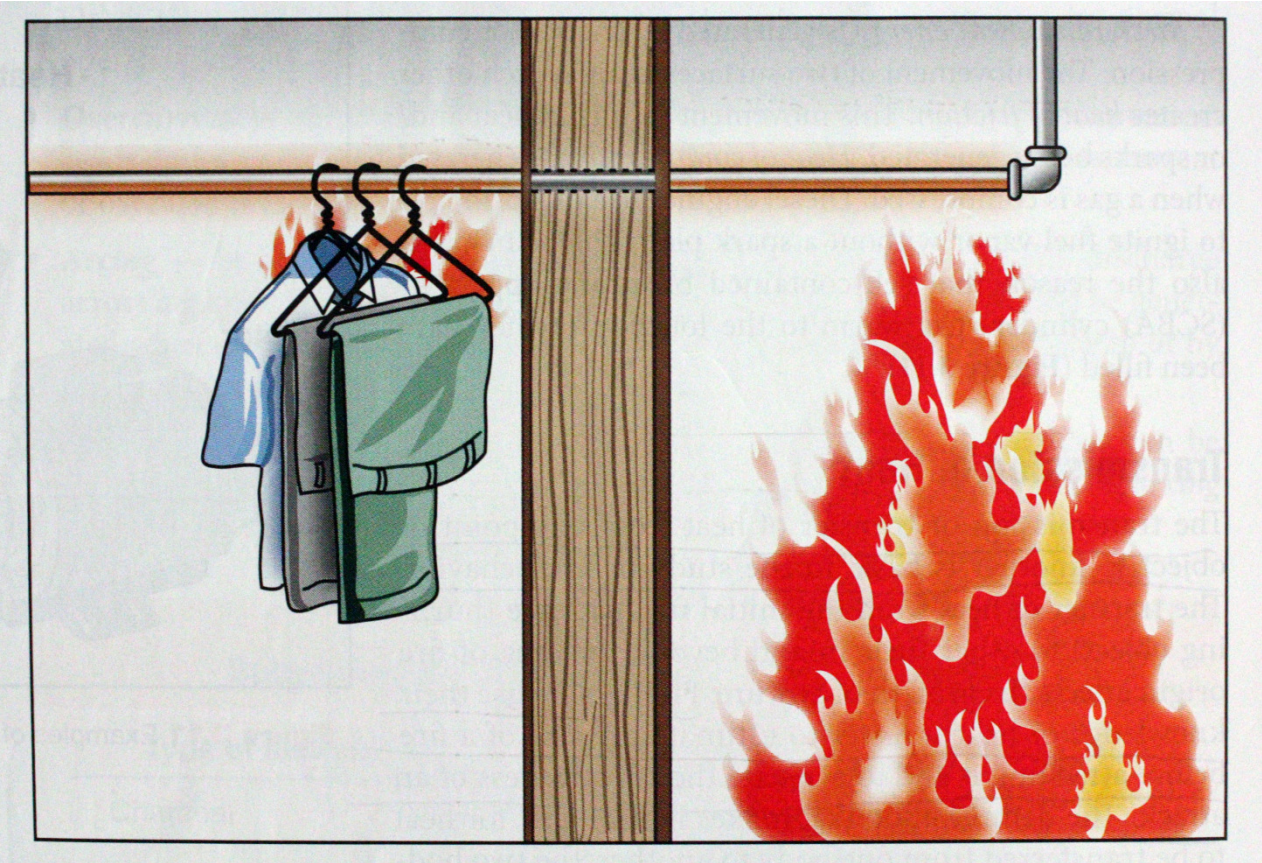
Teoria do Fogo (2ª parte)

Transmissão de Calor

- Condução
- Convecção
- Radiação

Condução

"É a transferência de calor dentro de um mesmo corpo sólido, ou entre dois corpos sólidos em contato direto".



Condução

É função de fatores como a área que está sendo aquecida, diferença de temperatura entre os corpos e a **condutividade do material**.

Material	Condutividade térmica [J/s/(m·K)] ou [W/(m.K)]
Prata	426
Cobre	398
Alumínio	237
Tungstênio	178
Ferro	80,3
Vidro	0,72 - 0,86
Água	0,61
Tijolo	0,4 - 0,8
Madeira (pinho)	0,11 - 0,14
Fibra de vidro	0,046
Espuma de poliestireno	0,033
Ar	0,026
Espuma de poliuretano	0,020
Polipropileno	0,25
Epoxi	0,30

"condutor"

"isolante térmico"

Condução

Elevada condutividade ajuda ou atrapalha?

Ajuda	Deve ser usada na presença de reações exotérmicas
	Eficiência da troca de calor
Atrapalha	Isolamento térmico, proteção contra o calor
	Aumenta propagação do fogo **por condução**

Condução

É função de fatores como a área que está sendo aquecida, diferença de temperatura entre os corpos e a **condutividade do material**.

Material	Condutividade térmica [J/s/(m·K)] ou [W/(m.K)]
Prata	426
Cobre	398
Alumínio	237
Tungstênio	178
Ferro	80,3
Vidro	0,72 - 0,86
Água	0,61
Tijolo	0,4 - 0,8
Madeira (pinho)	0,11 - 0,14
Fibra de vidro	0,046
Espuma de poliestireno	0,033
Ar	0,026
Espuma de poliuretano	0,020
Polipropileno	0,25
Epoxi	0,30

Isolante térmico

X

Resistência ao fogo

Exemplo:
Espuma de isolamento térmico.

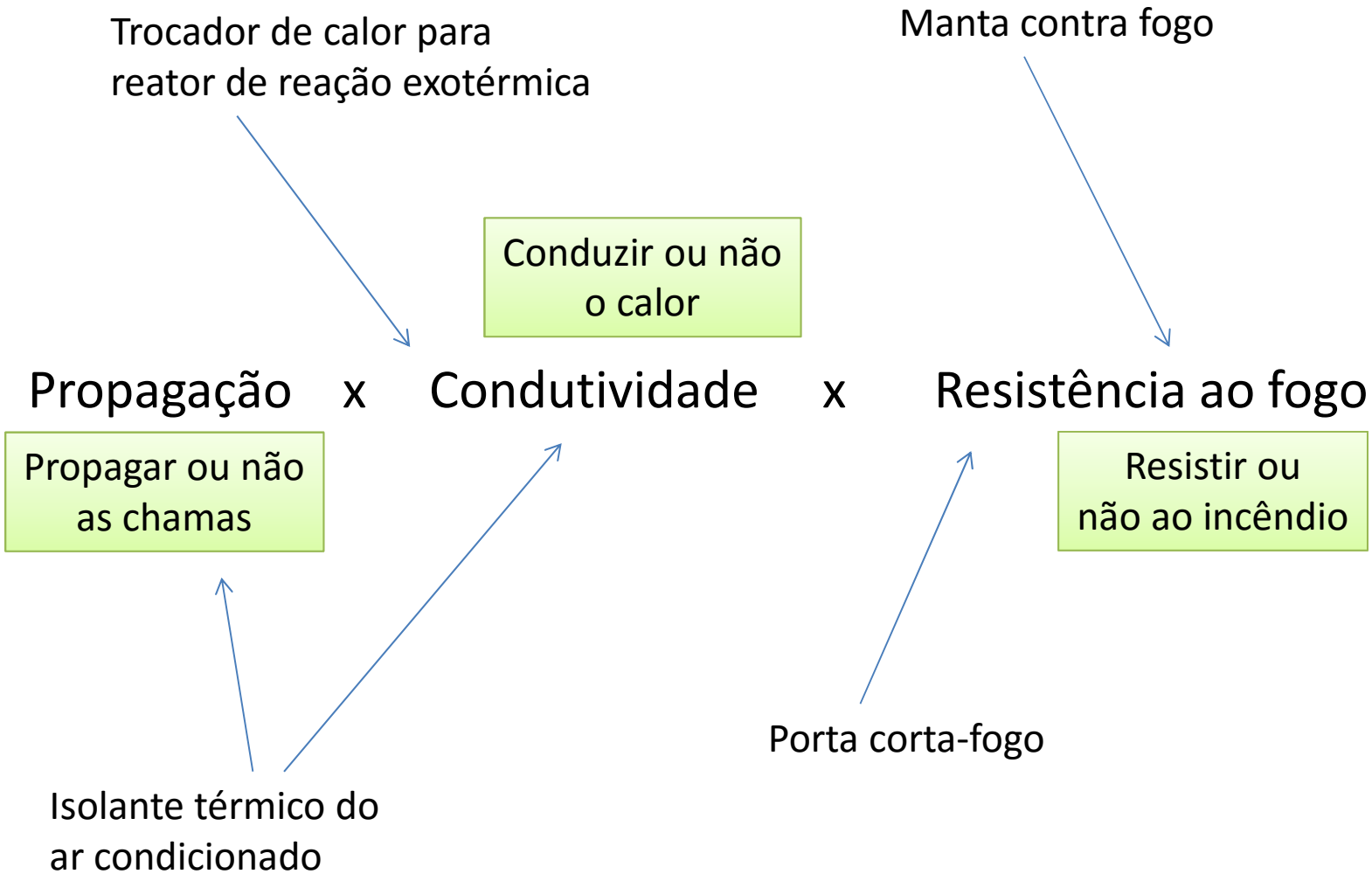
Conduzir ou não o calor

Propagação x Condutividade x Resistência ao fogo

Propagar ou não as chamas

Resistir ou não ao incêndio

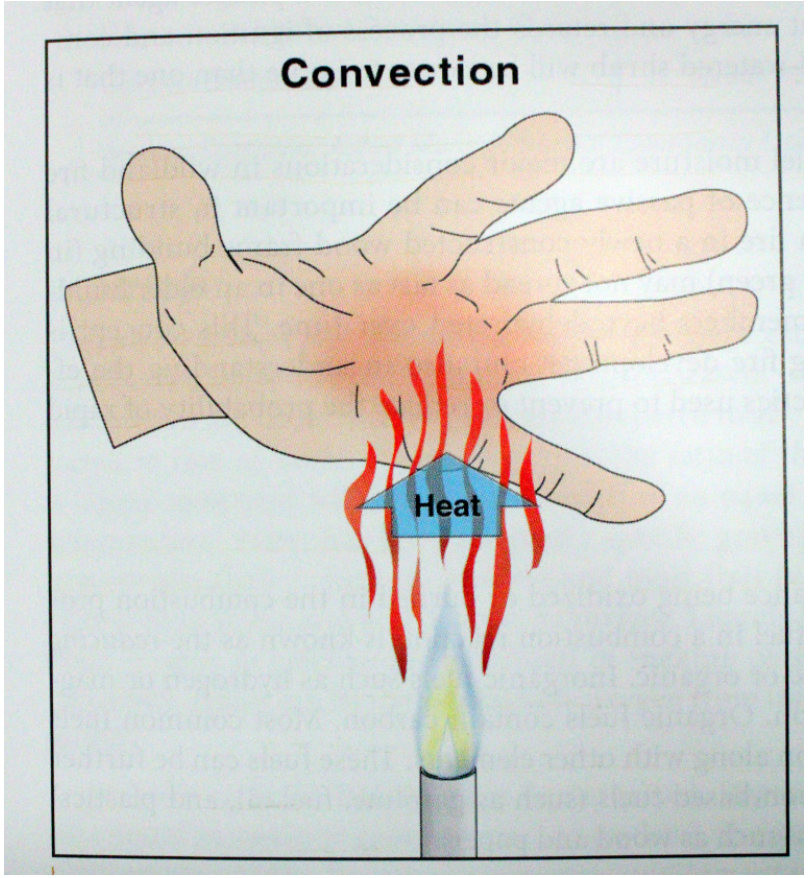
Alguns revestimentos são projetados para não propagarem as chamas, embora não resistam ao fogo.



Alguns revestimentos são projetados para não propagarem as chamas, embora não resistam ao fogo (Auto Extinguível). Exemplo tapetes e tecidos especiais.

