



Engineering Toolbox - Resources, Tools and Basic Information for Engineering and Design of Technical Applications!



Gases - Explosion and Flammability Concentration Limits

Flame and explosion limits for gases like propane, methane, butane, acetylene and more.

The *Flammable Range* (also called Explosive Range) is the concentration range of a gas or vapor that will burn (or explode) if an ignition source is introduced.

Three basic requirements must be met for explosion to take place:

1. flammable substance - fuel
2. oxidizer - oxygen or air
3. source of ignition - spark or high heat

Below the explosive or flammable range the mixture is too lean to burn and above the upper explosive or flammable limit the mixture is too rich to burn. The limits are commonly called the "Lower Explosive or Flammable Limit" (LEL/LFL) and the "Upper Explosive or Flammable Limit" (UEL/UFL).

The lower and upper explosion concentration limits for some commonly used gases are indicated in the table below. Some of the gases are commonly used as fuel in combustion processes.

Note! The limits indicated are for gas and air at 20°C and atmospheric pressure.

Fuel Gas	"Lower Explosive or Flammable Limit" (LEL/LFL) (% by volume of air)	"Upper Explosive or Flammable Limit" (UEL/UFL) (% by volume of air)
Butylbenzene	0.5	5.8
Biphenyl	0.6	5.8
Diesel fuel	0.6	7.5
Fuel Oil - No.1	0.7	5
Kerosene Jet A-1	0.7	5
Mineral spirits	0.7	6.5
Isooctane	0.79	5.94
Decane	0.8	5.4
Diborane	0.8	88
Nonane	0.8	2.9
Propylbenzene	0.8	6
Turpentine	0.8	
Isopropylbenzene	0.9	6.5
Naphtalene	0.9	5.9

Fuel Gas	"Lower Explosive or Flammable Limit" (LEL/LFL) (% by volume of air)	"Upper Explosive or Flammable Limit" (UEL/UFL) (% by volume of air)
Naphthalene	0.9	5.9
Triethylene glycol	0.9	9.2
o-Xylene	0.9	6.7
Butyl alcohol, Butanol	1	11
Butyl methyl ketone	1	8
Cyclohexanol	1	9
Cyclohexanone	1	9
Diisobutyl ketone	1	6
Diisopropyl ether	1	21
Ethylbenzene	1.0	7.1
Heptane	1.0	6.7
Heptane (n-Heptane)	1.0	6.0
Isophorone	1	4
Octane (n-Octane)	1.0	7
Piperidine	1	10
Triptane	1.08	6.69
Cycloheptane	1.1	6.7
Dibutylamine	1.1	6
Hexane	1.1	7.5
Pentyl acetat	1.1	7.5
Styrene	1.1	6.1
Toluene	1.1	7.1
m-Xylene	1.1	7
p-Xylene	1.1	7
Neohexane	1.19	7.58
Benzene	1.2	7.8
Ethylcyclobutane	1.2	7.7
Hexane (n-Hexane)	1.25	7.0
Aniline	1.3	11
Carbon disulfide	1.3	50
Chlorobenzene	1.3	9.6
Cyclohexane	1.3	8
Isopentane	1.32	9.16
Neopentane	1.38	7.22
Ethyl acrylate	1.4	14
Gasoline	1.4	7.6
Mesityl oxide	1.4	7.2
Pentane (n-Pentane)	1.4	7.8
Vinyl butanoate	1.4	8.8
Silane	1.5	98
Isobutanal	1.6	10.6
Methacrylic acid	1.6	8.8
Pentene (n-Pentene)	1.65	7.7
Butyl acetate	1.7	7.6
Butyl formate	1.7	8.2
Butylamine	1.7	9.8
Ethyl propyl ether	1.7	9
Ethyl vinyl ether	1.7	28
Cyclobutane	1.8	11.1
Diacetone alcohol	1.8	6.9
Isobutane	1.80	8.44

