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Gas Detection

GAS BOOK 1


Honeywell

Introduction

A diverse variety of applications and processes increasingly involve the use and manufacture of highly dangerous substances, particularly flammable, toxic and Oxygen gases. Inevitably, occasional escapes of gas occur, which create a potential hazard to the industrial plants, their employees and people living nearby. Worldwide incidents, involving asphyxiation, explosions and loss of life, are a constant reminder of this problem.

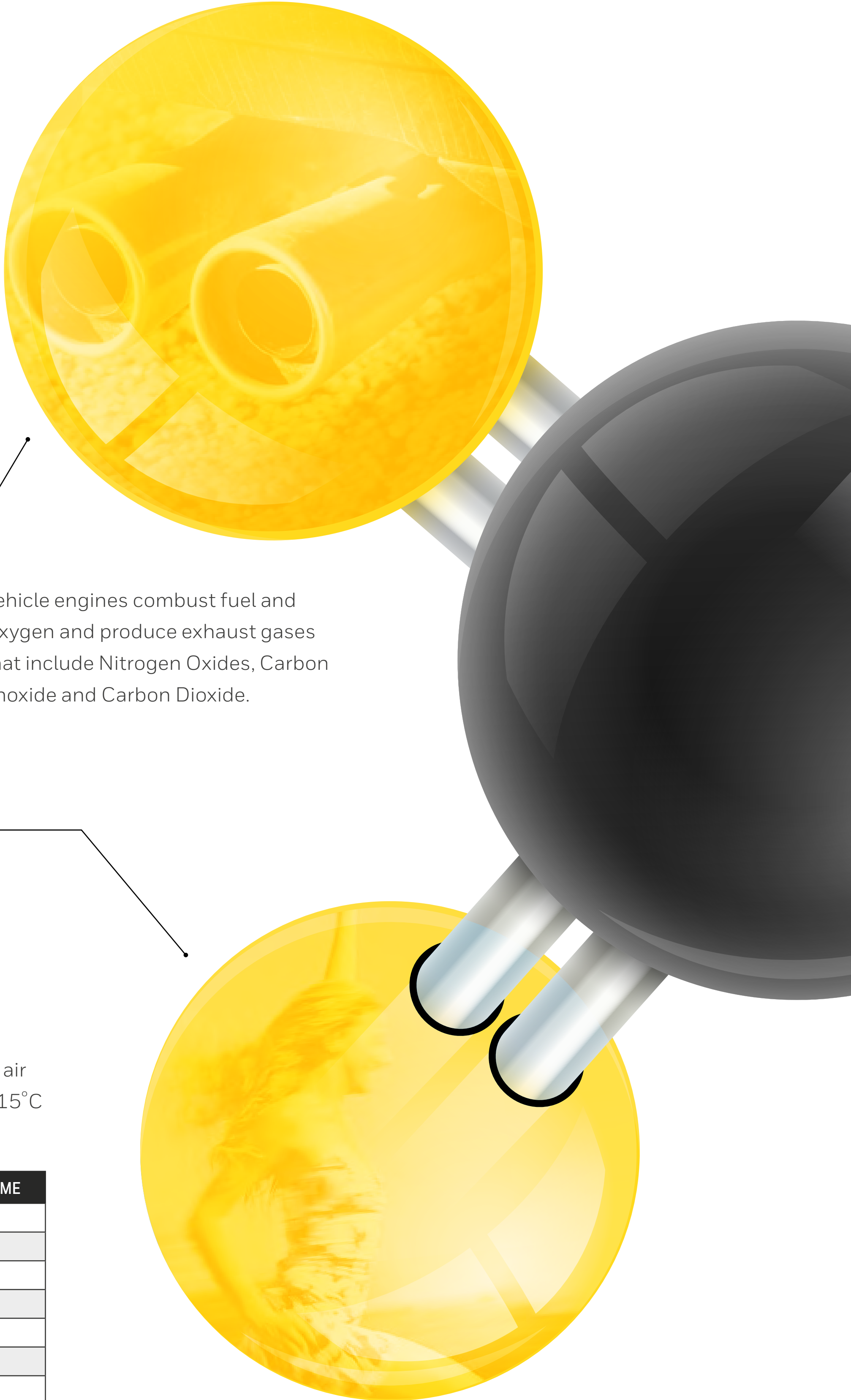
In most industries, one of the key parts of any safety plan for reducing risks to personnel and plant is the use of early warning devices such as gas detectors. These can help to provide more time in which to take remedial or protective action. They can also be used as part of a total, integrated monitoring and safety system which may include various other safety aspects including fire detection and emergency process shutdown.

Gas detection can be divided into two overriding categories; fixed gas detection and portable gas detection. As the name might suggest, fixed gas detection represents a static type of detection system for flammable, toxic and Oxygen gas hazards and is designed to monitor processes, and protect plant and assets as well as personnel on-site. Portable gas detection is designed specifically to protect personnel from the threat of flammable, toxic or Oxygen gas hazards and is typically a small device worn by an operator to monitor the breathing zone.

Many sites incorporate a mix of both fixed and portable gas detection as part of their safety philosophy, but the suitability of which type to use will depend on several factors, including how often the area is accessed by personnel.

What is Gas?

The name gas comes from the word chaos. Gas is a swarm of molecules moving randomly and chaotically, constantly colliding with each other and anything else around them. Gases fill any available volume and due to the very high speed at which they move will mix rapidly into any atmosphere in which they are released.



Vehicle engines combust fuel and Oxygen and produce exhaust gases that include Nitrogen Oxides, Carbon onoxide and Carbon Dioxide.

Different gases are all around us in everyday life. The air we breathe is made up of several different gases including Oxygen and Nitrogen.

Air Composition

The table gives the sea-level composition of air (in percent by volume at the temperature of 15°C and the pressure of 101325 Pa).

NAME	SYMBOL	PERCENT BY VOLUME
NITROGEN	N_2	78.084%
OXYGEN	O_2	20.9476%
ARGON	Ar	0.934%
CARBON DIOXIDE	CO_2	0.0314%
NEON	Ne	0.001818%
METHANE	CH_4	0.0002%
HELIUM	He	0.000524%
KRYPTON	Kr	0.000114%
HYDROGEN	H_2	0.00005%
XENON	Xe	0.0000087%

Gases can be lighter, heavier or about the same density as air. Gases can have an odour or be odourless. Gases can have colour or be colourless. If you can't see it, smell it or touch it, it doesn't mean that it is not there.

Natural Gas (Methane) is used in many homes for heating and cooking.

Gas Hazards

There are three main types of gas hazard:

Toxic

Risk of Poisoning

e.g. Carbon Monoxide, Hydrogen, Chlorine

Asphyxiant

Risk of suffocation

e.g. Oxygen deficiency. Oxygen can beconsumed or displaced by another gas

Flammable

Risk of fire and/or explosion

e.g. Methane, Butane, Propane

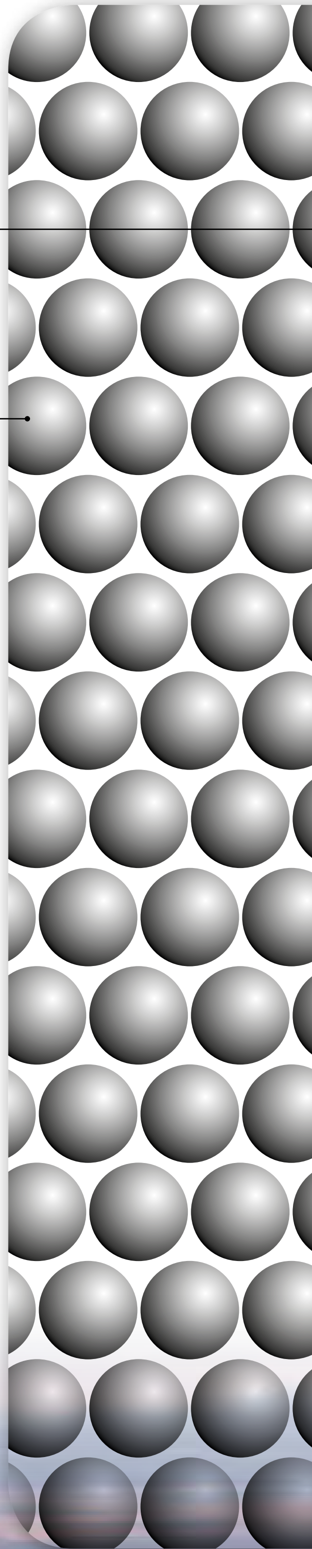
Toxic Gas Hazards

Some gases are poisonous and can be dangerous to life at very low concentrations. Some toxic gases have strong smells like the distinctive 'rotten eggs' smell of Hydrogen Sulphide (H_2S). The measurements most often used for the concentration of toxic gases are parts per million (ppm) and parts per billion (ppb). For example 1ppm would be equivalent to a room filled with a total of 1 million balls and 1 of those balls being red.