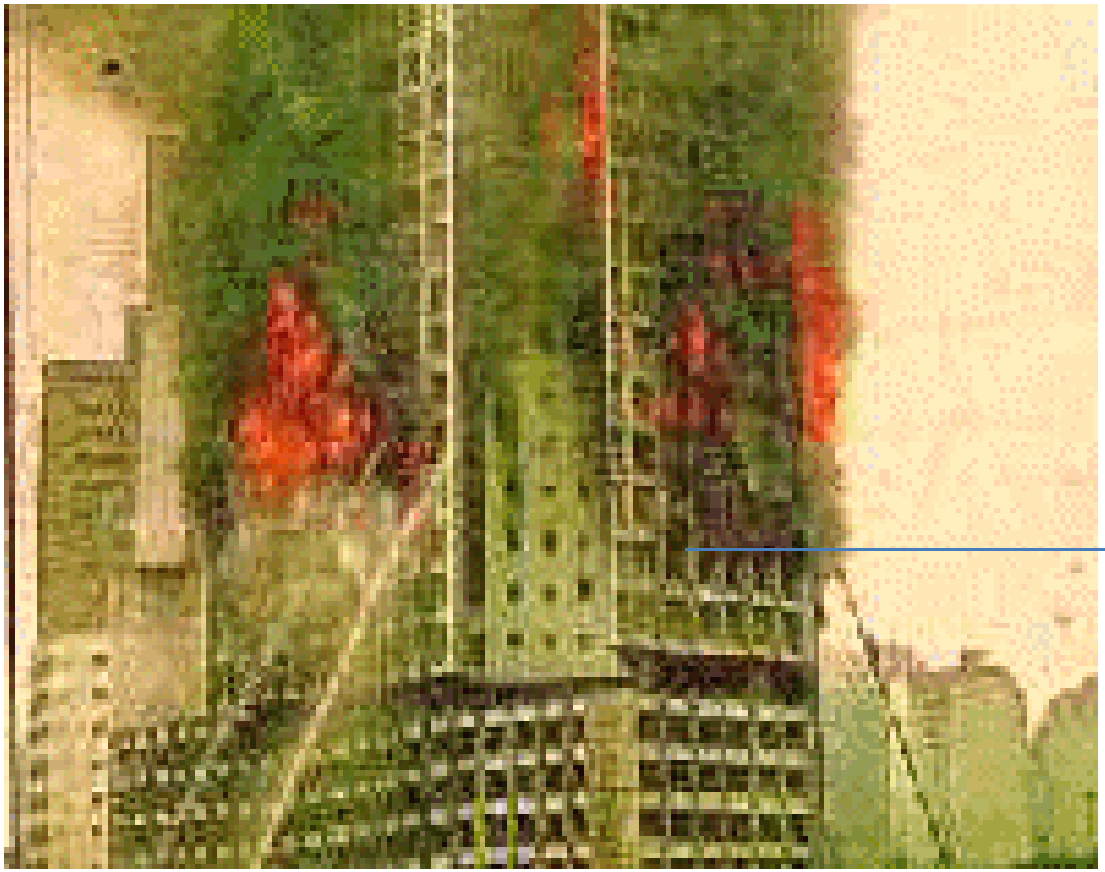
Convecção

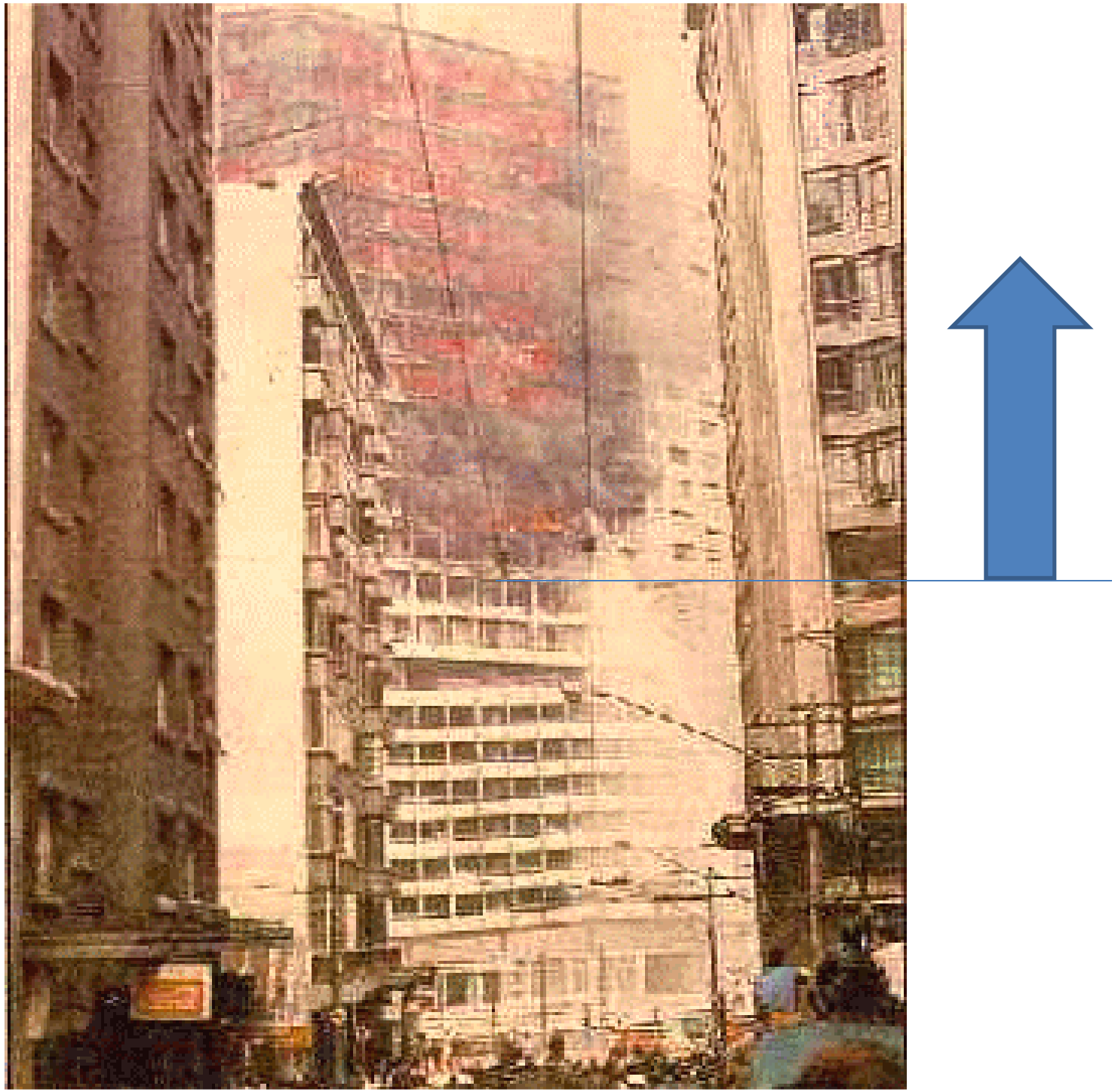
Correntes ascendentes (no caso ar).



Cria correntes ascendentes que levam a fumaça e gases da queima.
Aquece as áreas acima do fogo.

Os gases quentes sobem (convecção). Esse efeito é fundamental para entender que os incêndios tendem a subir.





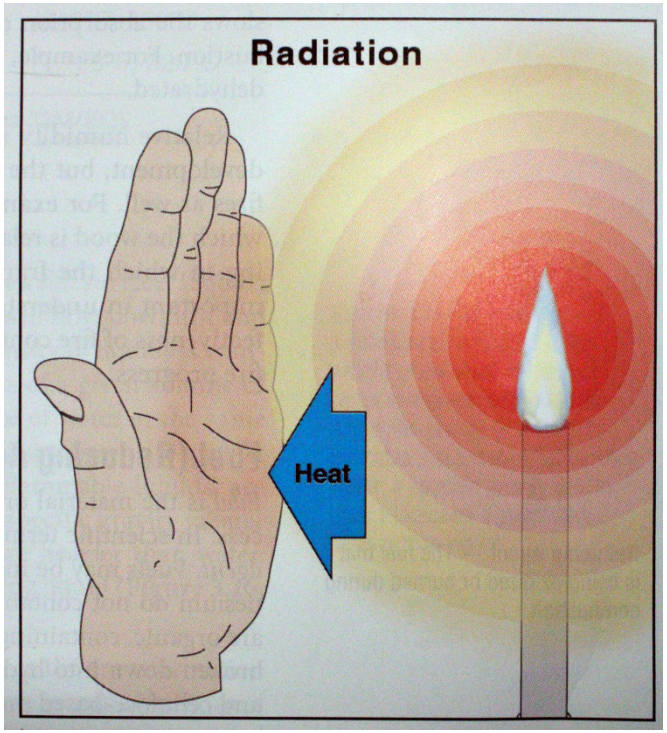
Embora, a queda de objetos em chamas e o vento possam alastrar o incêndio para baixo.

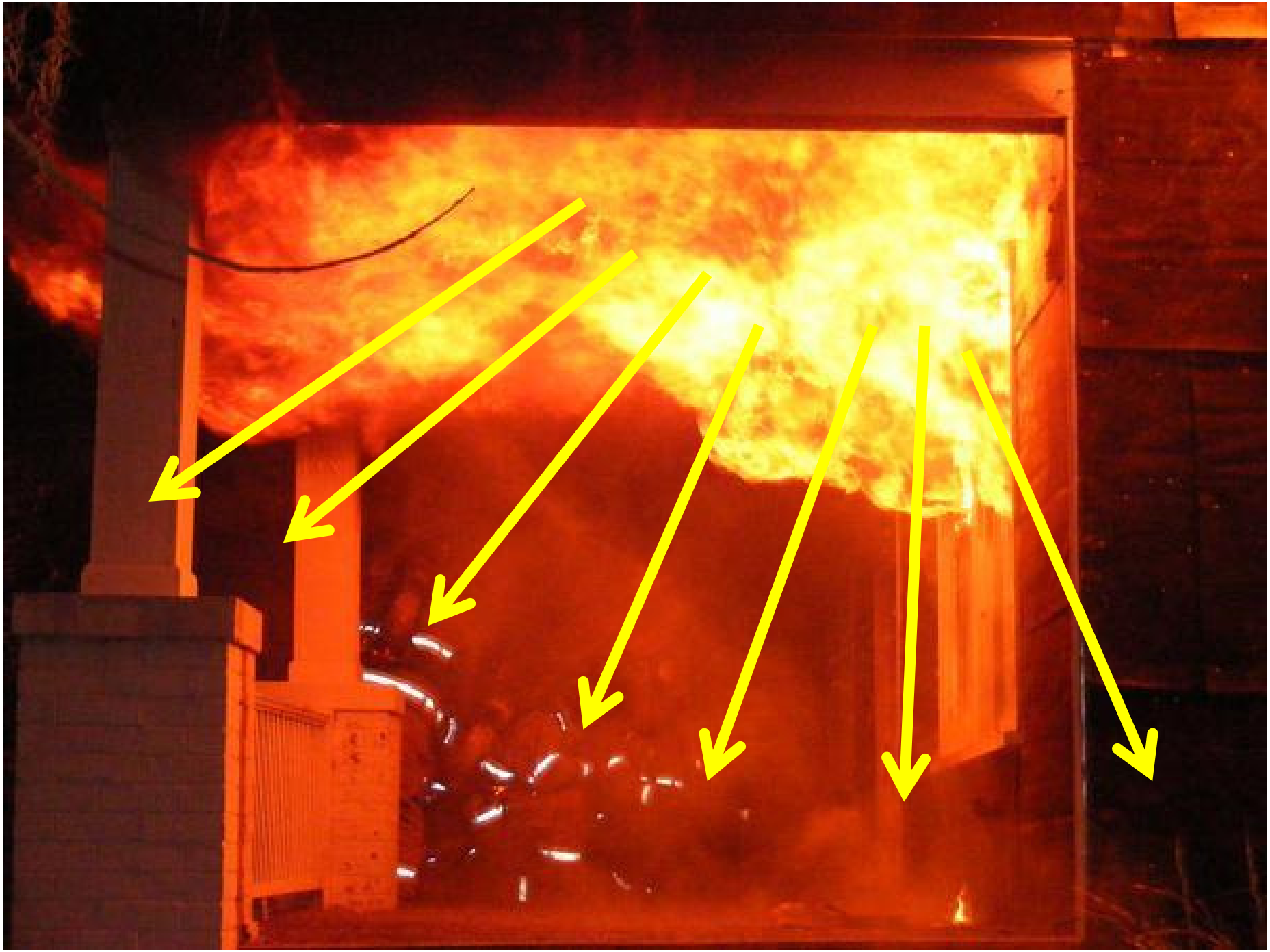
http://oglobo.globo.com/mundo/incendio-atinge-predio-residencial-de-79-andares-em-dubai-15399440

Radiação

É a transmissão de calor na forma de onda, no caso através do ar.

Torna-se uma forma de transferência de calor muito relevante para grandes incêndios, podendo promover a ignição de objetos afastados das chamas.





Definições Básicas

Flash Point ou Temperatura de Fulgor: é a menor temperatura na qual existe geração de vapor suficiente para criar uma mistura inflamável. Porém nessa temperatura a queima é rápida e não se sustenta.

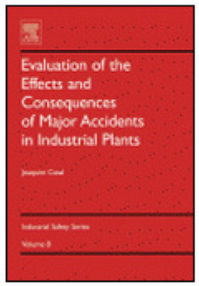
Fire Point ou Temperatura de Combustão: é a menor temperatura na qual o vapor sobre o líquido queima de forma continua uma vez tendo sofrido ignição. A temperatura de Fire Point é alguns graus superior a de Flash.

Definições Básicas

Flash Point ou Temperatura de Fulgor: é a menor temperatura na qual existe geração de vapor suficiente para criar uma mistura inflamável. Porém nessa temperatura a queima é rápida e não se sustenta.

Fire Point ou Temperatura de Combustão: é a menor temperatura na qual o vapor sobre o líquido queima de forma continua uma vez tendo sofrido ignição. A temperatura de Fire Point é alguns graus superior a de Flash.

Most tables of material properties will only list material flash points, but in general the fire points can be assumed to be about 10°C higher than the flash points. However, this is no substitute for testing if the fire point is safety critical.



Industrial Safety Series

About this Book Series

Volume 8, Pages 1-363 (2008)

Evaluation of the Effects and Consequences of Major Accidents in Industrial Plants

Edited by Joaquim Casal

ISBN: 978-0-444-53081-3

< Previous vol/iss | No next vol/iss

Volume 8
pp. 1-363 (2008)
Evaluation of the Effects and Consequences of Major Accidents in Industrial Plants

Volume 7
pp. 1-375 (2005)
Critical Temperatures for the Thermal Explosion of Chemicals

Volume 6
pp. 3-537 (1998)
Risk assessment and management in the context of the seveso II directive

Volume 5
pp. 1-331 (1995)
Safety of Reactive Chemicals and Pyrotechnics

Volume 3
pp. 1-523 (1994)
Fluid Mechanics for Industrial Safety and Environmental Protection

Download PDFs | Export

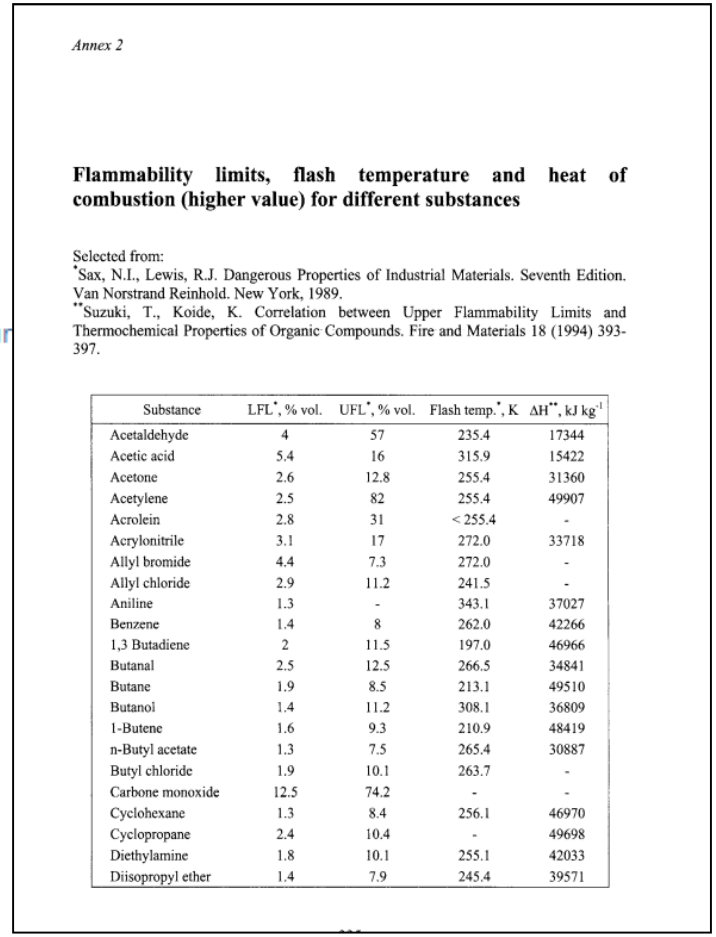
Preface
Pages VII-VIII
Joaquim Casal
PDF (87 K)

Chapter 1 Introduction
Pages 1-17
PDF (991 K)

Chapter 2 Source term
Pages 19-60
First page PDF | PDF (1953 K)

Chapter 3 Fire accidents
Pages 61-117
First page PDF | PDF (2989 K)

Chapter 4 Vapour cloud explosions
Pages 119-145



Annex 2

Flammability limits, flash temperature and heat of combustion (higher value) for different substances

Selected from:
*Sax, N.I., Lewis, R.J. Dangerous Properties of Industrial Materials. Seventh Edition. Van Norstrand Reinhold. New York, 1989.
**Suzuki, T., Koide, K. Correlation between Upper Flammability Limits and Thermochemical Properties of Organic Compounds. Fire and Materials 18 (1994) 393-397.