Fuel Gas	"Lower Explosive or Flammable Limit" (LEL/LFL) (% by volume of air)	"Upper Explosive or Flammable Limit" (UEL/UFL) (% by volume of air)
Isobutene	1.8	9.0
Methyl ethyl Ketone	1.8	10
Phenol	1.8	8.6
Butane (n-Butane)	1.86	8.41
Butanal	1.9	12.5
Butyll acrylate	1.9	9.9
Diethyl ether	1.9	36
Diethylether	1.9	48
Butylene	1.98	9.65
Butadiene (1,3-Butadiene)	2.0	12
Butanoic acid	2	10
Diethanolamine	2	13
Diethylamine	2	13
Ethyl acetate	2	12
Furan	2	14
Furfural	2	19
Isobutyl alcohol	2	11
Isopropyl alcohol, Isopropanol	2	12
Nitrobenzene	2	9
Propene	2	11.1
Propyl acetate	2	8
Propylamine	2	10.4
Propyl nitrate	2	100
Propylene	2.0	11.1
Pyridine	2	12
Tetrahydrofuran	2	12
Trimethylamine	2	11.6
Propane	2.1	10.1
Propyne	2.1	12.5
Alyllamine	2.2	22
Pentylamine	2.2	22
Propylene oxide	2.3	36
Acrylic acid	2.4	8
Cyclopropane	2.4	10.4
Acetylene	2.5	100
Allyl alcohol	2.5	18
Methylhydrazine	2.5	92
Acetone	2.6	12.8
Bromobuthane (1-Bromobuthane)	2.6	6.6
Fluoroethene	2.6	21.7
Vinyl acetate	2.6	13.4
Ethylene	2.75	28.6
Acrolein	2.8	31
Methyl acrylate	2.8	25
Allyl chloride	2.9	11.1
Propanoic acid	2.9	12.1
Acetonitrile	3	16
Acrylonitrile	3.0	17
Dimethyl sulphoxide	3	42
Ethane	3	12.4
Ethylene oxide	3	100

Fuel Gas	"Lower Explosive or Flammable Limit" (LEL/LFL) (% by volume of air)	"Upper Explosive or Flammable Limit" (UEL/UFL) (% by volume of air)
Ethylene glycol	3	22
Glycerol	3	19
Methyl acetate	3	16
Oxirane	3	100
Ethyl alcohol, Ethanol	3.3	19
Nitroethane	3.4	17
Ethylamine	3.5	14
Vinyl chloride	3.6	33
Chloroethane	3.8	15.4
Ethyl chloride	3.8	15.4
Acetaldehyde	4	60
Acetic acid	4	19.9
Epichlorohydrin	4	21
Ethyl nitrite	4	50
Hydrogen	4	75
Hydrogen sulfide	4.3	46
Methane	4.4	16.4
Methyl formate	4.5	23
Methylamine	4.9	20.7
Hydrazine	5	100
Arsine	5.1	78
Methyl isocyanate	5.3	26
Cyanogen	6.0	42.6
Dichloroethane (1,1-Dichloroethane)	6	11
Hydrogen	6	40
Methyl alcohol, Methanol	6.7	36
Bromoethane	6.8	8
Formaldehyde	7	73
Paraformaldehyde	7	73
Acetyl chloride	7.3	19
Nitromethane	7.3	22.2
Bromoethene	9	15
Tetrafluoroethene	10	50
Methyl chloride	10.7	17.4
Carbon monoxide	12	75
Carbon oxysulfide	12	29
Trichloroethylene	13	90
Ammonia	15	28
Formic acid	18	57

It is important that areas that store **flammable gases** are well ventilated. When designing ventilation systems be aware of the **specific gravity of the actual gas**. The gas mixture from a leakage will not be homogeneous and lighter gases concentrates along the ceiling. Heavy gases concentrates along the floor.

Ventilation, natural or mechanical, must be sufficient to limit the concentration of flammable gases or vapors to a maximum level of 25% of their "Lower Explosive or Flammable Limit" (LEL/LFL).