The red ball would represent 1ppm

1 million balls

1 red ball
100%V/V = 1,000,000ppm
1%V/V = 10,000ppm



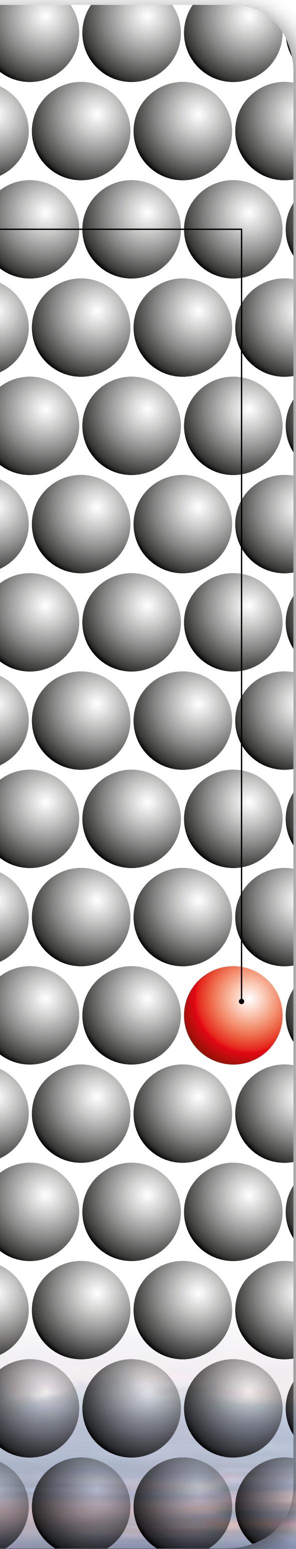
Example

100%LEL Ammonia = 15%V/V
50%LEL Ammonia = 7.5%V/V
50%LEL Ammonia = 75,000ppm

More people die from toxic gas exposure than from explosions caused by the ignition of flammable gas. (It should be noted that there is a large group of gases which are both combustible and toxic, so that even detectors of toxic gases sometimes have to carry hazardous area approval). The main reason for treating flammable and toxic gases separately is that the hazards and regulations involved and the types of sensor required are different.

With toxic substances, apart from the obvious environmental problems, the main concern is the effect on workers of exposure to even very low concentrations, which could be inhaled, ingested, or absorbed through the skin. Since adverse effects can often result from additive, long-term exposure, it is important not only to measure the concentration of gas, but also the total time of exposure. There are even some known cases of synergism, where substances can interact and produce a far worse effect when combined than the separate effect of each on its own.

Concern about concentrations of toxic substances in the workplace focus on both organic and inorganic compounds, including the effects they could have on the health and safety of employees, the possible contamination of a manufactured end-product (or equipment used in its manufacture) and also the subsequent disruption of normal working activities.



Workplace Exposure Limits

The term 'workplace exposure limits' or 'occupational hazard monitoring' is generally used to cover the area of industrial health monitoring associated with the exposure of employees to hazardous conditions of gases, dust, noise etc. In other words, the aim is to ensure that levels in the workplace are below the statutory limits.

This subject covers both area surveys (profiling of potential exposures) and personal monitoring, where instruments are worn by a worker and sampling is carried out as near to the breathing zone as possible. This ensures that the measured level of contamination is truly representative of that inhaled by the worker.

It should be emphasised that both personal monitoring and monitoring of the workplace should be considered as important parts of an overall, integrated safety plan. They are only intended to provide the necessary information about conditions as they exist in the atmosphere. This then allows the necessary action to be taken to comply with the relevant industrial regulations and safety requirements.

Whatever method is decided upon, it is important to take into account the nature of the toxicity of any of the gases involved.
For instance, any instrument which measures only a time-weighted average, or an instrument which draws a sample for subsequent laboratory analysis, would not protect a worker against a short exposure to a lethal dose of a highly toxic substance.

On the other hand, it may be quite normal to briefly exceed the average, Long-Term Exposure Limit (LTEL) levels in some areas of a plant, and it need not be indicated as an alarm situation. Therefore, the optimum instrument system should be capable of monitoring both short and long-term exposure levels as well as instantaneous alarm levels.

Toxic Gases Data

The toxic gases listed below can be detected using equipment supplied by Honeywell Gas Detection. Gas data is supplied where known. As product development is ongoing, contact Honeywell if the gas you require is not listed. Data may change by country and date, always refer to local up-to-date regulations.

The GESTIS Substance Database, maintained by the Institut für Arbeitsschutz der Deutschen Gesetzlichen Unfallversicherung (IFA, Institute for Occupational Safety and Health of the German Social Accident Insurance) limitvalue.ifa.dguv.de

			European Union				OSHA Permissible Exposure Limits (PEL)	
			Long-Term Exposure Limit (8-hour TWA reference period)		Short-Term Exposure Limit (15-minute reference period)		Long-term Exposure Limit (8-hour TWA reference period)	
COMMON NAME	**CAS NUMBER**	**FORMULA**	**PPM**	**MG/M3**	**PPM**	**MG/M3**	**PPM**	**MG/M3**
Ammonia	7664-41-7	NH_3	20	14	50	36	50	35
Arsine	7784-42-1	AsH_3					0.05	0.2
Boron Trifluoride	7637-07-2	BF_3					1	3
Bromine	7726-95-6	Br_2	0.1	0.7			0.1	0.7
Carbon Monoxide	630-08-0	CO	20	23	100	117	50	55
Chlorine	7782-50-5	Cl_2			0.5	1.5	1	3
Chlorine Dioxide	10049-04-4	ClO_2					0.1	0.3
1,4 Cyclohexane diisocyanate		CHDI						
Diborane	19287-45-7	B_2H_6					0.1	0.1
Dichlorosilane (DCS)	4109-96-0	H_2Cl_2Si						
Dimethyl Amine (DMA)	124-40-3	C_2H_7N	2	3.8	5	9.4	10	18
Dimethyl Hydrazine (UDMH)	57-14-7	$C_2H_8N_2$					0.5	1
Disilane	1590-87-0	Si_2H_6						
Ethylene Oxide	75-21-8	C_2H_4O					1	
Fluorine	7782-41-4	F_2	1	1.58	2	3.16	0.1	0.2
Germane	7782-65-2	GeH4						
Hexamethylene Diisocyanate (HDI)	822-06-0	$C_8H_{12}N_2O_2$						
Hydrazine	302-01-2	N_2H_4					1	1.3
Hydrogen	1333-74-0	H_2						
Hydrogen Bromide	10035-10-6	HBr			2	6.7	3	10
Hydrogen Chloride	7647-01-0	HCl	5	8	10	15		
Hydrogen Cyanide	74-90-8	HCN	0.9	1	4.5	5	10	11
Hydrogen Fluoride	7664-39-3	HF	1.8	1.5	3	2.5	3	2.5
Hydrogen Iodide	10034-85-2	HI						
Hydrogen Peroxide	7722-84-1	H_2O_2					1	1.4
Hydrogen Selenide	7783-07-5	H_2Se	0.02	0.07	0.05	0.17	0.05	0.2
Hydrogen Sulphide	7783-06-4	H_2S	5	7	10	14	4	
Hydrogenated Methylene Bisphenyl Isocyanate (HMDI)								
Isocyanatoethyl Methacrylate (IEM)		$C_7H_9NO_3$						
Isophorone Diisocyanate (IPDI)		$C_{12}H_{18}N_2O_2$						
Methyl Fluoride (R41)	593-53-3	CH_3F						

			European Union				OSHA Permissible Exposure Limits (PEL)	
			Long-Term Exposure Limit (8-hour TWA reference period)		Short-Term Exposure Limit (15-minute reference period)		Long-term Exposure Limit (8-hour TWA reference period)	
COMMON NAME	CAS NUMBER	FORMULA	PPM	MG/M3	PPM	MG/M3	PPM	MG/M3
Methylene Bisphenyl Isocyanate (MDI)	101-68-8	$C_{15}H_{10}N_2O_2$						
Methylene Bisphenyl Isocyanate -2 (MDI-2)	101-68-8	$C_{15}H_{10}N_2O_2$						
Methylenedianiline (MDA)	101-77-9	$C_{13}H_{14}N_2$					0.01	
Monomethyl Hydrazine (MMH)	60-34-4	CH_6N_2						
Naphthalene Diisocyanate (NDI)	3173-72-6	$C_{12}H_6N_2O_2$						
Nitric Acid	7697-37-2	HNO_3			1	2.6	2	5
Nitric Oxide	10102-43-9	NO	2	2.5			25	30
Nitrogen Dioxide	10102-44-0	NO_2	0.5	0.96	1	1.91		
Nitrogen Trifluoride	7783-54-2	NF_3					10	29
n-Butyl Amine (N-BA)	109-73-9	$C_4H_{11}N$						
Ozone	10028-15-6	O_3					0.1	0.2
Phosgene	75-44-5	$COCl_2$	0.02	0.08	0.1	0.4	0.1	0.4
Phosphine	7803-51-2	PH_3	0.1	0.14	0.2	0.28	0.3	0.4
Propylene Oxide	75-56-9	C_3H_6O					100	240
p-Phenylene Diamine (PPD)	106-50-3	$C_6H_8N_2$						0.1
p-Phenylene Diisocyanate (PPDI)	104-49-4	$C_8H_4N_2O_2$						
Silane	7803-62-5	SiH_4						
Stibine	7803-52-3	SbH_3					0.1	0.5
Sulphur Dioxide	7446-09-5	SO_2	0.5	1.3	1	2.7	5	13
Sulphuric Acid	7664-93-9	H_2SO_4						1
Tertiary Butyl Arsine (TBA)								
Tertiary Butyl Phosphine (TBP)	2501-94-2	$C_4H_{11}P$						
Tetraethyl Orthosilicate (TEOS)	78-10-4	$C_8H_{20}O_4Si$	5	44			100	850
Tetrakis (Dimethylamino) Titanium (TDMAT)	3275-24-9	$C_8H_{24}N_4Ti$						
Tetramethyl Xylene Diisocyanate (TMXDI)		$C_{14}H_{16}N_2O_2$						
Toluene Diamine (TDA)	95-80-7	$C_7H_{10}N_2$						
Toluene Diisocyanate (TDI)	584-84-9	$C_9H_6N_2O_2$						
Triethyl Amine (TEA)	121-44-8	$C_6H_{15}N$	2	8.4	3	12.6	25	100
Trimethylhexamethylene Diisocyanate (TMDI)		$C_{11}H_{18}N_2O_2$						
Unsymmetrical Dimethylhydrazine (UDMH)	57-14-7	$C_2H_8N_2$					0.5	1

Toxic Exposure Limits

European Occupational Exposure Limits

Occupational Exposure Limit values (OELs) are set by competent national authorities or other relevant national institutions as limits for concentrations of hazardous compounds in workplace air. OELs for hazardous substances represent an important tool for risk assessment and management and valuable information for occupational safety and health activities concerning hazardous substances.