Substance	LFL*, % vol.	UFL*, % vol.	Flash temp.*, K	ΔH**, kJ kg^{-1}
Acetaldehyde	4	57	235.4	17344
Acetic acid	5.4	16	315.9	15422
Acetone	2.6	12.8	255.4	31360
Acetylene	2.5	82	255.4	49907
Acrolein	2.8	31	< 255.4	-
Acrylonitrile	3.1	17	272.0	33718
Allyl bromide	4.4	7.3	272.0	-
Allyl chloride	2.9	11.2	241.5	-
Aniline	1.3	-	343.1	37027
Benzene	1.4	8	262.0	42266
1,3 Butadiene	2	11.5	197.0	46966
Butanal	2.5	12.5	266.5	34841
Butane	1.9	8.5	213.1	49510
Butanol	1.4	11.2	308.1	36809
1-Butene	1.6	9.3	210.9	48419
n-Butyl acetate	1.3	7.5	265.4	30887
Butyl chloride	1.9	10.1	263.7	-
Carbone monoxide	12.5	74.2	-	-
Cyclohexane	1.3	8.4	256.1	46970
Cyclopropane	2.4	10.4	-	49698
Diethylamine	1.8	10.1	255.1	42033
Diisopropyl ether	1.4	7.9	245.4	39571

Substance	LFL*, % vol.	UFL*, % vol.	Flash temp.*, K	ΔH**, kJ kg^{-1}
Acetaldehyde	4	57	235.4	17344
Acetic acid	5.4	16	315.9	15422
Acetone	2.6	12.8	255.4	31360
Acetylene	2.5	82	255.4	49907
Acrolein	2.8	31	< 255.4	-
Acrylonitrile	3.1	17	272.0	33718
Allyl bromide	4.4	7.3	272.0	-
Allyl chloride	2.9	11.2	241.5	-
Aniline	1.3	-	343.1	37027
Benzene	1.4	8	262.0	42266
1,3 Butadiene	2	11.5	197.0	46966
Butanal	2.5	12.5	266.5	34841
Butane	1.9	8.5	213.1	49510
Butanol	1.4	11.2	308.1	36809
1-Butene	1.6	9.3	210.9	48419
n-Butyl acetate	1.3	7.5	265.4	30887
Butyl chloride	1.9	10.1	263.7	-
Carbone monoxide	12.5	74.2	-	-
Cyclohexane	1.3	8.4	256.1	46970
Cyclopropane	2.4	10.4	-	49698
Diethylamine	1.8	10.1	255.1	42033
Diisopropyl ether	1.4	7.9	245.4	39571

Fonte: **Annex 2 Flammability limits, flash temperature and heat of combustion (higher value) for different substances**
Industrial Safety Series, Volume 8, 2008, Pages 335-336

Dimethyl ether	3.4	27	232.0	31702
Dimethylamine	2.8	14.4	255.4	39239
Ethanol	3.3	19	286.3	30588
Ethyl acetate	2.2	11	268.7	25804
Ethylene	2.7	36	-	50310
Ethylene oxide	3	100	253.1	29687
Formaldehyde	7	73	358.1	19008
Furan	2.3	14.3	237.6	31006
Gasoline	1.3	7.1	227.6	-
Heptane	1.05	6.7	269.3	47711
Hexane	1.2	7.5	250.1	48671
Hydrocyanic acid	5.6	40	255.4	-
Hydrogen	4.1	74.2	-	-
Isoamyl alcohol	1.2	9	315.9	-
Isobutane	1.9	8.5	-	49363
Isopentane	1.4	7.6	< 222.0	48893
Isopropyl alcohol	2.5	12	284.8	34126
Isopropylamine	2.3	10.4	235.9	40315
Kerosene	0.7	5	338.7 - 358.1	-
Methane	5.3	15	50.6	55505
Methyl acetate	3.1	16	263.1	21978
Methyl acrylate	2.8	25	270.4	24377
Methyl alcohol	6	36.5	285.4	23845
Methyl chloride	8.1	17	< 273.1	-

Methyl chloride	8.1	17	< 273.1	-
Methyl cyclohexane	1.2	6.7	269.3	46855
Methyl ethyl ketone	1.8	11.5	267.6	34374
Methyl formate	5.9	20	254.1	16703
Methyl methacrylate	2.1	12.5	283.1	-
Monomethyl amine	4.95	20.75	273.1	34936
Octane	1	4.7	286.5	48250
Pentane	1.5	7.8	< 233.1	49017
Propane	2.3	9.5	168.7	50338
Propyl amine	2	10.4	235.9	40535
Propylene	2.4	10.1	165.4	48902
Propylene oxide	2.8	37	235.9	33459
Toluene	1.27	7	277.6	42847
Triethyl amine	1.2	8	266.5	40859
Trimethyl amine	2	11.6	266.5	41330
Vinyl acetate	2.6	13.4	265.4	24566
Vinyl chloride	4	22	265.1	-
m-Xylene	1.1	7	298.1	43276
o-Xylene	1	6	290.1	43292
p-Xylene	1.1	7	298.1	43282

Não confunda Flash Point e AIT

	FLASH POINT	AUTO-IGNITION
Lubricating Oil	300°F	783°F
Fuel Oil #6	150°F to 270°F	765°F
Diesel	100°F	494°F
Kerosene	100°F to 130°F	410°F
Gasoline	-36°F to -45°F	536°F to 853°F

http://www.amerex-fire.com/system/document/file/92/Fire_and_Fire_Extinguishment.pdf

Líquido inflamável x Líquido Combustível

NFPA 30 (2015)

3.3.33 Liquid. Any material that (1) has a fluidity greater than that of 300 penetration asphalt when tested in accordance with ASTM D 5, *Standard Test Method for Penetration of Bituminous Materials*, or (2) is a viscous substance for which a specific melting point cannot be determined but that is determined to be a liquid in accordance with ASTM D 4359, *Standard Test for Determining Whether a Material is a Liquid or a Solid.*

3.3.33.1 ***Combustible Liquid.*** Any liquid that has a closed-cup flash point at or above 100°F (37.8°C), as determined by the test procedures and apparatus set forth in Section 4.4. Combustible liquids are classified according to Section 4.3.

3.3.33.2* ***Flammable Liquid.*** Any liquid that has a closed-cup flash point below 100°F (37.8°C), as determined by the test procedures and apparatus set forth in Section 4.4, and a Reid vapor pressure that does not exceed an absolute pressure of 40 psi (276 kPa) at 100°F (37.8°C), as deter-

Líquido inflamável x Líquido Combustível

NFPA 30 (2015)

4.3* Classification of Liquids. Any liquid within the scope of this code and subject to the requirements of this code shall be classified in accordance with this section.

4.3.1 Flammable liquids, as defined in 3.3.33.2 and 4.2.3, shall be classified as Class I liquids and shall be further subclassified in accordance with the following:

(1) Class IA Liquid — Any liquid that has a flash point below 73°F (22.8°C) and a boiling point below 100°F (37.8°C)
(2) Class IB Liquid — Any liquid that has a flash point below 73°F (22.8°C) and a boiling point at or above 100°F (37.8°C)
(3) Class IC Liquid — Any liquid that has a flash point at or above 73°F (22.8°C), but below 100°F (37.8°C)

4.3.2 Combustible liquids, as defined in 3.3.33.1 and 4.2.2, shall be classified in accordance with the following:

(1) Class II Liquid — Any liquid that has a flash point at or above 100°F (37.8°C) and below 140°F (60°C)
(2) Class III Liquid — Any liquid that has a flash point at or above 140°F (60°C)
    (a) Class IIIA Liquid — Any liquid that has a flash point at or above 140°F (60°C), but below 200°F (93°C)
    (b) Class IIIB Liquid — Any liquid that has a flash point at or above 200°F (93°C)

NFPA 30 and NFPA 30A: Flammable and Combustible Liquids Code Handbook, 2012 Edition

Agency	Agency Classification	Agency Flash Point °F	Agency Flash Point °C	NFPA Definition	NFPA Classification	NFPA Flash Point °F	NFPA Flash Point °C
ANSI Z129.1	Flammable	<141	<60.5	Flammable	Class I	<100	<37.8
				Combustible	Class II	≥100 to <140	≥37.8 to <60
					Class IIIA	≥140 to <200	≥60 to <93
	Combustible	≥141 to <200	≥60.5 to <93	Combustible	Class IIIA	≥140 to <200	≥60 to <93
DOT	Flammable	<141	<60.5	Flammable	Class I	<100	<37.8
				Combustible	Class II	≥100 to <140	≥37.8 to <60
					Class IIIA	≥140 to <200	≥60 to <93
	Combustible	≥141 to <200	≥60.5 to <93	Combustible	Class IIIA	≥140 to <200	≥60 to <93
DOT	Flammable	<100	<37.8	Flammable	Class I	<100	<37.8
HM-181 Domestic Exemption*	Combustible	≥100 to <200	≥37.8 to <93	Combustible	Class II	≥100 to <140	≥37.8 to <60
					Class IIIA	≥140 to <200	≥60 to <93
UN	Flammable	<141	<60.5	Flammable	Class I	<100	<37.8
				Combustible	Class II	≥100 to <140	≥37.8 to <60
					Class IIIA	≥140 to <200	≥60 to <93
	Combustible	≥141 to <200	≥60.5 to <93	Combustible	Class II	≥100 to <140	≥37.8 to <60
					Class IIIA	≥140 to <200	≥60 to <93
OSHA	Flammable	<100	<37.8	Flammable	Class I	<100	<37.8
	Combustible†	≥100	≥37.8	Combustible	Class II	≥100 to <140	≥37.8 to <60
					Class IIIA	≥140 to <200	≥60 to <93
					Class IIIB†	≥200	≥93

*See A.4.3.

†See 29 CFR 1910.106 for Class IIIB liquid exemptions.

NFPA 497 (2008)

Table 4.4.2 Selected Chemicals

Chemical	CAS No.	Class I Division Group	Type[a]	Flash Point (°C)	AIT (°C)	%LFL	%UFL	Vapor Density (Air = 1)	Vapor Pressure[b] (mm Hg)	Class I Zone Group[c]	MIE (mJ)	MIC Ratio	MESG (mm)
Acetaldehyde	75-07-0	C[d]	I	−38	175	4.0	60.0	1.5	874.9	IIA	0.37	0.98	0.92
Acetic Acid	64-19-7	D[d]	II	39	426		19.9	2.1	15.6	IIA		2.67	1.76
Acetic Acid-tert-Butyl Ester	540-88-5	D	II			1.7	9.8	4.0	40.6				
Acetic Anhydride	108-24-7	D	II	49	316	2.7	10.3	3.5	4.9	IIA			1.23
Acetone	67-64-1	D[d]	I	−20	465	2.5	12.8	2.0	230.7	IIA	1.15	1.00	1.02
Acetone Cyanohydrin	75-86-5	D	IIIA	74	688	2.2	12.0	2.9	0.3				
Acetonitrile	75-05-8	D	I	6	524	3.0	16.0	1.4	91.1	IIA			1.50
Acetylene	74-86-2	A[d]	GAS		305	2.5	100	0.9	36600	IIC	0.017	0.28	0.25
Acrolein (Inhibited)	107-02-8	B(C)[d]	I		235	2.8	31.0	1.9	274.1	IIB	0.13		
Acrylic Acid	79-10-7	D	II	54	438	2.4	8.0	2.5	4.3	IIB			0.86
Acrylonitrile	107-13-1	D[d]	I	0	481	3	17	1.8	108.5	IIB	0.16	0.78	0.87
Adiponitrile	111-69-3	D	IIIA	93	550			1.0	0.002				
Allyl Alcohol	107-18-6	C[d]	I	22	378	2.5	18.0	2.0	25.4	IIB			0.84
Allyl Chloride	107-05-1	D	I	−32	485	2.9	11.1	2.6	366	IIA		1.33	1.17
Allyl Glycidyl Ether	106-92-3	B(C)[e]	II		57			3.9					
Alpha-Methyl Styrene	98-83-9	D	II		574	0.8	11.0	4.1	2.7				
n-Amyl Acetate	628-63-7	D	I	25	360	1.1	7.5	4.5	4.2	IIA			1.02
sec-Amyl Acetate	626-38-0	D	I	23		1.1	7.5	4.5		IIA			
Ammonia	7664-41-7	D[d,f]	GAS		651	15	28	0.6	7498.0	IIA	680	6.85	3.17
Aniline	62-53-3	D	IIIA	70	615	1.2	8.3	3.2	0.7	IIA			

(continues)

NFPA 497 (2008)

Table 4.4.2 *Continued*

Chemical	CAS No.	Class I Division Group	Type[a]	Flash Point (°C)	AIT (°C)	%LFL	%UFL	Vapor Density (Air = 1)	Vapor Pressure[b] (mm Hg)	Class I Zone Group[c]	MIE (mJ)	MIC Ratio	MESG (mm)
Benzene	71-43-2	D[d]	I	−11	498	1.2	7.8	2.8	94.8	IIA	0.20	1.00	0.99
Benzyl Chloride	98-87-3	D	IIIA		585	1.1		4.4	0.5				
Bromopropyne	106-96-7	D	I	10	324	3.0							
n-Butane	3583-47-9	D[d,g]	GAS		288	1.9	8.5	2.0		IIA	0.25	0.94	1.07
1,3-Butadiene	106-99-0	B(D)[d,e]	GAS		420	2.0	11.5	1.9		IIB	0.13	0.76	0.79
1-Butanol	71-36-3	D[d]	I	36	343	1.4	11.2	2.6	7.0	IIA			0.91
Butyl alcohol (s) (butanol-2)	78-92-2	D[d]	I	23.8	405	1.7	9.8	2.6		IIA			
Butylamine	109-73-9	D	GAS	−12	312	1.7	9.8	2.5	92.9	IIA		1.13	
Butylene	25167-67-3	D	I		385	1.6	10.0	1.9	2214.6	IIA			0.94
n-Butyraldehyde	123-72-8	C[d]	I	−12	218	1.9	12.5	2.5	112.2	IIA			0.92
n-Butyl Acetate	123-86-4	D[d]	I	22	421	1.7	7.6	4.0	11.5	IIA		1.08	1.04
sec-Butyl Acetate	105-46-4	D	II	−8		1.7	9.8	4.0	22.2				
tert-Butyl Acetate	540-88-5	D	II			1.7	9.8	4.0	40.6				
n-Butyl Acrylate (Inhibited)	141-32-2	D	II	49	293	1.7	9.9	4.4	5.5	IIB			0.88
n-Butyl Glycidyl Ether	2426-08-6	B(C)[c]	II										
n-Butyl Formal	110-62-3	C	IIIA						34.3				
Butyl Mercaptan	109-79-5	C	I	2				3.1	46.4				
Butyl-2-Propenoate	141-32-2	D	II	49		1.7	9.9	4.4	5.5				
para tert-Butyl Toluene	98-51-1	D	IIIA										
n-Butyric Acid	107-92-6	D[d]	IIIA	72	443	2.0	10.0	3.0	0.8				