- Minimum ventilation required: 1 cfm/ft^2 ($20 \text{ m}^3/\text{h m}^2$)

- Recommended ventilation: 2 cfm/ft^2 ($40 \text{ m}^3/\text{h m}^2$) or *12 air changes per hour* - half the air supplied and exhausted near the ceiling and half the air supplied and exhausted near the floor

Related Topics

- **Combustion** - Boiler house topics - fuels like oil, gas, coal, wood - chimneys, safety valves, tanks - combustion efficiency
- **Gases and Compressed Air** - Air, LNG, LPG and other common gas properties, pipeline capacities, sizing of relief valves

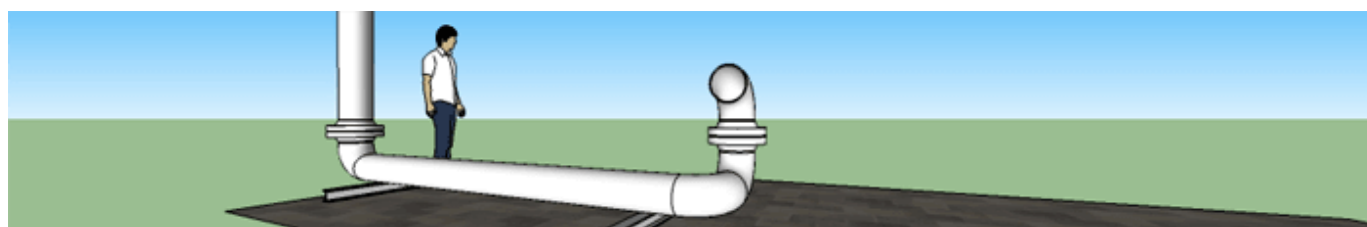
Related Documents

- **Acetone - Thermophysical Properties** - Chemical, physical and thermal properties of acetone, also called 2-propanone, dimethyl ketone and pyroacetic acid. Phase diagram included.
- **Acetylene - Thermophysical Properties** - Chemical, Physical and Thermal Properties of Acetylene.
- **Air Contaminants - Exposure Limits** - Exposure limits for various air contaminants.
- **Butane - Thermophysical Properties** - Chemical, physical and thermal properties of n-Butane.
- **Carbon Monoxide - Thermophysical Properties** - Chemical, Physical and Thermal Properties of Carbon Monoxide - CO .
- **Dust Explosions - Critical Temperatures and Concentrations** - Critical temperatures and concentration parameters for substances like coal, zinc, uranium and more.
- **Ethane - Liquid Thermal Properties** - Density, specific heat and more of liquid ethane.
- **Ethane - Specific Heat Gas vs. Temperature** - Specific heat of Ethane Gas - C_2H_6 - for temperatures ranging $250 - 900 \text{ K}$.
- **Flash Points - Liquids** - The flash points for some common liquids and fuels.
- **Fuels and Chemicals - Autoignition Temperatures** - Autoignition points for fuels and chemicals like butane, coke, hydrogen, petroleum and more.
- **Gases - Dangerous Concentration Levels** - Dangerous vs. tolerable concentration levels for some industrial gases.
- **Gases - Densities** - Densities and molecular weights of common gases like acetylene, air, methane, nitrogen, oxygen and others.
- **Gases - Gross and Net Heat Values** - Gross heat and net heat values for gases like hydrogen, methane and more.
- **Gases Solved in Water - Diffusion Coefficients** - Diffusion flux [$\text{kg}/\text{m}^2\text{s}$] tells how fast a substance solved in another substance flows due to concentration gradients. Diffusion constants [m^2/s] for several gases in water.
- **Hazardous Areas - European Classification Standard** - European hazardous area classification with zones, protection types, temperature codes and codes.
- **Hazardous Areas - North America Classification** - North American hazardous locations classification with classes, divisions and groups
- **Hydrocarbons - Autoignition Temperatures and Flash Points** - Autoignition temperatures and flash points ($^{\circ}\text{C}$ and $^{\circ}\text{F}$) of different types of hydrocarbons with varying carbon numbers up to C12.
- **Hydrogen - Thermophysical Properties** - Chemical, Physical and Thermal Properties of

Hydrogen - H_2 .