Occupational Exposure Limits can apply both to marketed products and to waste and by-products from production processes. The limits protect workers against health effects, but do not address safety issues such as explosive risk.

As limits frequently change and can vary by country, you should consult your relevant national authorities to ensure that you have the latest information.

Occupational Exposure Limits in Europe function under the European Union Directive 98/24/EC - risks related to chemical agents at work. Its objective is to lay down minimum requirements for the protection of workers from risks to their safety and health arising, or likely to arise, from the effects of chemical agents that are present at the workplace or as a result of any work activity involving chemical agents.

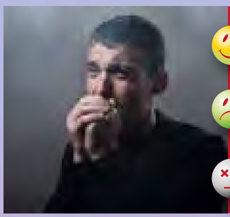
The Directive enforces the maximum occupational exposure limits for various chemicals. National regulations for individual countries may be tighter, but they cannot exceed the level stipulated by the European Union.

Occupational Exposure Limits are a combination of concentration of a chemical and length of time of exposure to the chemical.

The maximum admissible or accepted concentration varies from substance to substance according to its toxicity. The exposure times are averaged for eight hours (8-hour Time-Weighted Average TWA) and 15 minutes (Short-Term Exposure Limit STEL). For some substances, a brief exposure is considered so critical that they are set only a STEL, which should not be exceeded even for a shorter time.

Carcinogenicity, reproduction toxicity, irritation and sensitisation potential as well as the potency to penetrate through skin are considered when preparing a proposal for an OEL according to the present scientific knowledge.

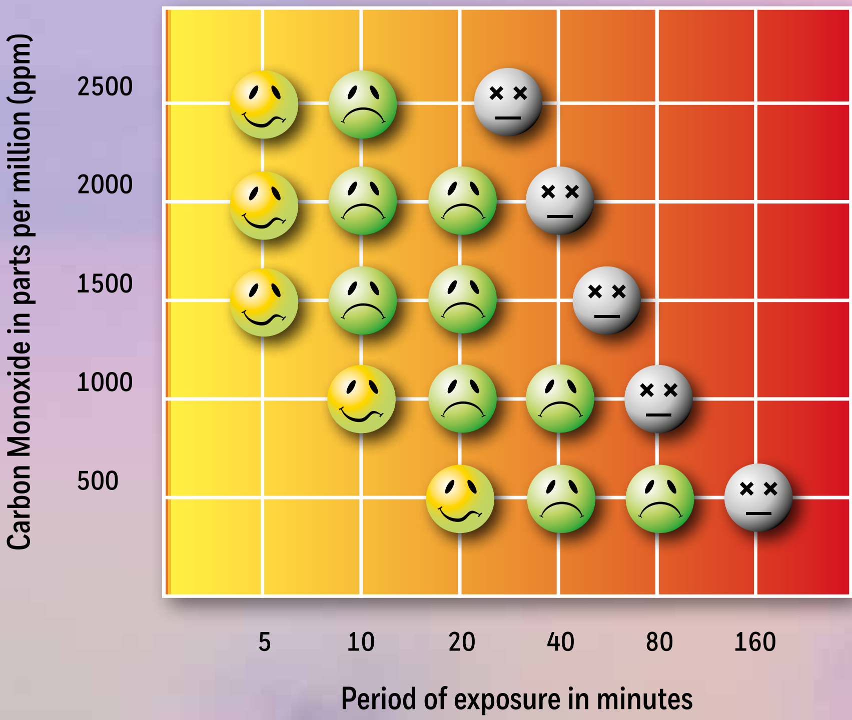
Effects of exposure to Carbon Monoxide



= Noticeable symtoms / start to feel unwell

= Feeling ill

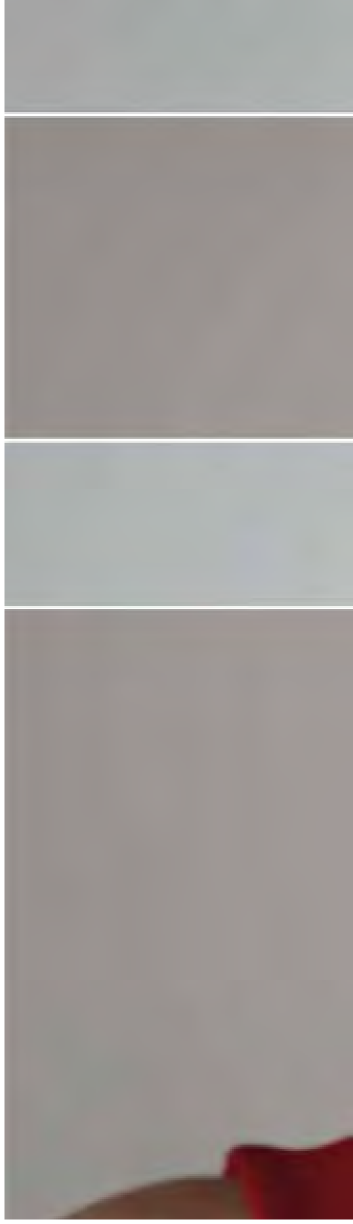
= Death



GAS FACT

Hydrogen is the lightest, most abundant and explosive gas on Earth.

US Occupational Exposure Limits



The Occupational Safety systems in the United States vary from state to state. Here, information is given on 3 major providers of the Occupational Exposure Limits in the USA - ACGIH, OSHA, and NIOSH. The American Conference of Governmental Industrial Hygienists (ACGIH) publishes Maximum Allowable Concentrations (MAC), which were later renamed to "Threshold Limit Values" (TLVs).

Threshold Limit Values are defined as an exposure limit "to which it is believed nearly all workers can be exposed day after day for a working lifetime without ill effect". The ACGIH is a professional organisation of occupational hygienists from universities or governmental institutions. Occupational hygienists from private industry can join as associate members. Once a year, the different committees propose new threshold limits or best working practice guides. The list of TLVs includes more than 700 chemical substances and physical agents, as well as dozens of Biological Exposure Indices for selected chemicals.

The ACGIH defines different TLV-Types as:

Threshold Limit Value – Time-Weighted Average (TLV-TWA):
The Time-Weighted Average concentration for a conventional 8-hour workday and a 40-hour workweek, to which it is believed that nearly all workers may be repeatedly exposed, day after day, without adverse effect.

Threshold Limit Value – Short-Term Exposure Limit (TLV-STEL):
the concentration to which it is believed that workers can be exposed continuously for a short period of time without suffering from irritation, chronic or irreversible tissue damage, or narcosis. STEL is defined as a 15-minute TWA exposure, which should not be exceeded at any time during a workday.

Threshold Limit Value – Ceiling (TLV-C):
the concentration that should not be exceeded during any part of the working exposure. There is a general excursion limit recommendation that applies to those TLV-TWAs that do not have STELs. Excursions in worker exposure levels may exceed 3 times the TLV-TWA for no more than a total of 30 minutes during a workday and under no workday and under no circumstances should they exceed 5 times the TLV-TWA, provided that the TLV-TWA is not exceeded.

ACGIH-TLVs do not have a legal force in the USA, they are only recommendations. OSHA defines regulatory limits. However, ACGIH-TLVs and the criteria documents are a very common base for setting TLVs in the USA and in many other countries. ACGIH exposure limits are in many cases more protective than OSHA's. Many US companies use the current ACGIH levels or other internal and more protective limits.

The Occupational Safety and Health Administration (OSHA) of the US Department of Labor publishes Permissible Exposure Limits (PEL). PELs are regulatory limits on the amount or concentration of a substance in the air and they are enforceable. The initial set of limits from 1971 was based on the ACGIH TLVs. OSHA currently has around 500 PELs for

various forms of approximately 300 chemical substances, many of which are widely used in industrial settings. Existing PELs are contained in a document called "29 CFR 1910.1000", the air contaminants standard. OSHA uses in a similar way as the ACGIH the following types of OELs: TWAs, Action Levels, Ceiling Limits, STELs, Excursion Limits and in some cases Biological Exposure Indices (BEIs).

The National Institute for Occupational Safety and Health (NIOSH) has the statutory responsibility for recommending exposure levels that are protective to workers. NIOSH has identified Recommended Exposure Levels (RELs) for around 700 hazardous substances. These limits have no legal force. NIOSH recommends their limits via criteria documents to OSHA and other OEL setting institutions. Types of RELs are TWA, STEL, Ceiling and BEIs.

The recommendations and the criteria are published in several different document types, such as Current Intelligent Bulletins (CIB), Alerts, Special Hazard Reviews, Occupational Hazard Assessments and Technical Guidelines.