NFPA 497 (2008)

Carbon Disulfide	75-15-0	d,h	I	−30	90	1.3	50.0	2.6	358.8	IIC	0.009	0.39	0.20
Carbon Monoxide	630-08-0	C[d]	GAS		609	12.5	74	0.97		IIB			0.54
Chloroacetaldehyde	107-20-0	C	IIIA	88					63.1				
Chlorobenzene	108-90-7	D	I	29	593	1.3	9.6	3.9	11.9				
1-Chloro-1-Nitropropane	2425-66-3	C	IIIA										
Chloroprene	126-99-8	D	GAS	−20		4.0	20.0	3.0					
Cresol	1319-77-3	D	IIIA	81	559	1.1		3.7					
Crotonaldehyde	4170-30-3	C[d]	I	13	232	2.1	15.5	2.4	33.1	IIB			0.81
Cumene	98-82-8	D	I	36	424	0.9	6.5	4.1	4.6	IIA			1.05
Cyclohexane	110-82-7	D	I	−17	245	1.3	8.0	2.9	98.8	IIA	0.22	1.0	0.94
Cyclohexanol	108-93-0	D	IIIA	68	300			3.5	0.7	IIA			
Cyclohexanone	108-94-1	D	II	44	420	1.1	9.4	3.4	4.3	IIA			0.98
Cyclohexene	110-83-8	D	I	−6	244	1.2		2.8	89.4	IIA		0.97	
Cyclopropane	75-19-4	D[d]	I		503	2.4	10.4	1.5	5430	IIA	0.17	0.84	0.91
p-Cymene	99-87-6	D	II	47	436	0.7	5.6	4.6	1.5	IIA			
Decene	872-05-9	D	II		235			4.8	1.7				
n-Decaldehyde	112-31-2	C	IIIA						0.09				
n-Decanol	112-30-1	D	IIIA	82	288			5.3	0.008				
Decyl Alcohol	112-30-1	D	IIIA	82	288			5.3	0.008				
Diacetone Alcohol	123-42-2	D	IIIA	64	603	1.8	6.9	4.0	1.4				
Di-Isobutylene	25167-70-8	D[d]	I	2	391	0.8	4.8	3.8			0.96		
Di-Isobutyl Ketone	108-83-8	D	II	60	396	0.8	7.1	4.9	1.7				
o-Dichlorobenzene	955-50-1	D	IIIA	66	647	2.2	9.2	5.1		IIA			
1,4-Dichloro-2,3 Epoxybutane	3583-47-9	D[d]	I			1.9	8.5	2.0		IIA	0.25	0.98	1.07
1,1-Dichloroethane	1300-21-6	D	I		438	6.2	16.0	3.4	227	IIA			1.82
1,2-Dichloroethylene	156-59-2	D	I	97	460	5.6	12.8	3.4	204	IIA			3.91
1,1-Dichloro-1-Nitroethane	594-72-9	C	IIIA	76				5.0					
1,3-Dichloropropene	10061-02-6	D	I	35		5.3	14.5	3.8					
Dicyclopentadiene	77-73-6	C	I	32	503				2.8	IIA			0.91
Diethylamine	109-87-9	C[d]	I	−28	312	1.8	10.1	2.5		IIA			1.15
Diethylaminoethanol	100-37-8	C	IIIA	60	320			4.0	1.6	IIA			

NFPA 497 (2008)

Decene	872-05-9	D	II		235			4.8	1.7				
n-Decaldehyde	112-31-2	C	IIIA						0.09				
n-Decanol	112-30-1	D	IIIA	82	288			5.3	0.008				
Decyl Alcohol	112-30-1	D	IIIA	82	288			5.3	0.008				
Diacetone Alcohol	123-42-2	D	IIIA	64	603	1.8	6.9	4.0	1.4				
Di-Isobutylene	25167-70-8	D[d]	I	2	391	0.8	4.8	3.8			0.96		
Di-Isobutyl Ketone	108-83-8	D	II	60	396	0.8	7.1	4.9	1.7				
o-Dichlorobenzene	955-50-1	D	IIIA	66	647	2.2	9.2	5.1		IIA			
1,4-Dichloro-2,3 Epoxybutane	3583-47-9	D[d]	I			1.9	8.5	2.0		IIA	0.25	0.98	1.07
1,1-Dichloroethane	1300-21-6	D	I		438	6.2	16.0	3.4	227	IIA			1.82
1,2-Dichloroethylene	156-59-2	D	I	97	460	5.6	12.8	3.4	204	IIA			3.91
1,1-Dichloro-1-Nitroethane	594-72-9	C	IIIA	76				5.0					
1,3-Dichloropropene	10061-02-6	D	I	35		5.3	14.5	3.8					
Dicyclopentadiene	77-73-6	C	I	32	503				2.8	IIA			0.91
Diethylamine	109-87-9	C[d]	I	−28	312	1.8	10.1	2.5		IIA			1.15
Diethylaminoethanol	100-37-8	C	IIIA	60	320			4.0	1.6	IIA			
Diethyl Benzene	25340-17-4	D	II	57	395			4.6					
Diethyl Ether (Ethyl Ether)	60-29-7	C[d]	I	−45	160	1.9	36	2.6	538	IIB	0.19	0.88	0.83
Diethylene Glycol Monobutyl Ether	112-34-5	C	IIIA	78	228	0.9	24.6	5.6	0.02				

NFPA 497 (2008)

Chemical	CAS No.	Class I Division Group	Type[a]	Flash Point (°C)	AIT (°C)	%LFL	%UFL	Vapor Density (Air = 1)	Vapor Pressure[b] (mm Hg)	Class I Zone Group[c]	MIE (mJ)	MIC Ratio	MESG (mm)
Diethylene Glycol Monomethyl Ether	111-77-3	C	IIIA	93	241				0.2				
n-n-Dimethyl Aniline	121-69-7	C	IIIA	63	371	1.0		4.2	0.7				
Dimethyl Formamide	68-12-2	D	II	58	455	2.2	15.2	2.5	4.1	IIA			1.08
Dimethyl Sulfate	77-78-1	D	IIIA	83	188			4.4	0.7				
Dimethylamine	124-40-3	C	GAS		400	2.8	14.4	1.6		IIA			
2,2-Dimethylbutane	75-83-2	D[g]	I	−48	405				319.3				
2,3-Dimethylbutane	78-29-8	D[g]	I		396								
3,3-Dimethylheptane	1071-26-7	D[g]	I		325				10.8				
2,3-Dimethylhexane	31394-54-4	D[g]	I		438								
2,3-Dimethylpentane	107-83-5	D[g]	I		335				211.7				
Di-N-Propylamine	142-84-7	C	I	17	299				27.1	IIA			0.95
1,4-Dioxane	123-91-1	C[d]	I	12	180	2.0	22.0	3.0	38.2	IIB	0.19		0.70
Dipentene	138-86-3	D	II	45	237	0.7	6.1	4.7		IIA			1.18
Dipropylene Glycol Methyl Ether	34590-94-8	C	IIIA	85		1.1	3.0	5.1	0.5				
Diisopropylamine	108-18-9	C	GAS	−6	316	1.1	7.1	3.5		IIA			1.02
Dodecene	6842-15-5	D	IIIA	100	255								
Epichlorohydrin	3132-64-7	C[d]	I	33	411	3.8	21.0	3.2	13.0				
Ethane	74-84-0	D[d]	GAS	−29	472	3.0	12.5	1.0		IIA	0.24	0.82	0.91
Ethanol	64-17-5	D[d]	I	13	363	3.3	19.0	1.6	59.5	IIA		0.88	0.89
Ethylamine	75-04-7	D[d]	I	−18	385	3.5	14.0	1.6	1048		2.4		
Ethylene	74-85-1	C[d]	GAS		490	2.7	36.0	1.0		IIB	0.070	0.53	0.65
Ethylenediamine	107-15-3	D[d]	I	33	385	2.5	12.0	2.1	12.5				
Ethylenimine	151-56-4	C[d]	I	−11	320	3.3	54.8	1.5	211		0.48		
Ethylene Chlorohydrin	107-07-3	D	IIIA	59	425	4.9	15.9	2.8	7.2				

NFPA 497 (2008)

Ethylene Dichloride	107-06-2	D[d]	I	13	413	6.2	16.0	3.4	79.7				
Ethylene Glycol Monoethyl Ether Acetate	111-15-9	C	II	47	379	1.7		4.7	2.3	IIA		0.53	0.97
Ethylene Glycol Monobutyl Ether Acetate	112-07-2	C	IIIA		340	0.9	8.5		0.9				
Ethylene Glycol Monobutyl Ether	111-76-2	C	IIIA		238	1.1	12.7	4.1	1.0				
Ethylene Glycol Monoethyl Ether	110-80-5	C	II		235	1.7	15.6	3.0	5.4				0.84
Ethylene Glycol Monomethyl Ether	109-86-4	D	II		285	1.8	14.0	2.6	9.2				0.85
Ethylene Oxide	75-21-8	B(C)[d,e]	I	−20	429	3	100	1.5	1314	IIB	0.065	0.47	0.59
2-Ethylhexaldehyde	123-05-7	C	II	52	191	0.8	7.2	4.4	1.9				
2-Ethylhexanol	104-76-7	D	IIIA	81		0.9	9.7	4.5	0.2				
2-Ethylhexyl Acrylate	103-09-3	D	IIIA	88	252				0.3				
Ethyl Acetate	141-78-6	D[d]	I	−4	427	2.0	11.5	3.0	93.2	IIA	0.46		0.99
Ethyl Acrylate (Inhibited)	140-88-5	D[d]	I	9	372	1.4	14.0	3.5	37.5	IIA			0.86
Ethyl Alcohol	64-17-5	D[d]	I	13	363	3.3	19.0	1.6	59.5	IIA		0.88	0.89
Ethyl Sec-Amyl Ketone	541-85-5	D	II	59									
Ethyl Benzene	100-41-4	D	I	15	432	0.8	6.7	3.7	9.6				
Ethyl Butanol	97-95-0	D	II	57		1.2	7.7	3.5	1.5				
Ethyl Butyl Ketone	106-35-4	D	II	46				4.0	3.6				
Ethyl Chloride	75-00-3	D	GAS	−50	519	3.8	15.4	2.2					
Ethyl Formate	109-94-4	D	GAS	−20	455	2.8	16.0	2.6		IIA			0.94
Ethyl Mercaptan	75-08-1	C[d]	I	−18	300	2.8	18.0	2.1	527.4	IIB		0.90	0.90
n-Ethyl Morpholine	100-74-3	C	I	32				4.0					

NFPA 497 (2008)

Chemical	CAS No.	Class I Division Group	Type[a]	Flash Point (°C)	AIT (°C)	%LFL	%UFL	Vapor Density (Air = 1)	Vapor Pressure[b] (mm Hg)	Class I Zone Group[c]	MIE (mJ)	MIC Ratio	MESG (mm)
2-Ethyl-3-Propyl Acrolein	645-62-5	C	IIIA	68				4.4					
Ethyl Silicate	78-10-4	D	II					7.2					
Formaldehyde (Gas)	50-00-0	B	GAS		430	7	73	1.0		IIB			0.57
Formic Acid	64-18-6	D	II	50	434	18.0	57.0	1.6	42.7	IIA			1.86
Fuel Oil 1	8008-20-6	D	II or IIIA[k]	38–72[k]	210	0.7	5.0						
Fuel Oil 2			II or IIIA[k]	52–96[k]	257								
Fuel Oil 6			IIIA or IIIB[k]	66–132[k]									
Furfural	98-01-1	C	IIIA	60	316	2.1	19.3	3.3	2.3				0.94
Furfuryl Alcohol	98-00-0	C	IIIA	75	490	1.8	16.3	3.4	0.6				
Gasoline	8006-61-9	D[d]	I	−46	280	1.4	7.6	3.0					
n-Heptane	142-82-5	D[d]	I	−4	204	1.0	6.7	3.5	45.5	IIA	0.24	0.88	0.91
n-Heptene	81624-04-6	D[g]	I	−1	204			3.4					0.97
n-Hexane	110-54-3	D[d,g]	I	−23	225	1.1	7.5	3.0	152	IIA	0.24	0.88	0.93
Hexanol	111-27-3	D	IIIA	63				3.5	0.8	IIA			0.98
2-Hexanone	591-78-6	D	I	35	424	1.2	8.0	3.5	10.6				
Hexene	592-41-6	D	I	−26	245	1.2	6.9		186				
sec-Hexyl Acetate	108-84-9	D	II	45				5.0					
Hydrazine	302-01-2	C	II	38	23		98.0	1.1	14.4				
Hydrogen	1333-74-0	B[d]	GAS		500	4	75	0.1		IIC	0.019	0.25	0.28
Hydrogen Cyanide	74-90-8	C[d]	GAS	−18	538	5.6	40.0	0.9		IIB			0.80
Hydrogen Selenide	7783-07-5	C	I						7793				
Hydrogen Sulfide	7783-06-4	C[d]	GAS		260	4.0	44.0	1.2		IIB	0.068		0.90
Isoamyl Acetate	123-92-2	D	I	25	360	1.0	7.5	4.5	6.1				
Isoamyl Alcohol	123-51-3	D	II	43	350	1.2	9.0	3.0	3.2	IIA			1.02
Isobutane	75-28-5	D[g]	GAS		460	1.8	8.4	2.0		IIA			0.95

NFPA 497 (2008)