- [Methane - Dynamic and Kinematic Viscosity vs. Temperature and Pressure](#) - Online calculator, figures and tables showing dynamic and kinematic viscosity of methane, CH_4 , at varying temperature and pressure - Imperial and SI Units.
- [Methane - Thermophysical Properties](#) - Chemical, Physical and Thermal Properties of Methane - CH_4 . Phase diagram included.
- [Molecular Weight of Substances](#) - Definition and molecular weight (molar mass) of some common substances.
- [Octane Liquid - Thermal Properties](#) - Density, specific heat, thermal conductivity and more.
- [Oxygen - Thermophysical properties](#) - Chemical, Physical and Thermal Properties of Oxygen - O_2 .
- [Propane - Thermophysical properties](#) - Chemical, physical and thermal properties of propane gas - C_3H_8 .
- [Propane - Vapor Pressure vs. Temperature](#) - Vapor pressure vs. temperature.
- [Propane Butane Mixture - Evaporation Pressure](#) - Evaporation pressure of propane butane mixture vs. temperature.
- [Propane Gas Piping - Capacity vs. Size](#) - Sizing of propane gas pipe lines with pressures above 5 psig (35 kPa).
- [Toluene - Density and Specific Weight vs. Temperature and Pressure](#) - Density and specific weight of liquid toluene.
- [Toluene Liquid - Thermal Properties vs- Temperature](#) - Density, specific heat, thermal conductivity and more.
- [Water Sprinkler - Protection Area vs. Classification](#) - Maximum fire sprinkler protection area vs. classification and construction.

Engineering ToolBox - SketchUp Extension - Online 3D modeling!



Add standard and customized parametric components - like flange beams, lumbers, piping, stairs and more - to your [Sketchup model](#) with the [Engineering ToolBox - SketchUp Extension](#) - enabled for use with the amazing, fun and free [SketchUp Make](#) and [SketchUp Pro](#). Add the Engineering ToolBox extension to your SketchUp from the [SketchUp Pro SketchUp Extension Warehouse!](#)

Translate this Page to

[Arabic](#) - [Chinese \(Simplified\)](#) - [Chinese \(Traditional\)](#) - [Dutch](#) - [French](#) - [German](#) - [Italian](#) - [Japanese](#) - [Korean](#) - [Portuguese](#) - [Russian](#) - [Spanish](#) - - or select [Your own language](#)

About the ToolBox

We appreciate any comments and tips on how to make The Engineering ToolBox a better information source. Please contact us by email

- editor.engineeringtoolbox@gmail.com

if You find any faults, inaccuracies, or otherwise unacceptable information.

The content in The Engineering ToolBox is [copyrighted](#) but can be used with [NO WARRANTY or LIABILITY](#) . Important information should always be double checked with alternative sources. All applicable national and local regulations and practices concerning this aspects must be strictly followed and adhered to.

Privacy

We don't collect information from our users. Only emails and answers are saved in our archive. Cookies are only used in the browser to improve user experience.

Some of our calculators and applications let you save application data to your local computer. These applications will - due to browser restrictions - send data between your browser and our server. We don't save this data.

Google use cookies for serving our ads and handling visitor statistics. Please read [Google Privacy & Terms](#) for more information about how you can control adserving and the information collected.

AddThis use cookies for handling links to social media. Please read [AddThis Privacy](#) for more information.

Advertise in the ToolBox

If you want to promote your products or services in the Engineering ToolBox - please use [Google Adwords](#). You can target the Engineering ToolBox by using [AdWords Managed Placements](#).

Citation

This page can be cited as

- Engineering ToolBox, (2003). *Gases - Explosion and Flammability Concentration Limits*. [online] Available at: https://www.engineeringtoolbox.com/explosive-concentration-limits-d_423.html [Accessed Day Mo. Year].

Modify access date.