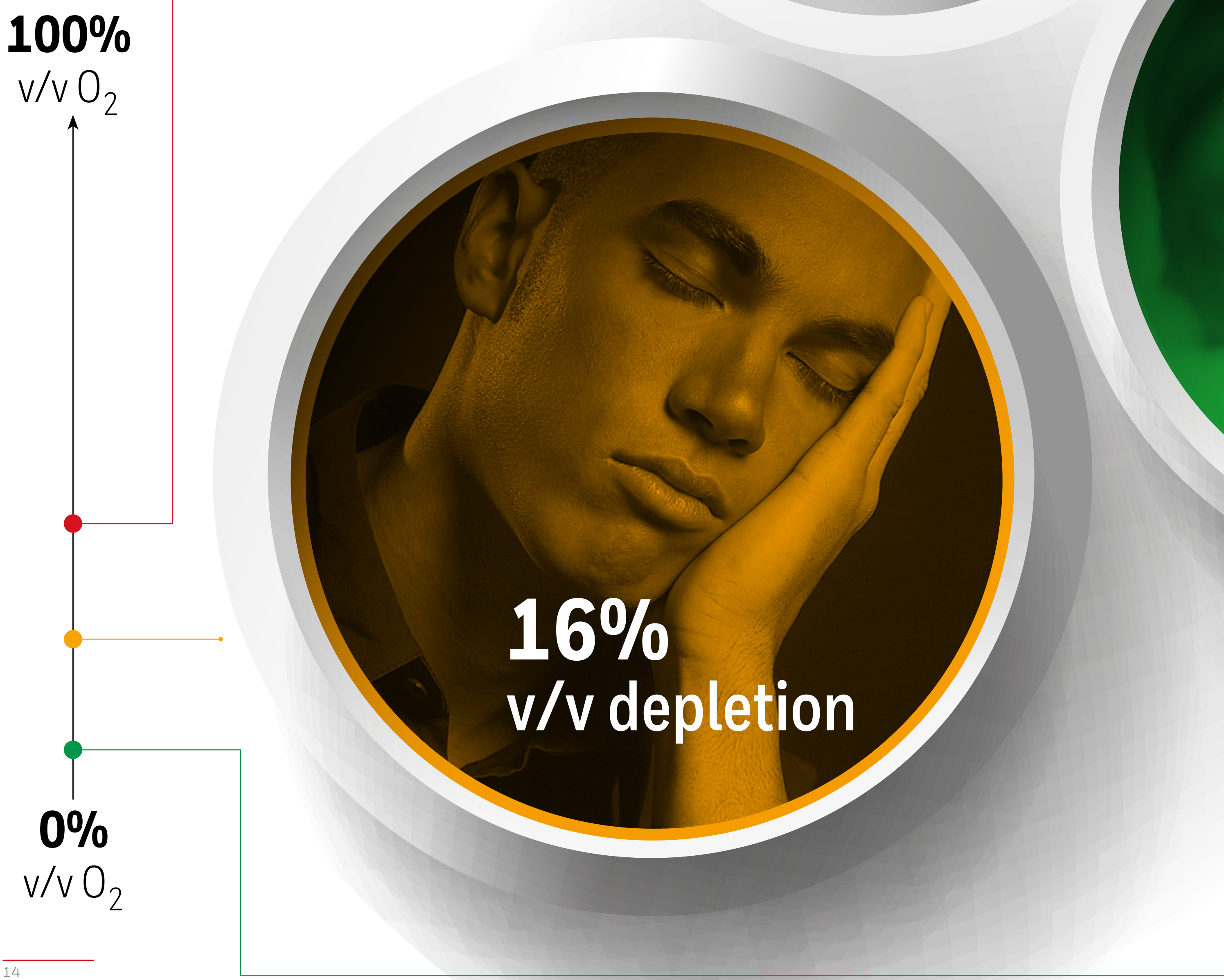
Occupational Exposure Limits Comparison Table

ACGIM	OSHA	NIOSH	MEANING
THRESHOLD LIMIT VALUES (TLVS)	PERMISSIBLE EXPOSURE LIMITS (PELS)	RECOMMENDED EXPOSURE LEVELS (RELS)	LIMIT DEFINITION
TLV-TWA	TWA	TWA	Long-term Exposure Limit (8hr-TWA reference period)
TLV-STEL	STEL	STEL	Short-Term Exposure Limit (15-minute exposure period)
TLV-C	Ceiling	Ceiling	The concentration that should not be exceeded during any part of the working exposure
EXCURSION LIMIT	Excursion Limit	–	Limit if no STEL stated
–	BEIs	BEIs	Biological Exposure Indicies

Asphyxiant Hazard

(Oxygen Deficiency)

We all need to breathe the Oxygen (O_2) in air to live. Air is made up of several different gases including Oxygen. Normal ambient air contains an Oxygen concentration of 20.9% v/v. When the Oxygen level falls below 19.5% v/v, the air is considered Oxygen-deficient. Oxygen concentrations below 16% v/v are considered unsafe for humans.



Oxygen Enrichment

It is often forgotten that Oxygen enrichment can also cause a risk. At increased O2 levels the flammability of materials and gases increases. At levels of 24% items such as clothing can spontaneously combust.

Oxyacetylene welding equipment combines Oxygen and Acetylene gas to produce an extremely high temperature. Other areas where hazards may arise from Oxygen enriched atmospheres include manufacturing areas for storing rocket propulsion systems, products used for bleaching in the pulp and paper industry and clean water treatment facilities.

Sensors have to be specially certified for use in O_2 enriched atmospheres.

GAS FACT

The atomic weight of Radon is 222 atomic mass units making it the heaviest known gas. It is 220 times heavier than the lightest gas, Hydrogen.

Flammable Gas Hazards

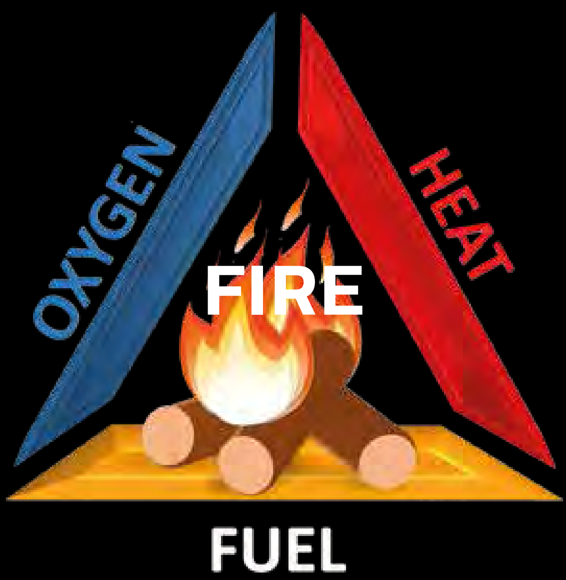
Combustion is a fairly simple chemical reaction in which Oxygen is combined rapidly with another substance resulting in the release of energy. This energy appears mainly as heat sometimes in the form of flames.

The igniting substance is normally, but not always, a Hydrocarbon compound and can be solid, liquid, vapour or gas. However, only gases and vapours are considered in this publication.

The Fire Triangle

The process of combustion can be represented by the well known fire triangle.

Three factors are always needed to cause combustion:



1. A source of ignition
2. Oxygen
3. Fuel in the form of a gas or vapour

In any fire protection system, therefore, the aim is to always remove at least one of these three potentially hazardous items.

Flammable Limit

GAS FACT

High levels of O_2 increase the flammability of materials and gases – at levels such as 24%, items such as clothing can spontaneously combust!

There is only a limited band of gas/air concentration which will produce a combustible mixture. This band is specific for each gas and vapour and is bounded by an upper level, known as the Upper Explosive Limit (or the UEL) and a lower level, called the Lower Explosive Limit (LEL).

Limits of Flammability

100% v/v gas 0% v/v air

TOO RICH

UEL (upper explosive limit)

FLAMMABLE RANGE

LEL (lower explosive limit)

TOO LEAN

0% v/v gas 100% v/v air

At levels below the LEL, there is insufficient gas to produce an explosion i.e. the mixture is too 'lean', whilst above the UEL, the mixture has insufficient Oxygen i.e. the mixture is too 'rich'. The flammable range therefore falls between the limits of the LEL and UEL for each individual gas or mixture of gases. Outside these limits, the mixture is not capable of combustion. The Flammable Gases Data on page 20-21 indicates the limiting values for some of the better-known combustible gases and compounds. The data is given for gases and vapours at normal conditions of pressure and temperature.

An increase in pressure, temperature or Oxygen content will generally broaden the flammability range.

In the average industrial plant, there would normally be no gases leaking into the surrounding area or, at worst, only a low background level of gas present. Therefore the detecting and early warning system will only be required to detect levels from 0% of gas up to the lower explosive limit. By the time this concentration is reached, shut-down procedures or site clearance should have been put into operation. In fact this will typically take place at a concentration of less than 50% of the LEL value, so that an adequate safety margin is provided.

However, it should always be remembered that in enclosed or unventilated areas, a concentration in excess of the UEL can sometimes occur. At times of inspection, special care needs to be taken when operating hatches or doors, since the ingress of air from outside can dilute the gases to a hazardous, combustible mixture.

(N.B LEL/LFL and UEL/UFL are, for the purpose of this publication, interchangeable).