Isobutane	75-28-5	D[g]	GAS		460	1.8	8.4	2.0		IIA			0.95
Isobutyl Acetate	110-19-0	D[d]	I	18	421	2.4	10.5	4.0	17.8				
Isobutyl Acrylate	106-63-8	D	I		427			4.4	7.1				
Isobutyl Alcohol	78-83-1	D[d]	I	−40	416	1.2	10.9	2.5	10.5	IIA		0.92	0.98
Isobutyraldehyde	78-84-2	C	GAS	−40	196	1.6	10.6	2.5		IIA			0.92
Isodecaldehyde	112-31-2	C	IIIA					5.4	0.09				
Isohexane	107-83-5	D[g]			264				211.7	IIA		1.00	
Isopentane	78-78-4	D[g]			420				688.6				
Isooctyl Aldehyde	123-05-7	C	II		197				1.9				
Isophorone	78-59-1	D		84	460	0.8	3.8	4.8	0.4				
Isoprene	78-79-5	D[d]	I	−54	220	1.5	8.9	2.4	550.6				
Isopropyl Acetate	108-21-4	D	I		460	1.8	8.0	3.5	60.4				
Isopropyl Ether	108-20-3	D[d]	I	−28	443	1.4	7.9	3.5	148.7	IIA	1.14		0.94
Isopropyl Glycidyl Ether	4016-14-2	C	I										
Isopropylamine	75-31-0	D	GAS	−26	402	2.3	10.4	2.0			2.0		
Kerosene	8008-20-6	D	II	72	210	0.7	5.0			IIA			
Liquefied Petroleum Gas	68476-85-7	D	I		405								
Mesityl Oxide	141-97-9	D[d]	I	31	344	1.4	7.2	3.4	47.6				
Methane	74-82-8	D[d]	GAS		600	5	15	0.6		IIA	0.28	1.00	1.12
Methanol	67-56-1	D[d]	I	12	385	6.0	36.0	1.1	126.3	IIA	0.14	0.82	0.92
Methyl Acetate	79-20-9	D	GAS	−10	454	3.1	16.0	2.6		IIA		1.08	0.99
Methyl Acrylate	96-33-3	D	GAS	−3	468	2.8	25.0	3.0		IIB		0.98	0.85
Methyl Alcohol	67-56-1	D[d]	I		385	6.0	36	1.1	126.3	IIA			0.91
Methyl Amyl Alcohol	108-11-2	D	II	41		1.0	5.5	3.5	5.3	IIA			1.01
Methyl Chloride	74-87-3	D	GAS	−46	632	8.1	17.4	1.7		IIA			1.00
Methyl Ether	115-10-6	C[d]	GAS	−41	350	3.4	27.0	1.6		IIB		0.85	0.84
Methyl Ethyl Ketone	78-93-3	D[d]	I	−6	404	1.4	11.4	2.5	92.4	IIB	0.53	0.92	0.84
Methyl Formal	534-15-6	C[d]	I	1	238			3.1					
Methyl Formate	107-31-3	D	GAS	−19	449	4.5	23.0	2.1		IIA			0.94
2-Methylhexane	31394-54-4	D[g]	I		280								
Methyl Isobutyl	141-79-7	D[d]	I	31	440	1.2	8.0	3.5	11				

NFPA 497 (2008)

Methyl Alcohol	67-56-1	D[d]	I		385	6.0	36	1.1	126.3	IIA			0.91
Methyl Amyl Alcohol	108-11-2	D	II	41		1.0	5.5	3.5	5.3	IIA			1.01
Methyl Chloride	74-87-3	D	GAS	−46	632	8.1	17.4	1.7		IIA			1.00
Methyl Ether	115-10-6	C[d]	GAS	−41	350	3.4	27.0	1.6		IIB		0.85	0.84
Methyl Ethyl Ketone	78-93-3	D[d]	I	−6	404	1.4	11.4	2.5	92.4	IIB	0.53	0.92	0.84
Methyl Formal	534-15-6	C[d]	I	1	238			3.1					
Methyl Formate	107-31-3	D	GAS	−19	449	4.5	23.0	2.1		IIA			0.94
2-Methylhexane	31394-54-4	D[g]	I		280								
Methyl Isobutyl Ketone	141-79-7	D[d]	I	31	440	1.2	8.0	3.5	11				
Methyl Isocyanate	624-83-9	D	GAS	−15	534	5.3	26.0	2.0		IIA			1.21

NFPA 497 (2008)

Chemical	CAS No.	Class I Division Group	Type[a]	Flash Point (°C)	AIT (°C)	%LFL	%UFL	Vapor Density (Air = 1)	Vapor Pressure[b] (mm Hg)	Class I Zone Group[c]	MIE (mJ)	MIC Ratio	MESG (mm)
fethyl Mercaptan	74-93-1	C	GAS	−18		3.9	21.8	1.7					
fethyl Methacrylate	80-62-6	D	I	10	422	1.7	8.2	3.6	37.2	IIA			0.95
fethyl N-Amyl Ketone	110-43-0	D	II	49	393	1.1	7.9	3.9	3.8				
fethyl Tertiary Butyl Ether	1634-04-4	D	I	−80	435	1.6	8.4	0.2	250.1				
-Methyloctane	3221-61-2				220				6.3				
-Methylpropane	75-28-5	D[g]	I		460				2639				
fethyl-1-Propanol	78-83-1	D[d]	I	−40	416	1.2	10.9	2.5	10.1	IIA			0.98
fethyl-2-Propanol	75-65-0	D[d]	I	10	360	2.4	8.0	2.6	42.2				
-Methyl-5-Ethyl Pyridine	104-90-5	D		74		1.1	6.6	4.2					
fethylacetylene	74-99-7	C[d]	I			1.7		1.4	4306		0.11		
fethylacetylene-Propadiene	27846-30-6	C	I							IIB			0.74
fethylal	109-87-5	C	I	−18	237	1.6	17.6	2.6	398				
fethylamine	74-89-5	D	GAS		430	4.9	20.7	1.0		IIA			1.10
-Methylbutane	78-78-4	D[g]		−56	420	1.4	8.3	2.6	688.6				
fethylcyclohexane	208-87-2	D	I	−4	250	1.2	6.7	3.4			0.27		
fethylcyclohexanol	25630-42-3	D		68	296			3.9					
-Methycyclohexanone	583-60-8	D	II					3.9					
-Methylheptane		D[g]			420								
-Methylhexane	589-34-4	D[g]			280				61.5				
-Methylpentane	94-14-0	D[g]			278								
-Methylpropane	75-28-5	D[g]	I		460				2639				
-Methyl-1-Propanol	78-83-1	D[d]	I	−40	223	1.2	10.9	2.5	10.5				
-Methyl-2-Propanol	75-65-0	D[d]	I		478	2.4	8.0	2.6	42.2				
-Methyloctane	2216-32-2	D[g]			220								
-Methyloctane	2216-33-3	D[g]			220				6.3				

NFPA 497 (2008)

3-Methyloctane	2216-33-3	D[g]			220				6.3				
4-Methyloctane	2216-34-4	D[g]			225				6.8				
Monoethanolamine	141-43-5	D		85	410			2.1	0.4	IIA			
Monoisopropanolamine	78-96-6	D		77	374			2.6	1.1				
Monomethyl Aniline	100-61-8	C			482				0.5				
Monomethyl Hydrazine	60-34-4	C	I	23	194	2.5	92.0	1.6					
Morpholine	110-91-8	C[d]	II	35	310	1.4	11.2	3.0	10.1	IIA			0.95
Naphtha (Coal Tar)	8030-30-6	D	II	42	277					IIA			
Naphtha (Petroleum)	8030-30-6	D[d,i]	I	42	288	1.1	5.9	2.5		IIA			
Neopentane	463-82-1	D[g]		−65	450	1.4	8.3	2.6	1286				
Nitrobenzene	98-95-3	D		88	482	1.8		4.3	0.3	IIA			0.94
Nitroethane	79-24-3	C	I	28	414	3.4		2.6	20.7	IIB			0.87
Nitromethane	75-52-5	C	I	35	418	7.3		2.1	36.1	IIA		0.92	1.17
1-Nitropropane	108-03-2	C	I	34	421	2.2		3.1	10.1	IIB			0.84
2-Nitropropane	79-46-9	C[d]	I	28	428	2.6	11.0	3.1	17.1				
n-Nonane	111-84-2	D[g]	I	31	205	0.8	2.9	4.4	4.4	IIA			
Nonene	27214-95-8	D	I			0.8		4.4					
Nonyl Alcohol	143-08-8	D				0.8	6.1	5.0	0.02	IIA			
n-Octane	111-65-9	D[d,g]	I	13	206	1.0	6.5	3.9	14.0	IIA			0.94
Octene	25377-83-7	D	I	8	230	0.9		3.9					
n-Octyl Alcohol	111-87-5	D						4.5	0.08	IIA			1.05
n-Pentane	109-66-0	D[d,g]	I	−40	243	1.5	7.8	2.5	513	IIA	0.28	0.97	0.93
1-Pentanol	71-41-0	D[d]	I	33	300	1.2	10.0	3.0	2.5	IIA			1.30
2-Pentanone	107-87-9	D	I	7	452	1.5	8.2	3.0	35.6	IIA			0.99
1-Pentene	109-67-1	D	I	−18	275	1.5	8.7	2.4	639.7				
2-Pentene	109-68-2	D	I	−18				2.4					
2-Pentyl Acetate	626-38-0	D	I	23		1.1	7.5	4.5					
Phenylhydrazine	100-63-0	D		89				3.7	0.03				
Process Gas > 30% H_2	1333-74-0	B[j]	GAS		520	4.0	75.0	0.1			0.019	0.45	
Propane	74-98-6	D[d]	GAS		450	2.1	9.5	1.6		IIA	0.25	0.82	0.97

NFPA 497 (2008)

Chemical	CAS No.	Class I Division Group	Type[a]	Flash Point (°C)	AIT (°C)	%LFL	%UFL	Vapor Density (Air = 1)	Vapor Pressure[b] (mm Hg)	Class I Zone Group[c]	MIE (mJ)	MIC Ratio	MESG (mm)
1-Propanol	71-23-8	D[d]	I	15	413	2.2	13.7	2.1	20.7	IIA			0.89
2-Propanol	67-63-0	D[d]	I	12	399	2.0	12.7	2.1	45.4	IIA	0.65		1.00
Propiolactone	57-57-8	D				2.9		2.5	2.2				
Propionaldehyde	123-38-6	C	I	−9	207	2.6	17.0	2.0	318.5	IIB			0.86
Propionic Acid	79-09-4	D	II	54	466	2.9	12.1	2.5	3.7	IIA			1.10
Propionic Anhydride	123-62-6	D		74	285	1.3	9.5	4.5	1.4				
n-Propyl Acetate	109-60-4	D	I	14	450	1.7	8.0	3.5	33.4	IIA			1.05
n-Propyl Ether	111-43-3	C[d]	I	21	215	1.3	7.0	3.5	62.3				
Propyl Nitrate	627-13-4	B[d]	I	20	175	2.0	100.0						
Propylene	115-07-1	D[d]	GAS		460	2.4	10.3	1.5		IIA	0.28		0.91
Propylene Dichloride	78-87-5	D	I	16	557	3.4	14.5	3.9	51.7	IIA			1.32
Propylene Oxide	75-56-9	B(C)[d,e]	I	−37	449	2.3	36.0	2.0	534.4	IIB	0.13		0.70
Pyridine	110-86-1	D[d]	I	20	482	1.8	12.4	2.7	20.8	IIA			
Styrene	100-42-5	D[d]	I	31	490	0.9	6.8	3.6	6.1	IIA		1.21	
Tetrahydrofuran	109-99-9	C[d]	I	−14	321	2.0	11.8	2.5	161.6	IIB	0.54		0.87
Tetrahydronaphthalene	119-64-2	D	IIIA		385	0.8	5.0	4.6	0.4				
Tetramethyl Lead	75-74-1	C	II	38				9.2					
Toluene	108-88-3	D[d]	I	4	480	1.1	7.1	3.1	28.53	IIA	0.24		
n-Tridecene	2437-56-1	D	IIIA			0.6		6.4	593.4				
Triethylamine	121-44-8	C[d]	I	−9	249	1.2	8.0	3.5	68.5	IIA	0.75		1.05
Triethylbenzene	25340-18-5	D		83			56.0	5.6					
2,2,3-Trimethylbutane		D[g]			442								
2,2,4-Trimethylbutane		D[g]			407								
2,2,3-Trimethylpentane		D[g]			396								
2,2,4-Trimethylpentane		D[g]			415					IIA			1.04
2,3,3-Trimethylpentane		D[g]			425								
Tripropylamine	102-69-2	D	II	41				4.9	1.5	IIA			1.13

NFPA 497 (2008)

Tripropylamine	102-69-2	D	II	41				4.9	1.5	IIA			1.13
Turpentine	8006-64-2	D	I	35	253	0.8			4.8				
n-Undecene	28761-27-5	D	IIIA			0.7		5.5					
Unsymmetrical Dimethyl Hydrazine	57-14-7	C[d]	I	−15	249	2.0	95.0	1.9		IIB			0.85
Valeraldehyde	110-62-3	C	I	280	222			3.0	34.3				
Vinyl Acetate	108-05-4	D[d]	I	−6	402	2.6	13.4	3.0	113.4	IIA	0.70		0.94
Vinyl Chloride	75-01-4	D[d]	GAS	−78	472	3.6	33.0	2.2		IIA			0.96
Vinyl Toluene	25013-15-4	D		52	494	0.8	11.0	4.1					
Vinylidene Chloride	75-35-4	D	I		570	6.5	15.5	3.4	599.4	IIA			3.91
Xylene	1330-20-7	D[d]	I	25	464	0.9	7.0	3.7		IIA	0.2		1.09
Xylidine	121-69-7	C	IIIA	63	371	1.0		4.2	0.7				

Limites de Inflamabilidade

Esses limites determinam uma faixa de concentração no ar, de gás, vapor ou de particulados, expressa em percentual volumétrico, que torna a mistura inflamável.

A menor concentração é chamada de Limite Inferior de Explosividade (LIE) ou LFL em inglês (lower flammable limit)

A maior concentração é chamada de Limite Superior de Explosividade (LSE) ou UFL em ingles (upper flammable limit)

LFL e UFL são medidas no ar!
O que varia é a concentração de combustível.

Limites de Inflamabilidade

Atmosferas ricas em Oxigênio podem ampliar a zona de inflamabilidade e reduzir a AIT.

