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

Part 15: IG-541 extinguishant

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

Partie 15: Agent extincteur IG-541

Reference number
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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 3.

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 part of ISO 14520 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 14520-15 was prepared by Technical Committee ISO/TC 21, *Equipment for fire protection and fire fighting*, Subcommittee SC 8, *Gaseous media fire extinguishing systems*.

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 3: FC-2-1-8 extinguishant*

— *Part 4: FC-3-1-10 extinguishant*

— *Part 6: HCFC Blend A extinguishant*

— *Part 7: HCFC 124 extinguishant*

— *Part 8: HCFC 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 properties and system design —

Part 15:
IG-541 extinguishant

1 Scope

1.1 This part of ISO 14520 contains specific requirements for gaseous fire-extinguishing systems, with respect to the IG-541 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 150 bar at 15 °C and 200 bar at 15 °C. This does not preclude the use of other systems, although design data for other pressures are not available at this time.

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 14520-1:2000, *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

IG-541 is a colourless, odourless, electrically non-conductive gas with a density approximately the same as that of air.

It is an inert gas mixture consisting nominally of 52 % nitrogen, 40 % argon and 8 % carbon dioxide. The mixture specification for IG-541 (based on 8 % carbon dioxide with tolerance of ± 5 %) is as follows:

a) carbon dioxide percentage range 7,6 % to 8,4 %;

b) argon percentage range 37,2 % to 42,8 %;

c) nitrogen percentage range 48,8 % to 55,2 %.

Individual container or batch analysis is based on carbon dioxide measurement only.

Extinguishant IG-541 shall comply with the specification shown in Table 1.

The physical properties are shown in Table 2.

IG-541 extinguishes fires mainly by a reduction of oxygen.

Table 1 — Component gas specification for IG-541

	Argon	Nitrogen	Carbon dioxide
Purity	99,997 % by volume, min.	99,99 % by volume, min.	99,5 % by volume, min.
Moisture	4×10^{-6} by mass, max.	5×10^{-6} by mass, max.	10×10^{-6} by mass, max.
Oxygen	3×10^{-6} by mass, max.	3×10^{-6} by mass, max.	10×10^{-6} by mass, max.
NOTE Only principal contaminants are shown. Other measurements may include hydrocarbons, CO, NO, NO_2. Most are < 20×10^{-6}.			

Table 2 — Physical properties of IG-541

Property	Units	Value
Molecular mass	—	34,0
Boiling point at 1,013 bar (absolute)	°C	–196
Freezing point	°C	–78,5
Critical temperature	°C	—
Critical pressure	bar abs	—
Critical volume	cm^3/mol	—
Critical density	kg/m^3	—
Vapour pressure 20 °C	bar abs	152
Liquid density 20 °C	kg/m^3	—
Saturated vapour density 20 °C	kg/m^3	—
Specific volume of superheated vapour at 1,013 bar and 20 °C	m^3/kg	0,697
Components	N_2 52 % by volume Ar 40 % by volume CO_2 8 % by volume	
Chemical name	Nitrogen/argon/carbon dioxide	

4.2 Use of IG-541 systems

IG-541 total flooding systems may be used for extinguishing fires of all classes within the limits specified in clause 4 of ISO 14520-1:2000.

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 14520-1:2000.

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 in Table 6.

Table 3 — IG-541 total flooding quantity

Temperature	Specific vapour volume	IG-541 volume requirements per unit volume of protected space, V/V (m^3/m^3)							
		Design concentration (by volume)							
T	S								
°C	m^3/kg	34 %	38 %	42 %	46 %	50 %	54 %	58 %	62 %
–40	0,5624	0,521	0,600	0,684	0,773	0,870	0,975	1,089	1,214
–35	0,5743	0,511	0,587	0,669	0,757	0,852	0,954	1,066	1,189
–30	0,5863	0,500	0,575	0,656	0,742	0,834	0,935	1,044	1,165
–25	0,5982	0,490	0,564	0,643	0,727	0,818	0,916	1,023	1,142
–20	0,6102	0,481	0,553	0,630	0,713	0,802	0,898	1,003	1,119
–15	0,6221	0,471	0,542	0,618	0,699	0,786	0,881	0,984	1,098
–10	0,6341	0,463	0,532	0,606	0,686	0,772	0,864	0,966	1,077
–5	0,6460	0,454	0,522	0,595	0,673	0,757	0,848	0,948	1,057
0	0,6580	0,446	0,513	0,584	0,661	0,744	0,833	0,931	1,038
5	0,6699	0,438	0,504	0,574	0,649	0,730	0,818	0,914	1,019
10	0,6819	0,430	0,495	0,564	0,638	0,717	0,804	0,898	1,001
15	0,6938	0,423	0,486	0,554	0,627	0,705	0,790	0,882	0,984
20	0,7058	0,416	0,478	0,545	0,616	0,693	0,777	0,868	0,968
25	0,7177	0,409	0,470	0,536	0,606	0,682	0,764	0,853	0,951
30	0,7297	0,402	0,462	0,527	0,596	0,670	0,751	0,839	0,936
35	0,7416	0,395	0,455	0,518	0,586	0,660	0,739	0,826	0,921
40	0,7536	0,389	0,448	0,510	0,577	0,649	0,727	0,812	0,906
45	0,7655	0,383	0,441	0,502	0,568	0,639	0,716	0,800	0,892
50	0,7775	0,377	0,434	0,494	0,559	0,629	0,705	0,787	0,878
55	0,7894	0,371	0,427	0,487	0,551	0,620	0,694	0,776	0,865
60	0,8014	0,366	0,421	0,480	0,543	0,610	0,684	0,764	0,852
65	0,8133	0,361	0,415	0,473	0,535	0,601	0,674	0,753	0,840
70	0,8253	0,355	0,409	0,466	0,527	0,593	0,664	0,742	0,827
75	0,8372	0,350	0,403	0,459	0,519	0,584	0,655	0,731	0,816
80	0,8492	0,345	0,397	0,453	0,512	0,576	0,645	0,721	0,804
85	0,8611	0,341	0,392	0,446	0,505	0,568	0,636	0,711	0,793
90	0,8731	0,336	0,386	0,440	0,498	0,560	0,628	0,701	0,782
95	0,8850	0,331	0,381	0,434	0,491	0,553	0,619	0,692	0,772
100	0,8970	0,327	0,376	0,429	0,485	0,545	0,611	0,683	0,761