Flammable Gas Properties

Ignition Temperature

Flammable gases also have a temperature where ignition will take place, even without an external ignition source such as a spark or flame. This temperature is called the Ignition Temperature. Apparatus for use in a hazardous area must not have a surface temperature that exceeds the Ignition Temperature. Apparatus is therefore marked with a maximum surface temperature or T rating.

Flash Point (F.P. °C)

The flash point of a flammable liquid is the lowest temperature at which the surface of the liquid emits sufficient vapour to be ignited by a small flame. Do not confuse this with Ignition Temperature as the two can be very different:

GAS / VAPOUR	FLASH POINT °C	IGNITION TEMP. °C
METHANE	<-188	595
KEROSENE	38	210
BITUMEN	270	310

To convert a Celsius temperature into Fahrenheit: Tf = ((9/5)*Tc)+32 E.g. to convert -20 Celsius into Fahrenheit, first multiply the Celsius temperature reading by nine-fifths to get -36. Then add 32 to get -4°F.

Vapour Density

Vapour density is a measure of how "heavy" a gas or vapour is, and can be used to help determine sensor placement.
The density of a gas or vapour is compared with air.

When air = 1.0:

A substance with a vapour density < 1.0 will rise

A substance with a vapour density > 1.0 will fall

GAS / VAPOUR	VAPOUR DENSITY
METHANE	0.55
CARBON MONOXIDE	0.97
HYDROGEN SULPHIDE	1.45
PETROL VAPOUR	3.0 approx

GAS FACT

It's not just gas that holds a potential threat - dust can also be explosive! Examples of explosive dusts include polystyrene, cornstarch and iron.

Flammable Gases Data

References: BS EN 60079-20-1 (supersedes 61779) Electrical apparatus for the detection and measurement of flammable gases-Part 1: General requirements and test methods. NIST Chemistry Web Book June 2005 release. Aldrich Handbook of Fine Chemicals and Laboratory Equipment 2003-2004.

Data may change by country and date, always refer to local up-to-date regulations.

Please note: Where "gas" is stated under Flash Point (F.P. C°), the compound is always in a gaseous state and therefore does not have a FP.

							FLAMMABLE LIMITS				
COMMON NAME	CAS NUMBER	FORMULA	MOLECULAR WEIGHT	BOILING POINT °C	RELATIVE VAPOURISATION DENSITY	F.P. °C	LFL % V/V	UFL % V/V	LFL MG/L	UFL MG/L	I.T. °C
Acetaldehyde	75-07-0	CH_3CHO	44.05	20	1.52	−38	4.00	60.00	74	1,108	204
Acetic acid	64-19-7	CH_3COOH	60.05	118	2.07	40	4.00	17.00	100	428	464
Acetic anhydride	108-24-7	$(CH_3CO)_2O$	102.09	140	3.52	49	2.00	10.30	85	428	334
Acetone	67-64-1	$(CH_3)_2CO$	58.08	56	2.00	<−20	2.50	13.00	80	316	535
Acetonitrile	75-05-8	CH_3CN	41.05	82	1.42	2	3.00	16.00	51	275	523
Acetyl chloride	75-36-5	CH_3COCl	78.5	51	2.70	−4	5.00	19.00	157	620	390
Acetylene	74-86-2	$CH=CH$	26	-84	0.90	gas	2.30	100.00	24	1,092	305
Acetyl fluoride	557-99-3	CH_3COF	62.04	20	2.14	<−17	5.60	19.90	142	505	434
Acrylaldehyde	107-02-8	$CH_2=CHCHO$	56.06	53	1.93	−18	2.80	31.80	65	728	217
Acrylic acid	79-10-7	$CH_2=CHCOOH$	72.06	139	2.48	56	2.90		85		406
Acrylonitrile	107-13-1	$CH_2=CHCN$	53.1	77	1.83	−5	2.80	28.00	64	620	480
Acryloyl chloride	814-68-6	$CH_2CHCOCl$	90.51	72	3.12	−8	2.68	18.00	220	662	463
Allyl acetate	591-87-7	$CH_2=CHCH_2OOCCH_3$	100.12	103	3.45	13	1.70	10.10	69	420	348
Allyl alcohol	107-18-6	$CH_2=CHCH_2CH$	58.08	96	2.00	21	2.50	18.00	61	438	378
Allyl chloride	107-05-1	$CH_2=CHCH_2Cl$	76.52	45	2.64	−32	2.90	11.20	92	357	390
Ammonia	7664-41-7	NH_3	17	-33	0.59	gas	15.00	33.60	107	240	630
Aniline	62-53-3	$C_6H_6NH_2$	93.1	184	3.22	75	1.20	11.00	47	425	630
Benzaldehyde	100-52-7	C_6H_5CHO	106.12	179	3.66	64	1.40		62		192
Benzene	71-43-2	C_6H_6	78.1	80	2.70	−11	1.20	8.60	39	280	560
1-Bromobutane	109-65-9	$CH_3(CH_2)_2CH_2Br$	137.02	102	4.72	13	2.50	6.60	143	380	265
Bromoethane	74-96-4	CH_3CH_2Br	108.97	38	3.75	<−20	6.70	11.30	306	517	511
1,3 Butadiene	106-99-0	$CH_2=CHCH=CH_2$	54.09	-4.5	1.87	gas	1.40	16.30	31	365	430
Butane	106-97-8	C_4H10	58.1	-1	2.05	gas	1.40	9.30	33	225	372
Isobutane	75-28-5	$(CH_3)_2CHCH_3$	58.12	-12	2.00	gas	1.30	9.80	31	236	460
Butan-1-ol	71-36-3	$CH_3(CH_2)_2CH2OH$	74.12	116	2.55	29	1.40	12.00	52	372	359
Butanone	78-93-3	$CH_3CH_2COCH_3$	72.1	80	2.48	−9	1.50	13.40	45	402	404
But-1-ene	106-98-9	$CH_2=CHCH_2CH_3$	56.11	-6.3	1.95	gas	1.40	10.00	38	235	440
But-2-ene (isomer not stated)	107-01-7	$CH_3CH=CHCH_3$	56.11	1	1.94	gas	1.60	10.00	40	228	325
Butyl acetate	123-86-4	$CH_3COOCH_2(CH_2)_2CH_3$	116.2	127	4.01	22	1.20	8.50	58	408	370
n-Butyl acrylate	141-32-2	$CH_2=CHCOOC_4H_9$	128.17	145	4.41	38	1.20	9.90	63	425	268
Butylamine	109-73-9	$CH_3(CH_2)_3NH_2$	73.14	78	2.52	−12	1.70	9.80	49	286	312
Isobutylamine	78-81-9	$(CH_3)_2CHCH_2NH_2$	73.14	64	2.52	−20	1.47	10.80	44	330	374
Isobutylisobutyrate	97-85-8	$(CH_3)_2CHCOOCH_2CH(CH_3)_2$	144.21	145	4.93	34	0.80		47		424
Butylmethacrylate	97-88-1	$CH_2=C(CH_3)COO(CH_2)_3CH_3$	142.2	160	4.90	53	1.00	6.80	58	395	289
Tert-butyl methyl ether	1634-04-4	$CH_3OC(CH_3)_2$	88.15	55	3.03	−27	1.50	8.40	54	310	385
n-Butylpropionate	590-01-2	$C_2H_5COOC_4H9$	130.18	145	4.48	40	1.00	7.70	53	409	389
Butyraldehyde	123-72-8	$CH_3CH_2CH_2CHO$	72.1	75	2.48	−16	1.80	12.50	54	378	191
Isobutyraldehyde	78-84-2	$(CH_3)_2CHCHO$	72.11	63	2.48	−22	1.60	11.00	47	320	176
Carbon disulphide	75-15-0	CS_2	76.1	46	2.64	−30	0.60	60.00	19	1,900	95
Carbon monoxide	630-08-0	CO	28	-191	0.97	gas	10.90	74.00	126	870	805