"Nunca permita óleo, graxa, ou qualquer outra substância altamente combustível entrem em contato com os cilindros, válvulas, reguladores, medidores, ou acessórios para oxigênio. Nunca lubrifique válvulas, reguladores, medidores, ou acessórios de oxigênio com óleo, graxa ou qualquer outra substância combustível"

Limites de Inflamabilidade

Abaixo do LIE: a mistura do gás ou vapor com o ar é chamada de **mistura pobre**

Acima do LSE: **mistura rica.**

Esses limites na prática devem ser usados com muito cuidado pois a mobilidade do ar pode mudar rapidamente a concentração do gás ou do vapor.

LIE = LII (limite inferior de inflamabilidade)= LFL = LEL

LSE = LSI (limite superior de inflamabilidade)= UFL = UEL

produtos	**limites de inflamabilidade (% volume no ar)**	
	inferior	**superior**
gasolina	1,5	7,6
hexano	1,1	7,5
metanol	6,7	36,0
etanol	3,3	19,0
querosene	0,7	5,0
monóxido de carbono	12,5	74,0
hidrogênio	4,0	75,0
acetileno	2,0	> 80,0

Explosímetro

Parte N° 89220

Indicador de gas combustible
Modelo 2A

Manual de Instrucciones y
Lista de Partes.

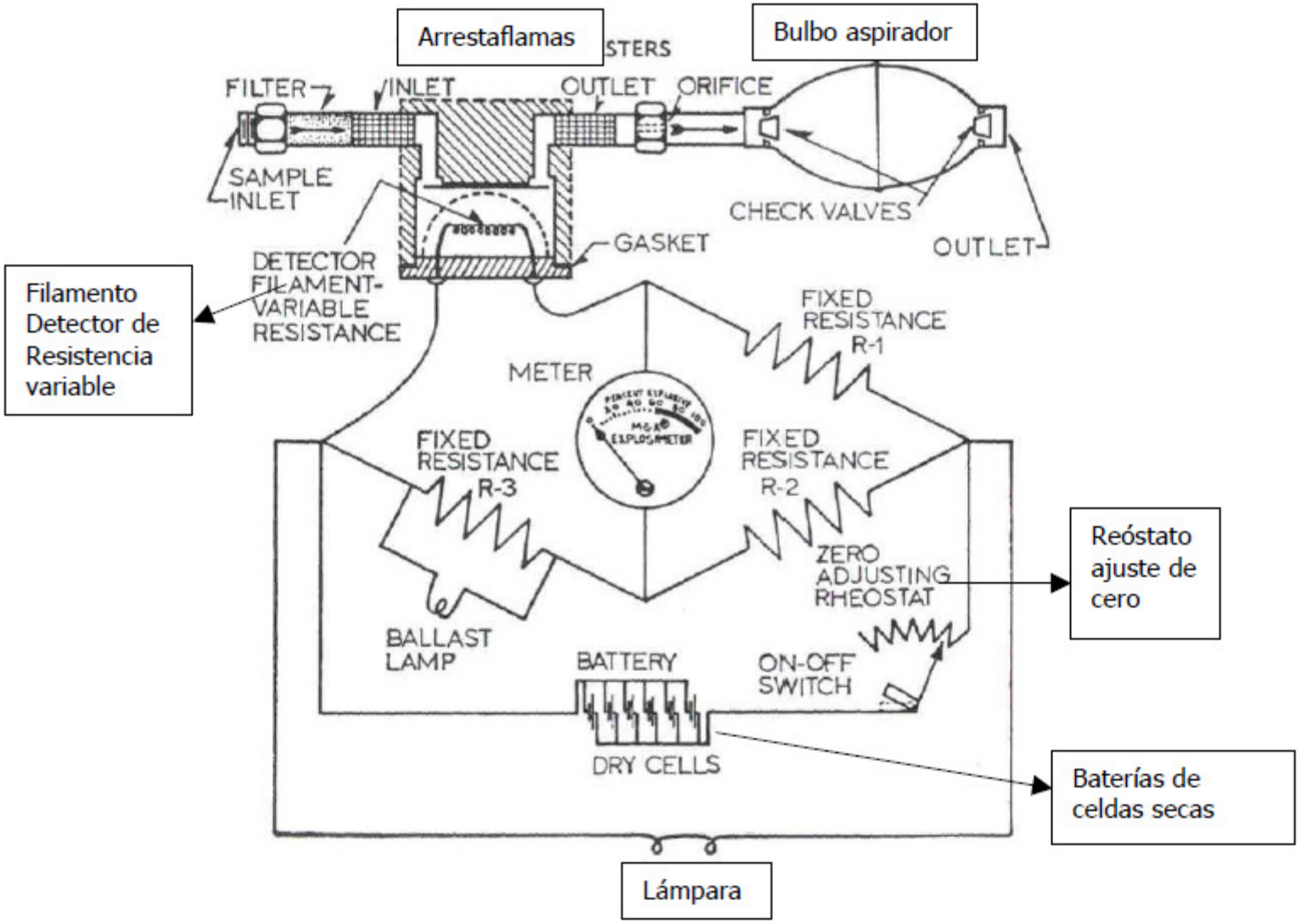
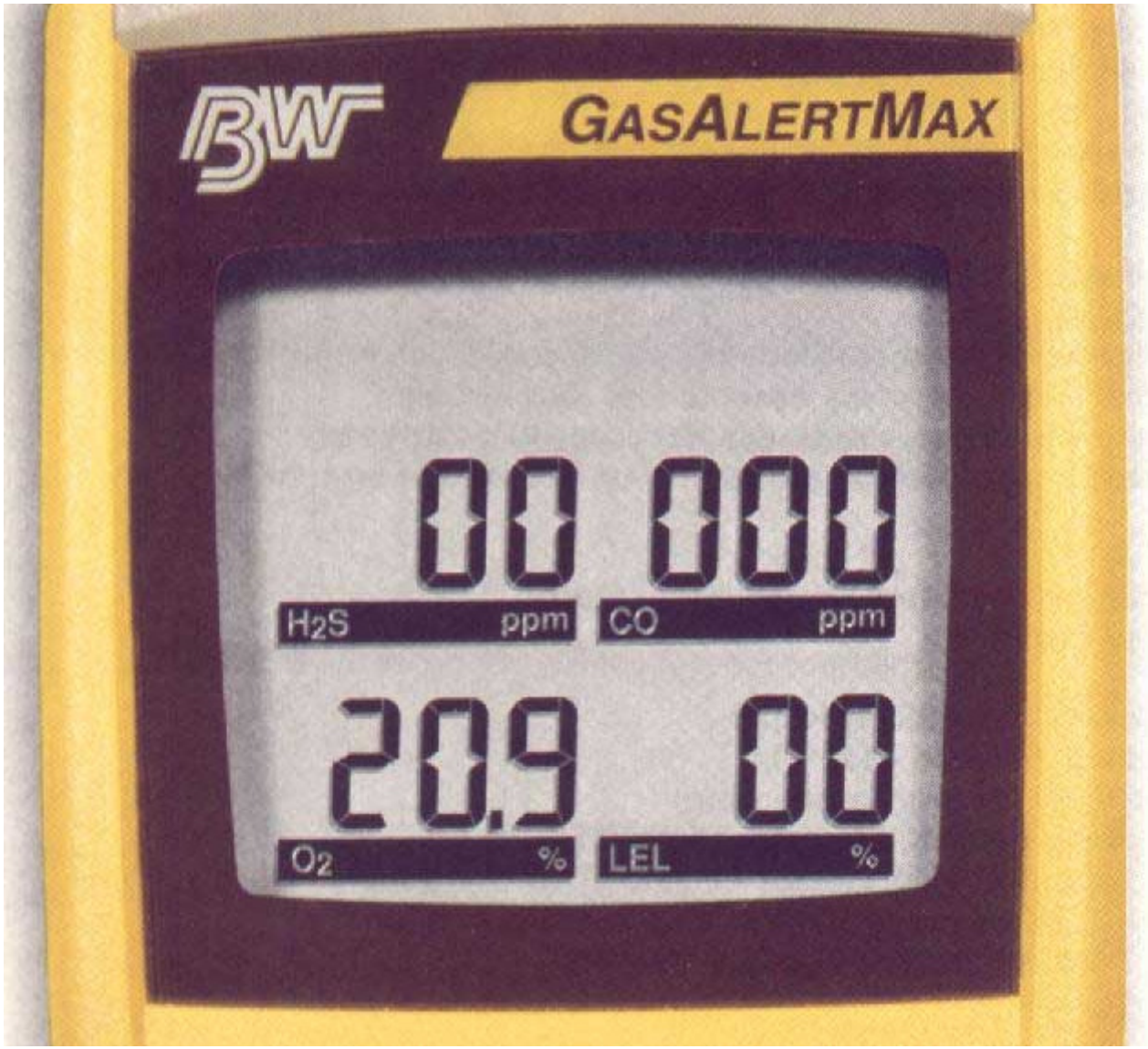


Figure 1—Schematic Flow System and Wiring Diagram.


Explosímetro®
indicador de gás combustível
INSTITUTO DE ELETROTÉCNICA
UIEP
APROVADO
modelo 2A
Nº peça 297000
Nº série
Intrinsicamente Seguro para uso em Classe 1, Divisão 1, Grupo D cont. NBR 8447 e não Incendível para uso em Classe 1, Divisão 2, Grupo A,B,C e D Locais Perigosos, como definido pela NEC (National Eletric Code – USA)
Fabricado por
MSA
MSA DO BRASIL


MICRO
EMISSION ANALYZER

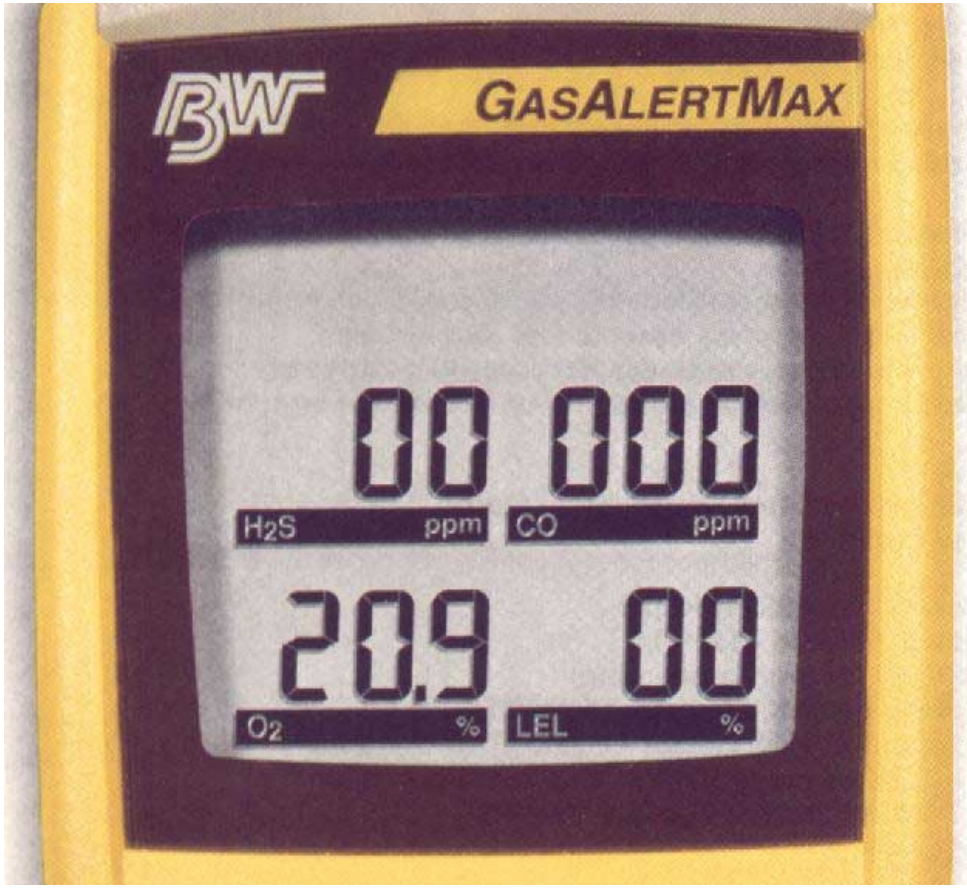

BW
GASALERTMAX
00
H2S
ppm
000
CO
ppm
20.9
O2
%
00
LEL
%
CAL
MAX
TWA
OK



Explosímetros marcam a % em relação a LEL

LEL UEL

0% 100%



Explosímetro Digital Portátil

- Display de cristal líquido (LCD) 3 ½ dígitos
- Escala: 0 - 100%LEL (Metano CH4)

Alarme alto:25%LEL 80%LEL
Alarme baixo: 10%LEL - 25%LEL

- Precisão: ±5% F. S.
- Tempo de resposta: T<30s
- Indicação: O display indica a hora, modo de alarme, mau funcionamento, baixa tensão da bateria, alarme sonoro e vibratório
- Observação: A Instrutherm pode fornecer outro equipamento preparado para detectar outros tipos de gases a escolha do cliente; observando que o mesmo acopla apenas 1 sensor. Conforme abaixo;

Propano C3H8, Monóxido de Carbono CO, Amônia NH3,
Sulfeto de Hidrogênio H2S, Hidroqênio-2 H2, Oxiqênio O2

Aviso: O detector não detecta etanol e isopropanol

- Tipo do sensor: Catalítico
- Tipo de teste: Por difusão
- Auto-teste de função completa de integridade do sensor, bateria e circuitos
- Grau de proteção IP-65 (Protegido contra poeira e água)
- Temperatura de operação: -40° a 70°C
- Umidade de operação: <90% UR
- Alimentação: Bateria de lítio de 3,6V DC; 1200Ah (110 ou 220V)
- Tempo de carga da bateria: 4h a 6h
- Duração da bateria: Gás combustível: 8h continuamente
- Validade do sensor: 1 ano
- Peso: 200g (com bateria)
- Dimensões: 110 x 60 x 40mm
- Fornecido: Chave de fenda, Clipe de cinto tipo jacaré, Clipe de cinto simples, Carregador e manual de instruções
- Opcional (Vendido Separadamente): Maleta para Transporte Mod.MA-800 e Maleta para Transporte Mod.MA-810

Limiting Oxygen Concentration (LOC):

A LFL é a concentração do combustível no ar. Porém, para haver combustão é necessária também a presença de oxigênio.

