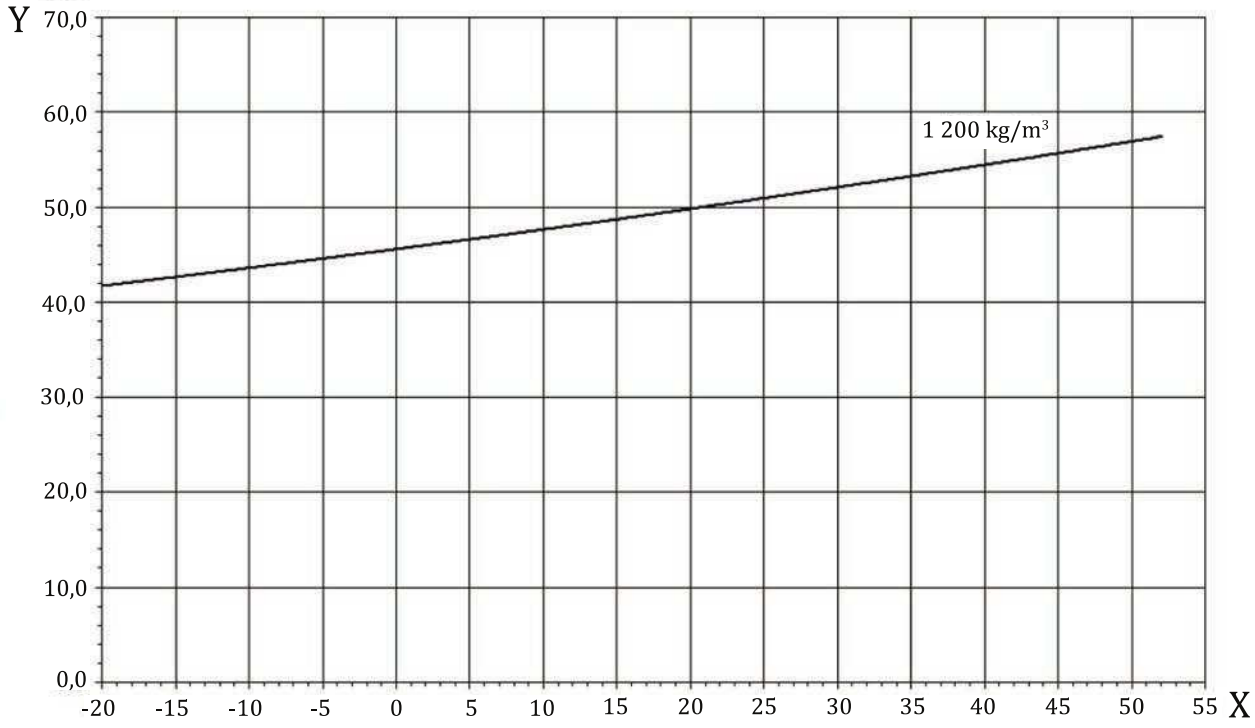


Key

X temperature, °C

Y pressure, bar

Figure 3 — Temperature/pressure graph for FK-5-1-12 superpressurized with nitrogen to 42 bar at 20 °C



Key

X temperature, °C

Y pressure, bar

Figure 4 — Temperature/pressure graph for FK-5-1-12 superpressurized with nitrogen to 50 bar at 21 °C

7 Environmental properties

For information purposes, environmental properties of FK-5-1-12 extinguishant are provided:

GWP (100 years)	1
ODP	0[1)]

NOTE 1 See ISO 14520-1:2015, 4.2.1 for a discussion of GWP values and their relation to the impact of a gas on climate change/global warming.

NOTE 2 Environmental properties were derived from the following:

— 2005 IPCC/TEAP Special Report Safeguarding the Ozone Layer and the Global Climate System: Issues Related to Hydrofluorocarbons and Perfluorocarbons;

— 2007 Fourth Assessment Report of the Intergovernmental Panel on Climate Change;

— U.S. EPA.

1) Extinguishant FK-5-1-12 has zero ODP because it contains no chlorine, bromine, or iodine, the primary kinetically active species for ozone depletion.

ICS 13.220.10

Price based on 9 pages