COMMON NAME	CAS NUMBER	FORMULA	MOLECULAR WEIGHT	BOILING POINT °C	RELATIVE VAPOURISATION DENSITY	F.P. °C	FLAMMABLE LIMITS				I.T. °C
							LFL % V/V	UFL % V/V	LFL MG/L	UFL MG/L	
Carbonyl sulphide	463-58-1	COS	60.08	-50	2.07	gas	6.50	28.50	100	700	209
Chlorobenzene	108-90-7	C_6H_5Cl	112.6	132	3.88	28	1.30	11.00	60	520	637
1-Chlorobutane	109-69-3	$CH_3(CH_2)_2CH_2Cl$	92.57	78	3.20	−12	1.80	10.00	69	386	250
2-Chlorobutane	78-86-4	$CH_3CHClC_2H_5$	92.57	68	3.19	<−18	2.00	8.80	77	339	368
1-Chloro-2,3-epoxypropane	106-89-8	OCH_2CHCH_2Cl	92.52	115	3.30	28	2.30	34.40	86	1,325	385
Chloroethane	75-00-3	CH_3CH_2Cl	64.5	12	2.22	gas	3.60	15.40	95	413	510
2-Chloroethanol	107-07-3	CH_2ClCH_2OH	80.51	129	2.78	55	4.90	16.00	160	540	425
Chloroethylene	75-01-4	$CH_2=CHCl$	62.3	-15	2.15	gas	3.60	33.00	94	610	415
Chloromethane	74-87-3	CH_3Cl	50.5	-24	1.78	gas	7.60	19.00	160	410	625
1-Chloro-2-methylpropane	513-36-0	$(CH_3)_2CHCH_2Cl$	92.57	68	3.19	<−14	2.00	8.80	75	340	416
3-Chloro-2-methylprop-1-ene	563-47-3	$CH_2=C(CH_3)CH_2Cl$	90.55	71	3.12	−16	2.10		77		478
5-Chloropentan-2-one	5891-21-4	$CH_3CO(CH_2)_3Cl$	120.58	71	4.16	61	2.00		98		440
1-Chloropropane	540-54-5	$CH_3CH_2CH_2Cl$	78.54	37	2.70	−32	2.40	11.10	78	365	520
2-Chloropropane	75-29-6	$(CH_3)_2CHCl$	78.54	47	2.70	<−20	2.80	10.70	92	350	590
Chlorotrifluoroethyl-ene	79-38-9	$CF_2=CFCl$	116.47	-28.4	4.01	gas	4.60	84.30	220	3,117	607
α-Chlorotoluene	100-44-7	$C_6H_5CH_2Cl$	126.58		4.36	60	1.10		55		585
Cresols (mixed isomers)	1319-77-3	CH_3C5H_4OH	108.14	191	3.73	81	1.10		50		555
Crotonaldehyde	123-73-9	$CH_3CH=CHCHO$	70.09	102	2.41	13	2.10	16.00	82	470	280
Cumene	98-82-8	$c_6H_5CH(CH_3)_2$	120.19	152	4.13	31	0.80	6.50	40	328	424
Cyclobutane	287-23-0	$CH_2(CH_2)_2CH_2$	56.1	13	1.93	gas	1.80		42		
Cycloheptane	291-64-5	$CH_2(CH_2)_5CH_2$	98.19	118.5	3.39	<10	1.10	6.70	44	275	
Cyclohexane	110-82-7	$CH_2(CH_2)_4CH_2$	84.2	81	2.90	−18	1.00	8.00	35	290	259
Cyclohexanol	108-93-0	$CH_2(CH_2)_4CHOH$	100.16	161	3.45	61	1.20	11.10	50	460	300
Cyclohexanone	108-94-1	$CH_2(CH_2)_4CO$	98.1	156	3.38	43	1.30	8.40	53	386	419
Cyclohexene	110-83-8	$CH_2(CH_2)_3CH=CH$	82.14	83	2.83	−17	1.10	8.30	37		244
Cyclohexylamine	108-91-8	$CH_2(CH_2)_4CHNH_2$	99.17	134	3.42	32	1.10	9.40	47	372	293
Cyclopentane	287-92-3	$CH_2(CH_2)_3CH_2$	70.13	50	2.40	−37	1.40		41		320
Cyclopentene	142-29-0	$CH=CHCH_2CH_2CH$	68.12	44	2.30	<−22	1.48		41		309
Cyclopropane	75-19-4	$CH_2CH_2CH_2$	42.1	-33	1.45	gas	2.40	10.40	42	183	498
Cyclopropyl methyl ketone	765-43-5	$CH_3COCHCH_2CH_2$	84.12	114	2.90	15	1.70		58		452
p-Cymene	99-87-6	$CH_3C_6H_4CH(CH_3)_2$	134.22	176	4.62	47	0.70	5.60	39	366	436
Decahydro-naphthalene trans	493-02-7	$CH_2(CH_2)_3CHCH(CH_2)_3CH_2$	138.25	185	4.76	54	0.70	4.90	40	284	288
Decane (mixed isomers)	124-18-5	$C_{10}H_{22}$	142.28	173	4.90	46	0.70	5.60	41	332	201
Dibutyl ether	142-96-1	$(CH_3(CH_2)_3)_2O$	130.2	141	4.48	25	0.90	8.50	48	460	198
Dichlorobenzenes (isomer not stated)	106-46-7	$C_6H_4Cl_2$	147	179	5.07	86	2.20	9.20	134	564	648
Dichlorodiethyl-silane	1719-53-5	$(C_2H_5)SiCl_2$	157.11	128	3.42	24	3.40		223		
1,1-Dichloroethane	75-34-3	CH_3CHCl_2	99	57	3.42	−10	5.60	16.00	230	660	440
1,2-Dichloroethane	107-06-2	CH_2ClCH_2Cl	99	84	3.55	13	6.20	16.00	255	654	438
Dichloroethylene	540-59-0	$ClCH=CHCl$	96.94	37	3.90	−10	9.70	12.80	391	516	440

Flammable Gases Data

(continued)

COMMON NAME	CAS NUMBER	FORMULA	MOLECULAR WEIGHT	BOILING POINT °C	RELATIVE VAPOURISATION DENSITY	F.P. °C	FLAMMABLE LIMITS				I.T. °C
							LFL % V/V	UFL % V/V	LFL MG/L	UFL MG/L	
1,2-Dichloro-propane	78-87-5	$CH_3CHClCH_2Cl$	113	96	4.55	15	3.40	14.50	160	682	557
Dicyclopentadiene	77-73-6	$C_{10}H_{12}$	132.2	170	2.53	36	0.80		43		455
Diethylamine	109-89-7	$(C_2H_5)_2NH$	73.14	55	4.07	-23	1.70	10.00	50	306	312
Diethylcarbonate	105-58-8	$(CH_3CH_2O)_2CO$	118.13	126	2.55	24	1.40	11.70	69	570	450
Diethyl ether	60-29-7	$(CH_3CH_5)_2O$	74.1	34	2.21	-45	1.70	36.00	60	1,118	160
1,1-Difluoro-ethylene	75-38-7	$CH_2=CF_2$	64.03	-83	4.45	gas	3.90	25.10	102	665	380
Diisobutylamine	110-96-3	$((CH_3)_2CHCH_2)_2NH$	129.24	137	4.97	26	0.80	3.60	42	190	256
Diisobutyl carbinol	108-82-7	$((CH_3)_2CHCH_2)_2CHOH$	144.25	178	5.45	75	0.70	6.10	42	370	290
Diisopentyl ether	544-01-4	$(CH_3)_2CH(CH_2)_2O(CH_2)_2CH(CH_3)_2$	158.28	170	3.48	44	1.27		104		185
Diisopropylamine	108-18-9	$((CH_3)_2CH)_2NH$	101.19	84	3.52	-20	1.20	8.50	49	358	285
Diisopropyl ether	108-20-3	$((CH_3)_2CH)_2O$	102.17	69	1.55	-28	1.00	21.00	45	900	405
Dimethylamine	124-40-3	$(CH_3)_2NH$	45.08	7	2.60	gas	2.80	14.40	53	272	400
Dimethoxymethane	109-87-5	$CH_2(OCH)_3)_2$	76.09	41	3.38	-21	2.20	19.90	71	630	247
3-(Dimethylamino) propiononitrile	1738-25-6	$(CH3)_2NHCH_2CH_2CN$	98.15	171	1.59	50	1.57		62		317
Dimethyl ether	115-10-6	$(CH_3)_2O$	46.1	-25	2.51	gas	2.70	32.00	51	610	240
N,N-Dimethylformamide	68-12-2	$HCON(CH_3)_2$	73.1	152	3.87	58	1.80	16.00	55	500	440
3,4-Dimethyl hexane	583-48-2	$CH_3CH_2CH(CH_3)CH(CH_3)CH_2CH_3$	114.23	119	2.07	2	0.80	6.50	38	310	305
N,N-Dimethyl hydrazine	57-14-7	$(CH_3)_2NNH_2$	60.1	62	3.03	-18	2.40	20	60	490	240
1,4-Dioxane	123-91-1	$OCH_2CH_2OCH_2CH_2$	88.1	101	2.55	11	1.40	22.50	51	813	379
1,3-Dioxolane	646-06-0	$OCH_2CH_2OCH_2$	74.08	74	3.48	-5	2.30	30.50	70	935	245
Dipropylamine	142-84-7	$(CH_3CH_2CH_2)_2NH$	101.19	105	1.04	4	1.20	9.10	50	376	280
Ethane	74-84-0	CH_3CH_3	30.1	-87	2.11	gas	2.50	15.50	31	194	515
Ethanethiol	75-08-1	CH_3CH_2SH	62.1	35	1.59	<-20	2.80	18.00	73	466	295
Ethanol	64-17-5	CH_3CH_2OH	46.1	78	3.10	12	3.10	19.00	59	359	363
2-Ethoxyethanol	110-80-5	$CH_3CH_2OCH_2CH_2OH$	90.12	135	4.72	40	1.70	15.70	68	593	235
2-Ethoxyethyl acetate	111-15-9	$CH_3COOCH_2CH_2OCH_2CH_3$	132.16	156	3.04	47	1.20	12.70	65	642	380
Ethyl acetate	141-78-6	$CH_3COOCH_2CH_3$	88.1	77	4.50	-4	2.00	2.80	73	470	460
Ethyl acetoacetate	141-97-9	$CH_3COCH_2COOCH_2CH_3$	130.14	181	3.45	65	1.00	9.50	54	519	350
Ethyl acrylate	140-88-5	$CH_2=CHCOOCH_2CH_3$	100.1	100	1.50	9	1.40	14.00	59	588	350
Ethylamine	75-04-7	$C_2H_5NH_2$	45.08	16.6	3.66	<-20	3.50	14.00	49	260	425
Ethylbenzene	100-41-4	$CH_2CH_3C_6H_5$	106.2	135	4.00	23	0.80	7.80	44	340	431
Ethyl butyrate	105-54-4	$CH_3CH_2CH_2COOC_2H5$	116.16	120	2.90	21	1.40		66		435
Ethylcyclobutane	4806-61-5	$CH_3CH_2CHCH_2CH_2CH_2$	84.16	131	3.87	<-16	1.20	7.70	42	272	212
Ethylcyclohexane	1678-91-7	$CH_3CH_2CH(CH_2)_4CH_2$	112.2	103	3.40	<24	0.80	6.60	42	310	238
Ethylcyclopentane	1640-89-7	$CH_3CH_2CH(CH_2)_3CH_2$	98.2	-104	0.97	<5	1.05	6.80	42	280	262
Ethylene	74-85-1	$CH_2=CH_2$	28.1				2.30	36.00	26	423	425
Ethylenediamine	107-15-3	$NH_2CH_2CH_2NH_2$	60.1	118	2.07	34	2.50	18.00	64	396	403
Ethylene oxide	75-21-8	CH_2CH_2O	44	11	1.52	<-18	2.60	100.00	47	1,848	435
Ethyl formate	109-94-4	$HCOOCH_2CH_3$	74.08	52	2.65	-20	2.70	16.50	87	497	440
Ethyl isobutyrate	97-62-1	$(CH_3)_2CHCOOC_2H_5$	116.16	112	4.00	10	1.60		75		438