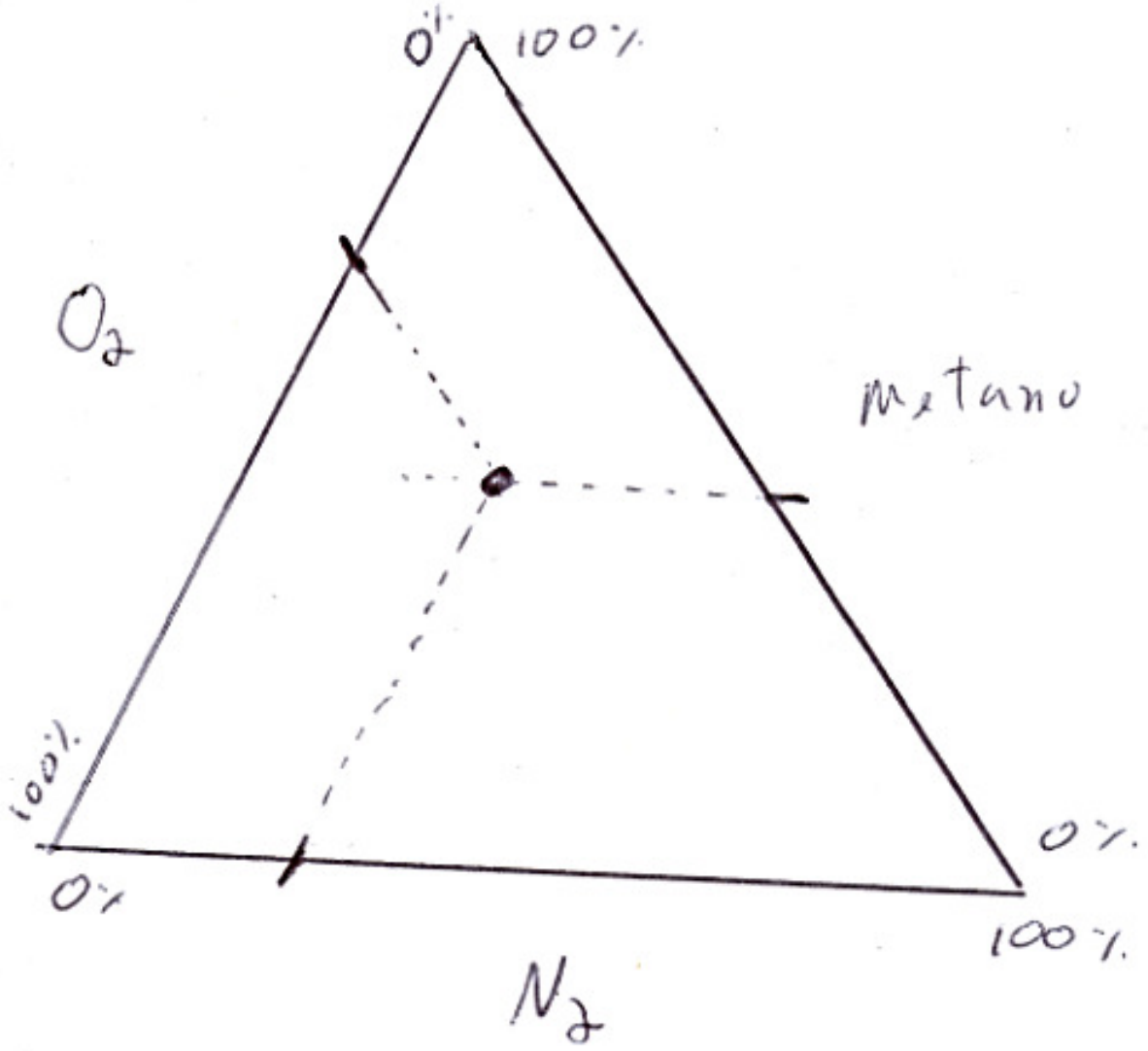
A LOC é o teor mínimo de oxigênio necessário para manter o fogo na presença um gás inerte e o combustível. Abaixo da LOC a reação não gera energia suficiente para aquecer a mistura toda de gases (inclusive inertes) de modo a se auto-propagar.

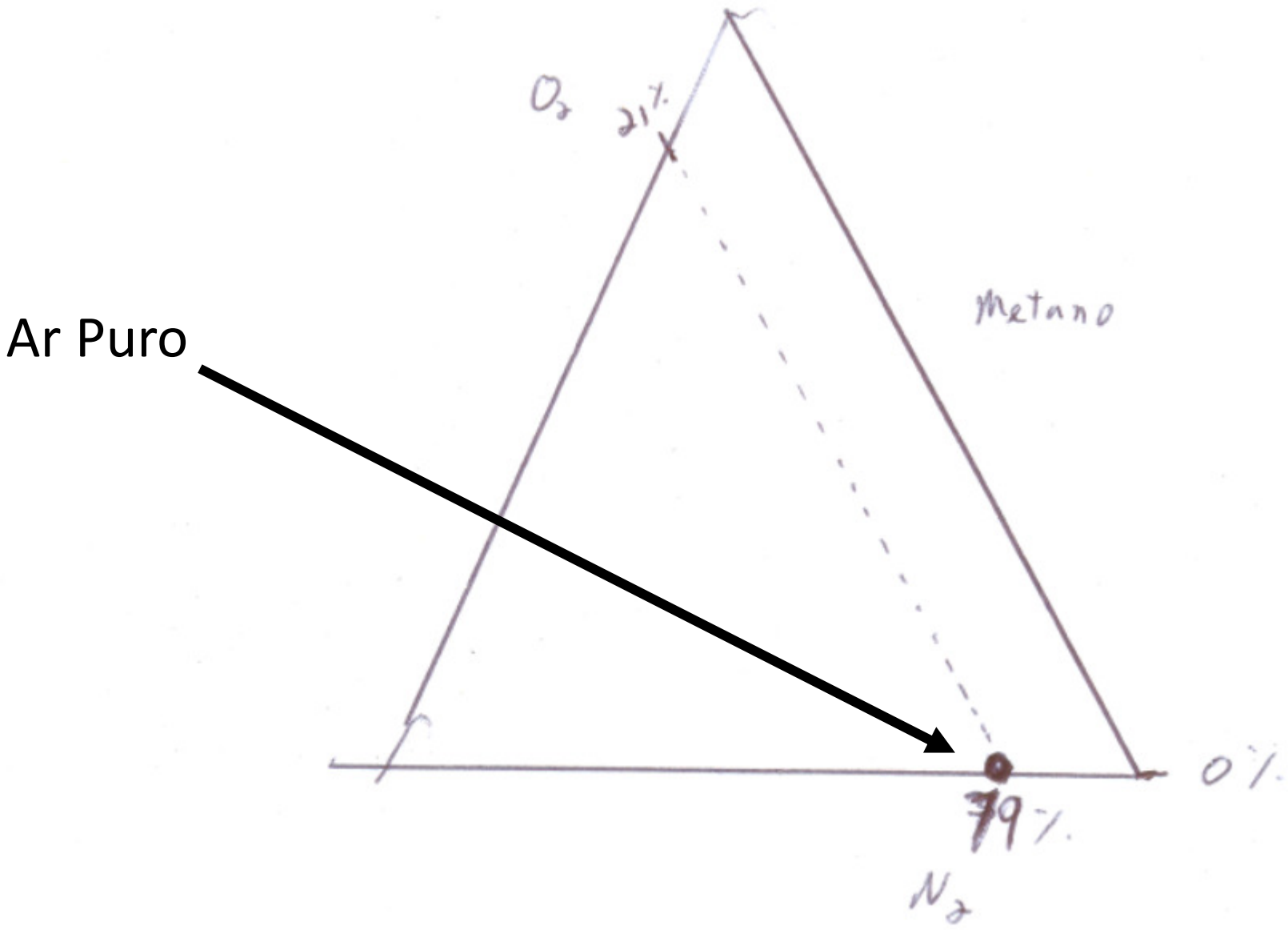
Também denominada MOC (minimum oxygen concentration) e MSOC (minimum safety oxygen concentration).

Table 6-2 Limiting Oxygen Concentrations (LOCs) (volume percent oxygen concentration above which combustion can occur)[1]

Gas or vapor	N_2/Air	CO_2/Air	Gas or vapor	N_2/Air	CO_2/Air
Methane	12	14.5	Kerosene	10 (150°C)	13 (150°C)
Ethane	11	13.5	JP-1 fuel	10.5 (150°C)	14 (150°C)
Propane	11.5	14.5	JP-3 fuel	12	14.5
n-Butane	12	14.5	JP-4 fuel	11.5	14.5
Isobutane	12	15	Natural gas	12	14.5
n-Pentane	12	14.5	*n*-Butyl chloride	14	–
Isopentane	12	14.5		12 (100°C)	–
n-Hexane	12	14.5	Methylene chloride	19 (30°C)	–
n-Heptane	11.5	14.5		17 (100°C)	–
Ethylene	10	11.5	Ethylene dichloride	13	–
Propylene	11.5	14		11.5 (100°C)	–
1-Butene	11.5	14	Methyl chloroform	14	–
Isobutylene	12	15	Trichloroethylene	9 (100°C)	–
Butadiene	10.5	13	Acetone	11.5	14
3-Methyl-1-butene	11.5	14	*t*-butanol	NA	16.5 (150°C)
Benzene	11.4	14	Carbon disulfide	5	7.5
Toluene	9.5	–	Carbon monoxide	5.5	5.5
Styrene	9.0	–	Ethanol	10.5	13
Ethylbenzene	9.0	–	2-Ethyl butanol	9.5 (150°C)	–
Vinyltoluene	9.0	–	Ethyl ether	10.5	13
Diethylbenzene	8.5	–	Hydrogen	5	5.2
Cyclopropane	11.5	14	Hydrogen sulfide	7.5	11.5
Gasoline			Isobutyl formate	12.5	15
(73/100)	12	15	Methanol	10	12
(100/130)	12	15	Methyl acetate	11	13.5
(115/145)	12	14.5			

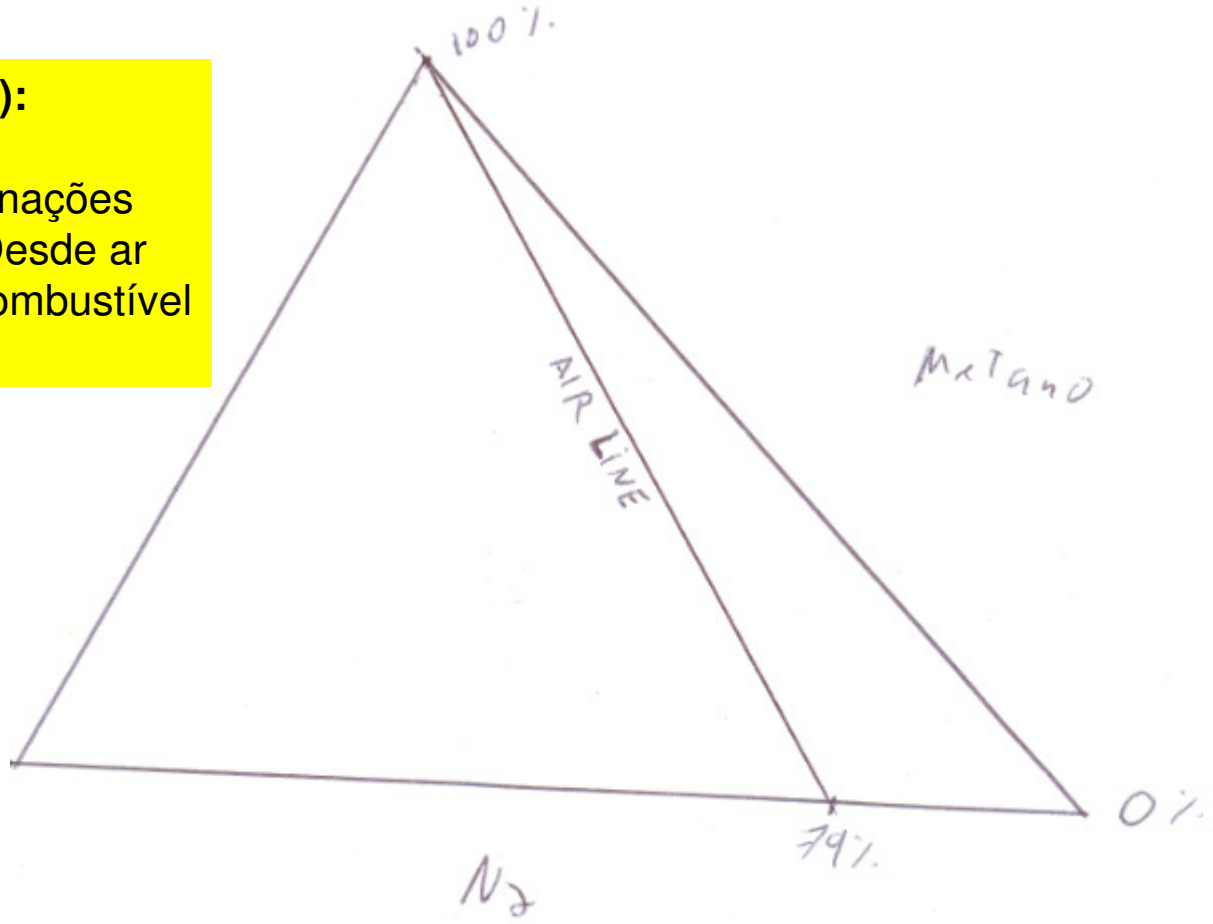
Diagrama de Inflamabilidade



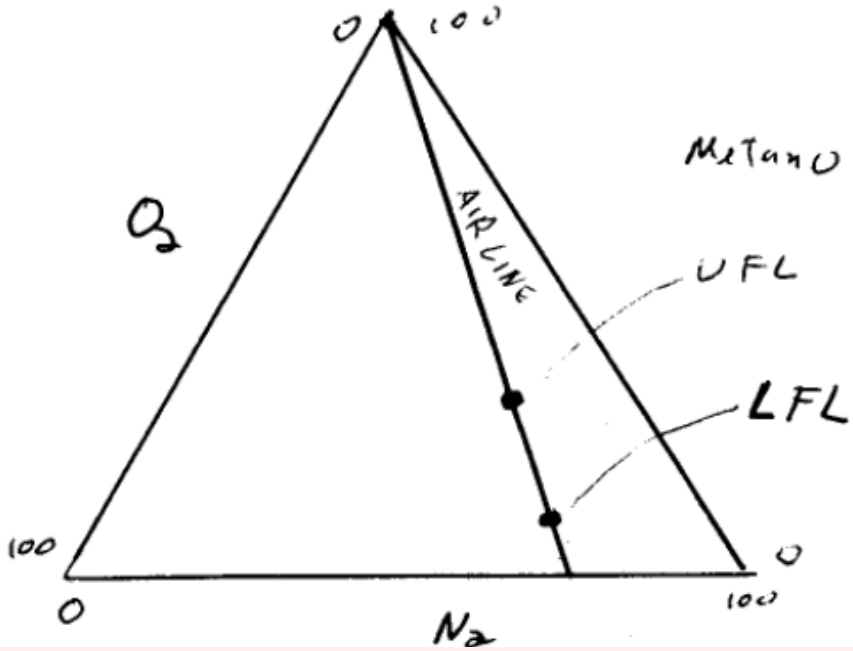

Ar Puro
O_2
21%
Metano
0%
79%
N_2

Linha do Ar (air line):

representa todas as combinações de **combustível mais ar**. Desde ar puro (sem combustível) até combustível puro.