NOTE This information was supplied by the manufacturer, Tyco International Ltd. It refers only to the product Inergen, and may not represent any other products containing argon, nitrogen and carbon dioxide.

Symbols:

V/V is the agent volume requirements (m^3/m^3); i.e. the quantity Q (m^3) of agent required at a temperature of 20 °C and a pressure of 1,013 bar per cubic metre of protected volume to produce the indicated concentration at the temperature specified:

$$Q = V \frac{S_R}{S} \ln\left(\frac{100}{100 - c}\right)$$

V is the nett volume of hazard (m^3); i.e. the enclosed volume minus the fixed structures impervious to extinguishant;

S_R is the specific reference volume (m^3/kg); i.e. the specific vapour volume at the filling reference temperature;

T is the temperature (°C); i.e. the design temperature of the protected area;

S is the specific volume (m^3/kg); the specific volume of superheated IG-541 vapour at a pressure of 1,013 bar may be approximated by the formula:

$$S = k_1 + k_2 T$$

where

k_1 = 0,657 99

k_2 = 0,002 39

c is the concentration (%); i.e. the volumetric concentration of IG-541 in air at the temperature indicated, and a pressure of 1,013 bar absolute.

Table 4 — IG-541 reference extinguishing and design concentrations

Fuel	Extinguishment %	Minimum design %
Heptane [a]	33,8	43,9
Surface class A hazards [b, c]	28,1	36,5

[a] Heptane extinguishing concentration was derived using the ICI style cup burner.

[b] Values were derived in accordance with the VdS test protocol.

[c] See 7.5.1.3 of ISO 14520-1:2000.

Table 5 — IG 541 extinguishing and design concentrations for other fuels

Fuel	Extinguishment %	Minimum design %
Acetone	30,3	35,3
Acetonitrile	26,7	34,7
Avgas 100	29,5	35,4
Avtur (Jet A)	36,2	47,1
1-Butanol	37,2	48,4
Cyclopentanone	42,1	54,7
Diesel No. 2	35,8	46,5
Diethlyl ether	34,9	45,4
Ethane	29,5	38,4
Ethanol	35,0	45,5
Ethly acetate	32,7	42,5
Ethylene	42,1	54,7
Hexane	31,1	37,5
Isopropanol	28,3	33,9
Methane	15,4	20,0
Methanol	44,2	57,5
Methyl ethyl ketone	35,8	46,5
Methyl isobutyl ketone	32,3	42,0
Octane	35,8	46,5
Pentane	37,2	48,4
Petroleum ether	35,0	45,5
Propane	32,3	42,0
Regular gasoline	35,8	46,5
Toluene	25,0	30,0
Vinyl acetate	34,4	44,7
Vacuum pump oil	32,0	41,6

NOTE Extinguishing concentrations for all class B fuels listed were derived in accordance with ISO 14520-1:2000, annex B.

Minimum design values have been increased to the minimum design concentration established for heptane in accordance with ISO 14520-1:2000, 7.5.1.

Table 6 — IG-541 inerting and design concentrations

Fuel	Inerting %	Minimum design %
Methane	43,0	47,3
Propane	49,0	53,9
NOTE Inerting and minimum design concentrations were derived in accordance with the requirements of ISO 14520-1:2000, annex D.		

5 Safety of personnel

Any hazard to personnel created by the discharge of IG-541 shall be considered in the design of the system.

Potential hazards can arise from the following:

a) the extinguishant itself, by reduction in oxygen; and

b) the combustion products of the fire.

For minimum safety requirements, see ISO 14520-1:2000, clause 5.

Physiological information for IG-541 is shown in Table 7.

Table 7 — Physiological information for IG-541

Property	Value %
No observed adverse effect level (NOAEL)	43
Lowest observed adverse effect level (LOAEL)	52
NOTE These values are based on the physiological effects on human subjects of hypoxic atmospheres. These values are the functional equivalents of NOAEL and LOAEL values, and correspond to 12 % minimum oxygen for the no-effect level and 10 % minimum oxygen for the low-effect level.	

6 System design

6.1 Fill pressure

The fill pressure of the container shall not exceed the values given in Tables 8 and 9 for systems operating at 150 bar and 200 bar respectively.

Other pressures may be used and the minimum design pressure specified accordingly.

The relationships between pressure and temperature are shown in Figures 1 and 2.