COMMON NAME	CAS NUMBER	FORMULA	MOLECULAR WEIGHT	BOILING POINT °C	RELATIVE VAPOURISATION DENSITY	F.P. °C	FLAMMABLE LIMITS LFL % V/V	UFL % V/V	LFL MG/L	UFL MG/L	I.T. °C
Ethyl methacrylate	97-63-2	$CH_2=CCH_3COOCH_2CH_3$	114.14	118	3.90	20	1.50		70		
Ethyl methyl ether	540-67-0	$CH_3OCH_2CH_3$	60.1	8	2.10	gas	2.00	10.10	50	255	190
Ethyl nitrite	109-95-5	CH_3CH_2ONO	75.07		2.60	-35	3.00	50.00	94	1,555	95
Formaldehyde	50-00-0	$HCHO$	30	-19	1.03	60	7.00	73.00	88	920	424
Formic acid	64-18-6	$HCOOH$	46.03	101	1.60	42	18.00	57.00	190	1,049	520
2-Furaldehyde	98-01-1	$OCH=CHCH=CHCHO$	96.08	162	3.30	60	2.10	19.30	85	768	316
Furan	110-00-9	$CH=CHCH=CHO$	68.07	32	2.30	<-20	2.30	14.30	66	408	390
Furfuryl alcohol	98-00-0	$OC(CH_2OH)CHCHCH$	98.1	170	3.38	61	1.80	16.30	70	670	370
1,2,3-Trimethyl-benzene	526-73-8	$CHCHCHC(CH_3)C(CH_3)C(CH_3)$	120.19	175	4.15	51	0.80	7.00			470
Heptane (mixed isomers)	142-82-5	C_7H_{16}	100.2	98	3.46	-4	0.85	6.70	35	281	215
Hexane (mixed isomers)	110-54-3	$CH_3(CH_2)_4CH_3$	86.2	69	2.97	-21	1.00	8.90	35	319	233
1-Hexanol	111-27-3	$C_6H_{13}OH$	102.17	156	3.50	63	1.10		47		293
Hexan-2-one	591-78-6	$CH_3CO(CH_2)_3CH_3$	100.16	127	3.46	23	1.20	9.40	50	392	533
Hydrogen	1333-74-0	H_2	2	-253	0.07	gas	4.00	77.00	3.4	63	560
Hydrogen cyanide	74-90-8	HCN	27	26	0.90	<-20	5.40	46.00	60	520	538
Hydrogen sulphide	7783-06-4	H_2S	34.1	-60	1.19	gas	4.00	45.50	57	650	270
4-Hydroxy-4-methyl-penta-2-one	123-42-2	$CH_3COCH_2C(CH_3)_2OH$	116.16	166	4.00	58	1.80	6.90	88	336	680
Kerosene	8008-20-6			150		38	0.70	5.00			210
1,3,5-Trimethylbenzene	108-67-8	$CHC(CH_3)CHC(CH_3)CHC(CH_3)$	120.19	163	4.15	44	0.80	7.30	40	365	499
Methacryloyl chloride	920-46-7	CH_2CCH_3COCl	104.53	95	3.60	17	2.50		106		510
Methane (firedamp)	74-82-8	CH_4	16	-161	0.55	<-188	4.40	17.00	29	113	537
Methanol	67-56-1	CH_3OH	32	65	1.11	11	6.00	36.00	73	665	386
Methanethiol	74-93-1	CH_3SH	48.11	6	1.60	4.10	4.10	21.00	80	420	
2-Methoxyethanol	109-86-4	$CH_3OCH_2CH_2OH$	76.1	124	2.63	39	1.80	20.60	76	650	285
Methyl acetate	79-20-9	CH_3COOCH_3	74.1	57	2.56	-10	3.10	16.00	95	475	502
Methyl acetoacetate	105-45-3	$CH_3COOCH_2COCH_3$	116.12	169	4.00	62	1.30	14.20	62	685	280
Methyl acrylate	96-33-3	$CH_2=CHCOOCH_3$	86.1	80	3.00	-3	1.95	16.30	71	581	415
Methylamine	74-89-5	CH_3NH_2	31.1	-6	1.00	gas	4.20	20.70	55	270	430
2-Methylbutane	78-78-4	$(CH_3)_2CHCH_2CH_3$	72.15	30	2.50	-56	1.30	8.30	38	242	420
2-Methylbutan-2-ol	75-85-4	$CH_3CH_2C(OH)(CH_3)_2$	88.15	102	3.03	16	1.40	10.20	50	374	392
3-Methylbutan-1-ol	123-51-3	$(CH_3)_2CH(CH_2)_2OH$	88.15	130	3.03	42	1.30	10.50	47	385	339
2-Methylbut-2-ene	513-35-9	$(CH_3)_2C=CHCH_3$	70.13	35	2.40	-53	1.30	6.60	37	189	290
Methyl chloro-formate	79-22-1	CH_3OOCC	94.5	70	3.30	10	7.50	26	293	1,020	475
Methylcyclohexane	108-87-2	$CH_3CH(CH_2)_4CH_2$	98.2	101	3.38	-4	1.00	6.70	41	275	258
Methylcyclo-pentadienes (isomer not stated)	26519-91-5	C_6H_6	80.13		2.76	<-18	1.30	7.60	43	249	432
Methylcyclopentane	96-37-7	$CH_3CH(CH_2)_3CH_2$	84.16	72	2.90	<-10	1.00	8.40	35	296	258
Methylenecyclo-butane	1120-56-5	$C(=CH_2)CH_2CH_2CH_2$	68.12		2.35	<0	1.25	8.60	35	239	352
2-Methyl-1-buten-3-yne	78-80-8	$HC=CC(CH_3)CH_2$	66.1	32	2.28	-54	1.40		38		272
Methyl formate	107-31-3	$HCOOCH_3$	60.05	32	2.07	-20	5.00	23.00	125	580	450

Flammable Gases Data

(continued)

