

Spotlight on Asphyxiants

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Asphyxiants are chemicals that deprive body tissues of oxygen. They are generally divided into two types, simple and chemical. Simple asphyxiants act by diluting or displacing atmospheric oxygen, which lowers the concentration of oxygen in the air.

Breathing air with low oxygen concentration can result in insufficient oxygen in blood and tissues, causing headache, unconsciousness, and eventually death. Inert gases, such as helium and argon, are simple asphyxiants. Other examples of simple asphyxiants are presented in Table 1.

Simple asphyxiants, when present in high concentrations in air, act by limiting the availability of oxygen, without producing significant physiological effects on the body. Because the limiting factor is the available oxygen, simple asphyxiants usually do not have threshold limit values (TLVs). The minimal oxygen content of air should be 18% by volume under normal atmospheric pressure.

Table 1. Simple Asphyxiants

Asphyxiant	CAS No. ¹	Chemical Formula	Description
Acetylene (Ethyne)	74-86-2	C ₂ H ₂	Colorless gas with a faint odor. Commercial grade has a garlic-like odor.
Argon	7440-37-1	Ar	Inert, monatomic gas. Colorless, odorless, tasteless. Normal constituent of air at 0.94 %.
Carbon dioxide	124-38-9	CO ₂	Colorless, odorless gas. Normal constituent of air at 0.033 %.
Ethane	74-84-0	C ₂ H ₆	Colorless, odorless gas.
Ethylene (Ethene)	74-85-1	H ₂ C ₂ H ₂	Colorless gas with a sweet odor and taste.
Helium	7440-59-7	He	Inert, monatomic gas. Colorless, odorless, tasteless.
Hydrogen	1333-74-0	H ₂	Diatomic gas.
Methane	74-82-8	CH ₄	Colorless, odorless, tasteless gas.

(Natural gas)			A warning odor is added to household fuel gas as a safety precaution. Lighter than air.
Neon	7440-01-9	Ne	Inert, monatomic gas. Colorless, odorless, tasteless. Normal constituent of air at 0.0012 %.
Nitrogen	7727-37-9	N ₂	Diatomic gas. Colorless, odorless, tasteless. Normal constituent of air at ~80 %.
Propane (Bottled gas)	74-98-6	C ₃ H ₈	Colorless, odorless gas. A bad-smelling odorant is often added when used for fuel.
Propylene (Propene)	115-07-1	CH ₃ CHCH ₂	Colorless gas.

¹ Chemical Abstracts Service (CAS) registry number.

Chemical asphyxiants act in one of two ways. Some prevent uptake of oxygen in the blood. Carbon monoxide, for example, binds more strongly to hemoglobin in the blood than oxygen does. This binding leaves insufficient hemoglobin available for oxygen uptake into the blood and transport to the tissues.

A second type of chemical asphyxiant inhibits normal oxygen transfer either from the blood to the tissues or within a cell. Hydrogen cyanide is an example of this type. It interferes with electron transport within cells during aerobic respiration.

Hydrogen sulfide is an example of a chemical that is both a simple and a chemical asphyxiant. The chemical action, a neurotoxic systemic poison, paralyzes the lungs, thus inhibiting oxidation of the respiratory tissues. Because no air then enters the lungs, simple asphyxiation occurs.

Examples of chemical asphyxiants are presented in Table 2.

Table 2. Chemical Asphyxiants

Asphyxiant	CAS No. ¹	Chemical Formula	TLV-TWA ² ppm mg/m ³	
Aniline (phenylamine, aminobenzene)	62-53-3	C ₆ H ₅ NH ₂	2	7.6
Carbon disulfide	75-15-0	CS ₂	10	31

(carbon bisulfide)				
Carbon monoxide	630-08-0	CO	25	29
Cyanogen (dicyan)	460-19-5	C ₂ N ₂	10	21
Hydrogen cyanide (hydrocyanic acid)	74-90-8	HCN	TLV-Ceiling 4.7	5
Hydrogen sulfide	7783-06-4	H ₂ S	10	14
Nitrobenzene	98-95-3	C ₆ H ₅ NO ₂	1	5
Toluidene (aminotoluene)	95-53-4, 108-44-1, 106-49-0	CH ₃ C ₆ H ₄ NH ₂	2	8.8

¹ Chemical Abstracts Service (CAS) registry number.

² Threshold limit value - time weighted average, (TLV-TWA), American Conference of Governmental Industrial Hygienists airborne concentration guidelines to assist in the control of health hazards.