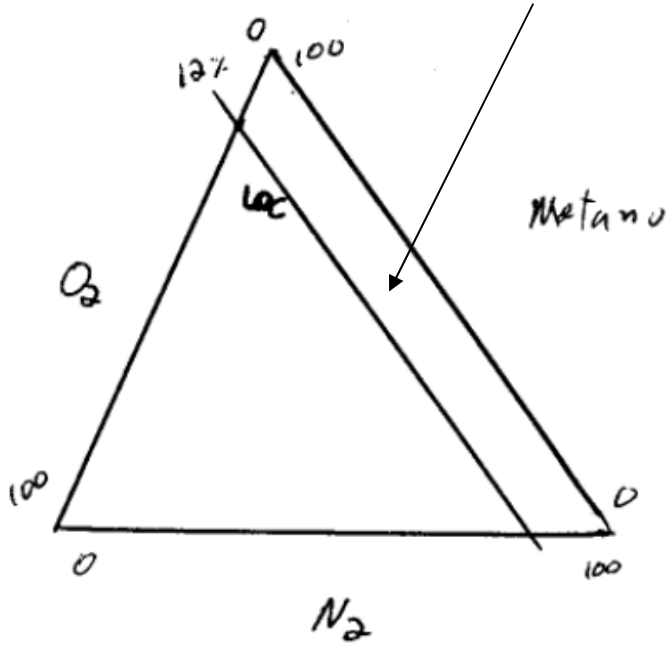
UFL e LFL:
São obtidos experimentalmente para mistura combustível / ar.
Logo, localizam-se sobre a linha de ar.



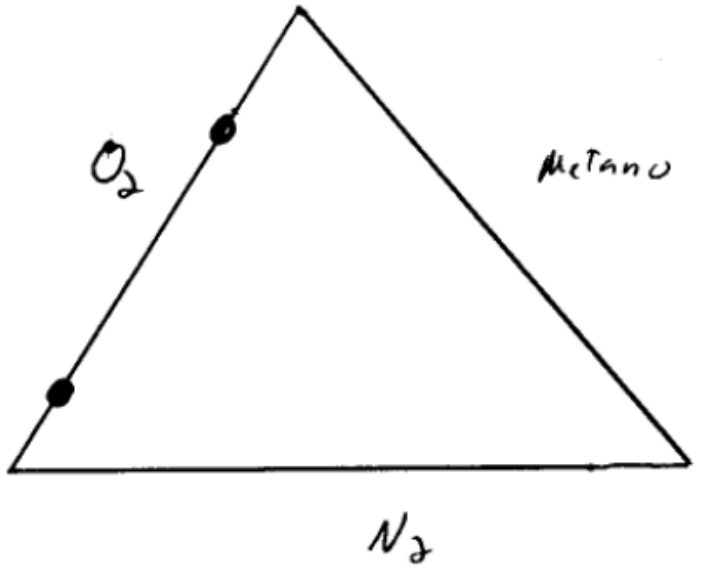
LOC:
É a concentração mínima de oxigênio no ar e na presença de um inerte.

É representada por uma reta de concentração de oxigênio constante.
No caso do inerte ser nitrogênio, e o combustível metano, LOC vale 12%.

Região com pouco oxigênio

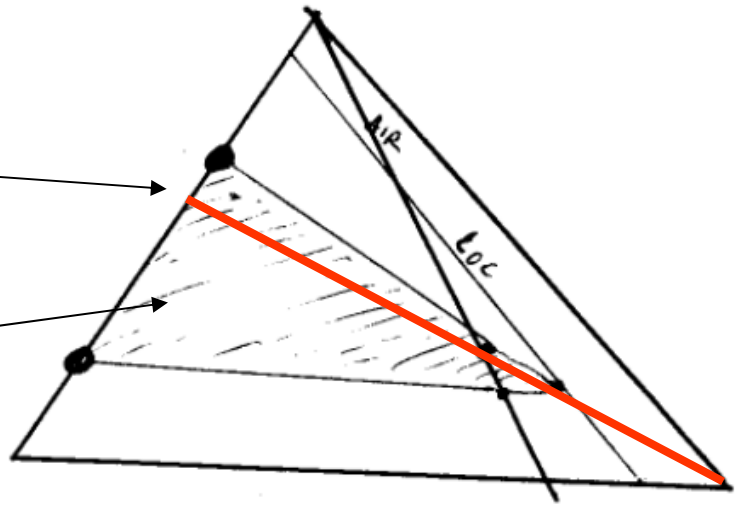


Limites superior e inferior de inflamabilidade do oxigênio puro.



Linha estequimétrica

Zona de Inflamabilidade



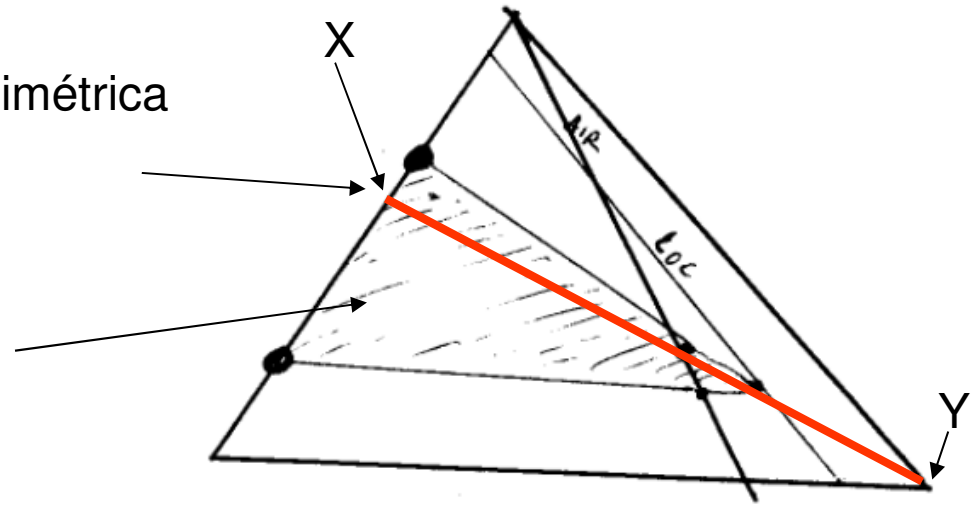
1 Combustível + z oxigênio → Produtos da Combustão

1 mol de combustível
z moles de oxigênio
0 mol de nitrogênio

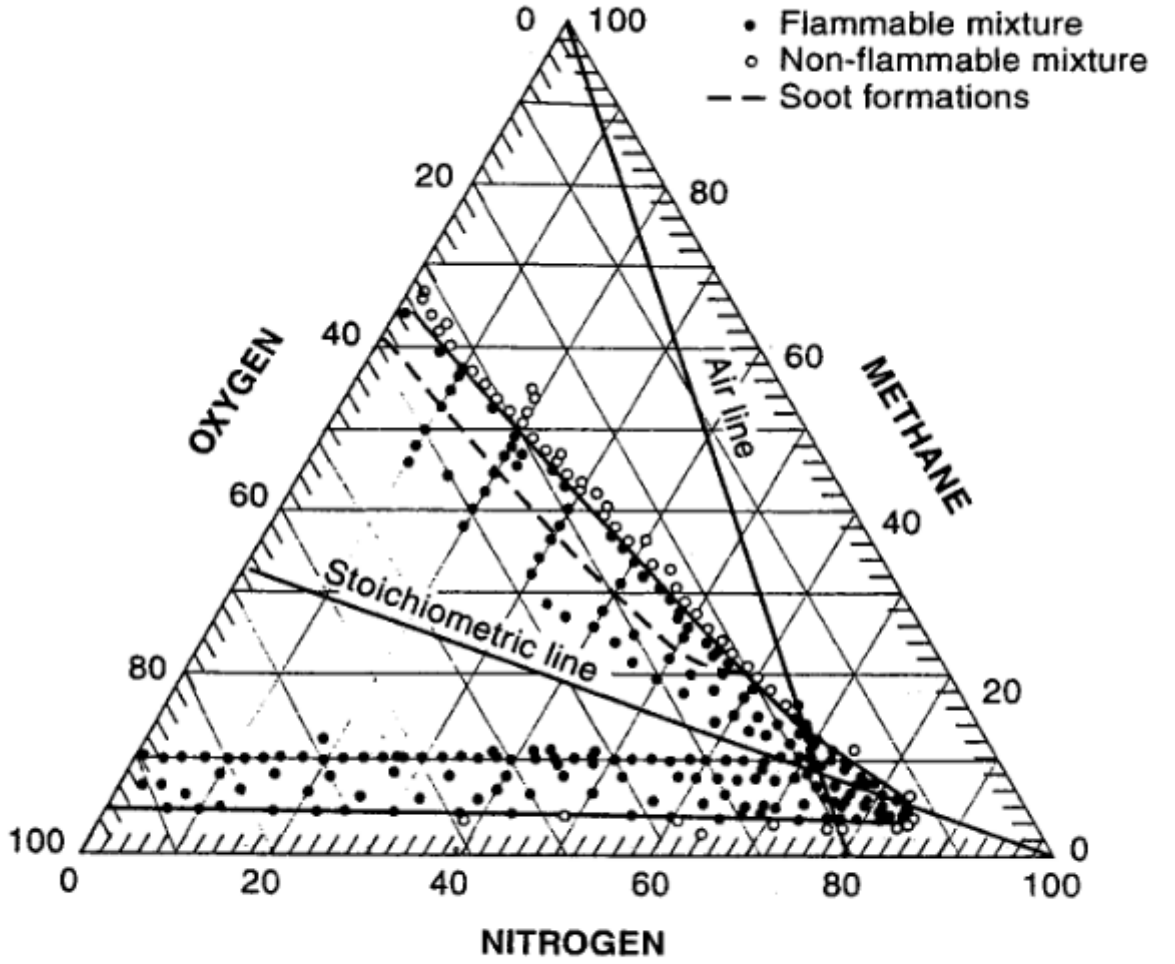
X = 100 (z / 1 + z)
Y = Nitrogênio puro

Linha estequimétrica

Zona de Inflamabilidade



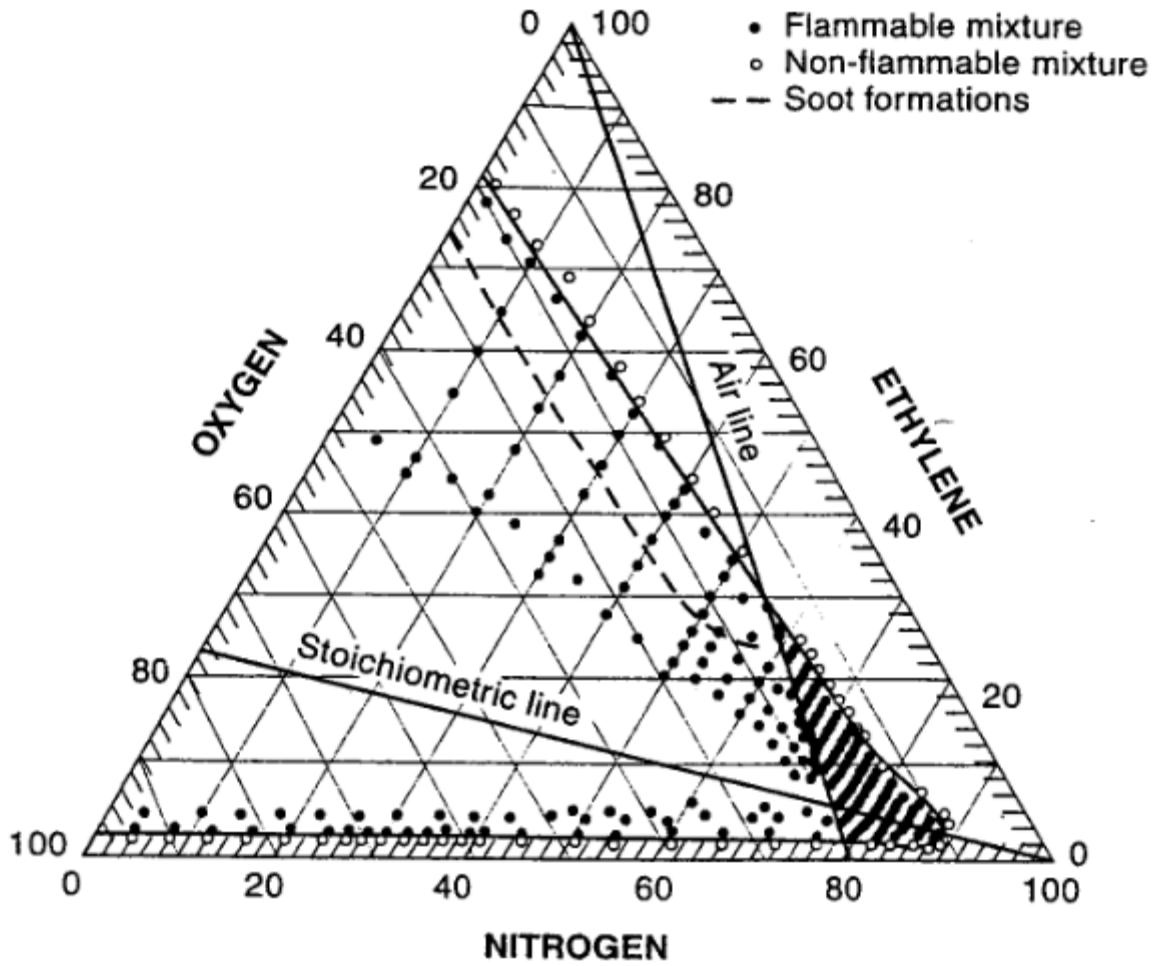
A zona de inflamabilidade varia de um composto para outro:



Experimental conditions

Initial pressure: 14.69 psia
Initial temperature: 25°C
Reactor volume: 20 liters

Ignitor type: 1 cm 40 AWG SnCu / 500VA
Ignitor energy: 10 J
Ignitor location: Center



Experimental conditions

Initial pressure: 14.69 psia
Initial temperature: 25°C
Reactor volume: 20 liters

Ignitor type: 1 cm 40 AWG SnCu / 500VA
Ignitor energy: 10 J
Ignitor location: Center