COMMON NAME	CAS NUMBER	FORMULA	MOLECULAR WEIGHT	BOILING POINT °C	RELATIVE VAPOURISATION DENSITY	F.P. °C	FLAMMABLE LIMITS				I.T. °C
							LFL % V/V	UFL % V/V	LFL MG/L	UFL MG/L	
2-Methylfuran	534-22-5	$OC(CH_3)CHCHCH$	82.1	63	2.83	<-16	1.40	9.70	47	325	318
Methylisocyanate	624-83-9	CH_3NCO	57.05	37	1.98	-7	5.30	26.00	123	605	517
Methyl methacrylate	80-62-6	$CH_3{=}CCH_3COOCH_3$	100.12	100	3.45	10	1.70	12.50	71	520	430
4-Methylpentan-2-ol	108-11-2	$(CH_3)_2CHCH_2CHOHCH_3$	102.17	132	3.50	37	1.14	5.50	47	235	334
4-Methylpentan-2-one	108-10-1	$(CH_3)_2CHCH_2COCH_3$	100.16	117	3.45	16	1.20	8.00	50	336	475
2-Methylpent-2-enal	623-36-9	$CH_3CH_2CHC(CH_3)COH$	98.14	137	3.78	30	1.46		58		206
4-Methylpent-3-en-2-one	141-79-7	$(CH_3)_2(CCHCOCH)_3$	98.14	129	3.78	24	1.60	7.20	64	289	306
2-Methyl-1-propanol	78-83-1	$(CH_3)_2CHCH_2OH$	74.12	108	2.55	28	1.40	11.00	43	340	408
2-Methylprop-1-ene	115-11-7	$(CH_3)_2C{=}CH_2$	56.11	-6.9	1.93	gas	1.60	10	37	235	483
2-Methylpyridine	109-06-8	$NCH(CH_3)CHCHCHCH$	93.13	128	3.21	27	1.20		45		533
3-Methylpyridine	108-99-6	$NCHCH(CH_3)CHCHCH$	93.13	144	3.21	43	1.40	8.10	53	308	537
4-Methylpyridine	108-89-4	$NCHCHCH(CH_3)CHCH$	93.13	145	3.21	43	1.10	7.80	42	296	534
-Methyl styrene	98-83-9	$C_6H_5C(CH_3){=}CH_2$	118.18	165	4.08	40	0.80	11.00	44	330	445
Methyl tert-pentyl ether	994-05-8	$(CH_3)_2C(OCH_3)CH_2CH_3$	102.17	85	3.50	<-14	1.50		62		345
2-Methylthiophene	554-14-3	$SC(CH_3)CHCHCH$	98.17	113	3.40	-1	1.30	6.50	52	261	433
Morpholine	110-91-8	$OCH_2CH_2NHCH_2CH_2$	87.12	129	3.00	31	1.40	15.20	65	550	230
Naphtha				35	2.50	<-18	0.90	6.00			290
Naphthalene	91-20-3	$C_{10}H_8$	128.17	218	4.42	77	0.60	5.90	29	317	528
Nitrobenzene	98-95-3	$CH3CH2NO_2$	123.1	211	4.25	88	1.40	40.00	72	2,067	480
Nitroethane	79-24-3	$C_2H_5NO_2$	75.07	114	2.58	27	3.40		107		410
Nitromethane	75-52-5	CH_3NO_2	61.04	102.2	2.11	36	7.30	63.00	187	1,613	415
1-Nitropropane	108-03-2	$CH_3CH_2CH_2NO_2$	89.09	131	3.10	36	2.20		82		420
Nonane	111-84-2	$CH_3(CH_2)7CH_2$	128.3	151	4.43	30	0.70	5.60	37	301	205
Octane	111-65-9	$CH_3(CH_2)_3CH_3$	114.2	126	3.93	13	0.80	6.50	38	311	206
1-Octanol	111-87-5	$CH_3(CH_2)_6CH_2OH$	130.23	196	4.50	81	0.90	7.00	49	385	270
Penta-1,3-diene	504-60-9	$CH_2{=}CH{-}CH{=}CH{-}CH_3$	68.12	42	2.34	<-31	1.20	9.40	35	261	361
Pentanes (mixed isomers)	109-66-0	C_5H_{12}	72.2	36	2.48	-40	1.40	7.80	42	261	258
Pentane-2,4-dione	123-54-6	$CH_3COCH_2COCH_3$	100.1	140	3.50	34	1.70		71		340
Pentan-1-ol	71-41-0	$CH_3(CH_2)_3CH_2OH$	88.15	136	3.03	38	1.06	10.50	36	385	298
Pentan-3-one	96-22-0	$(CH_3CH_2)_2CO$	86.13	101.5	3.00	12	1.60		58		445
Pentyl acetate	628-63-7	$CH_3COO{-}(CH_2)_4{-}CH_3$	130.18	147	4.48	25	1.00	7.10	55	387	360
Petroleum					2.80	<-20	1.20	8.00			560
Phenol	108-95-2	C_6H_5OH	94.11	182	3.24	75	1.30	9.50	50	370	595
Propane	74-98-6	$CH_3CH_2CH_3$	44.1	-42	1.56	gas	1.70	10.90	31	200	470
Propan-1-ol	71-23-8	$CH_3CH_2CH_2OH$	60.1	97	2.07	22	2.10	17.50	52	353	405
Propan-2-ol	67-63-0	$(CH_3)_2CHOH$	60.1	83	2.07	12	2.00	12.70	50	320	425
Propene	115-07-1	$CH_2{=}CHCH_3$	42.1	-48		gas	2.00	11.10	35	194	455
Propionic acid	79-09-4	CH_3CH_2COOH	74.08	141	2.55	52	2.10	12.00	64	370	435
Propionic aldehyde	123-38-6	C_2H_5CHO	58.08	46	2.00	<-26	2.00		47		188
Propyl acetate	109-60-4	$CH_3COOCH_2CH_2CH_3$	102.13	102	3.60	10	1.70	8.00	70	343	430

COMMON NAME	CAS NUMBER	FORMULA	MOLECULAR WEIGHT	BOILING POINT °C	RELATIVE VAPOURISATION DENSITY	F.P. °C	FLAMMABLE LIMITS LFL % V/V	FLAMMABLE LIMITS UFL % V/V	FLAMMABLE LIMITS LFL MG/L	FLAMMABLE LIMITS UFL MG/L	I.T. °C
Isopropyl acetate	108-21-4	$CH_3COOCH(CH_3)_2$	102.13	85	3.51	4	1.70	8.10	75	340	467
Propylamine	107-10-8	$CH_3(CH_2)_2NH_2$	59.11	48	2.04	-37	2.00	10.40	49	258	318
Isopropylamine	75-31-0	$(CH_3)_2CHNH_2$	59.11	33	2.03	<-24	2.30	8.60	55	208	340
Isopropyl Chloroacetate	105-48-6	$ClCH_2COOCH(CH_3)_2$	136.58	149	4.71	42	1.60		89		426
2-Isopropyl-5-methylhex-2-enal	35158-25-9	$(CH_3)_2CH\text{-}C(CHO)CHCH_2CH(CH_3)_2$	154.25	189	5.31	41	3.05		192		188
Isopropyl nitrate	1712-64-7	$(CH_3)_2CHONO_2$	105.09	101		11	2.00	100.00	75	3,738	175
Propyne	74-99-7	$CH_3C{=}CH$	40.06	-23.2	1.38	gas	1.70	16.8	28	280	340
Prop-2-yn-1-ol	107-19-7	$HC{=}CCH_2OH$	56.06	114	1.89	33	2.40		55		346
Pyridine	110-86-1	C_5H_5N	79.1	115	2.73	17	1.70	12.40	56	398	550
Styrene	100-42-5	$C_6H_5CH{=}CH_2$	104.2	145	3.60	30	1.00	8.00	42	350	490
Tetrafluoroethylene	116-14-3	$CF_2{=}CF_2$	100.02		3.40	gas	10.00	59.00	420	2,245	255
2,2,3,3-Tetrafluoropropyl acrylate	7383-71-3	$CH_2{=}CHCOOCH_2CF_2CF_2H$	186.1	132	6.41	45	2.40		182		357
2,2,3,3-Tetrafluoropropyl methacrylate	45102-52-1	$CH_2{=}C(CH_2)COOCH_2CF_2CF_2H$	200.13	124	6.90	46	1.90		155		389
Tetrahydrofuran	109-99-9	$CH_2(CH_2)_2CH_2O$	72.1	64	2.49	-20	1.50	12.40	46	370	224
Tetrahydrofurfuryl alcohol	97-99-4	$OCH_2CH_2CH_2CHCH_2OH$	102.13	178	3.52	70	1.50	9.70	64	416	280
Tetrahydrothiophene	110-01-0	$CH_2(CH_2)_2CH_2S$	88.17	119	3.04	13	1.00	12.30	42	450	200
N,N,N', N'-Tetramethyldiaminomethane	51-80-9	$(CH_3)_2NCH_2N(CH_3)_2$	102.18	85	3.50	<-13	1.61		67		180
Thiophene	110-02-1	$CH{=}CHCH{=}CHS$	84.14	84	2.90	-9	1.50	12.50	50	420	395
Toluene	108-88-3	$C_6H_5CH_3$	92.1	111	3.20	4	1.10	7.80	39	300	535
Triethylamine	121-44-8	$(CH_3CH_2)_3N$	101.2	89	3.50	-7	1.20	8.00	51	339	
1,1,1-Trifluoroethane	420-46-2	CF_3CH_3	84.04		2.90		6.80	17.60	234	605	714
2,2,2-Trifluoroethanol	75-89-8	CF_3CH_2OH	100.04	77	3.45	30	8.40	28.80	350	1,195	463
Trifluoroethylene	359-11-5	$CF_2{=}CFH$	82.02		2.83		27.00	502	904	319	
3,3,3-Trifluoro-prop-1-ene	677-21-4	$CF_3CH{=}CH_2$	96.05	-16	3.31		4.70		184		490
Trimethylamine	75-50-3	$(CH_3)_3N$	59.1	3	2.04	gas	2.00	12.00	50	297	190
2,2,4-Trimethylpentane	540-84-1	$(CH_3)_2CHCH_2C(CH_3)_3$	114.23	98	3.90	-12	0.70	6.00	34	284	411
2,4,6-Trimethyl-1,3,5-trioxane	123-63-7	$OCH(CH_3)OCH(CH_3)OCH(CH_3)$	132.16	123	4.56	27	1.30		72		235
1,3,5-Trioxane	110-88-3	$OCH_2OCH_2OCH_2$	90.1	115	3.11	45	3.20	29.00	121	1,096	410
Turpentine		$C_{10}H_{16}$		149		35	0.80				254
Isovaleraldehyde	590-86-3	$(CH_3)_2CHCH_2CHO$	86.13	90	2.97	-12	1.30	13.00	60		207
Vinyl acetate	108-05-4	$CH_3COOCH{=}CH_2$	86.09	72	3.00	-8	2.60	13.40	93	478	425
Vinylcyclohexenes (isomer not stated)	100-40-3	$CH_2CHC_6H_9$	108.18	126	3.72	15	0.80		35		257
Vinylidene chloride	75-35-4	$CH_2{=}CCl_2$	96.94	30	3.40	-18	6.50	16.00	260	645	440
2-Vinylpyridine	100-69-6	$NC(CH_2{=}CH)CHCHCHCH$	105.14	79	3.62	35	1.20		51		482
4-Vinylpyridine	100-43-6	$NCHCHC(CH_2{=}CH)CHCH$	105.14	62	3.62	43	1.10		47		501
Xylenes	1330-20-7	$C_6H_4(CH_3)_2$	106.2	144	3.66	30	1.00	7.60	44	335	464