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GAS DETECTION

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Macurco Gas Detection Products

Carbon Monoxide (CO) Training

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Carbon Monoxide (CO) Training

Outline

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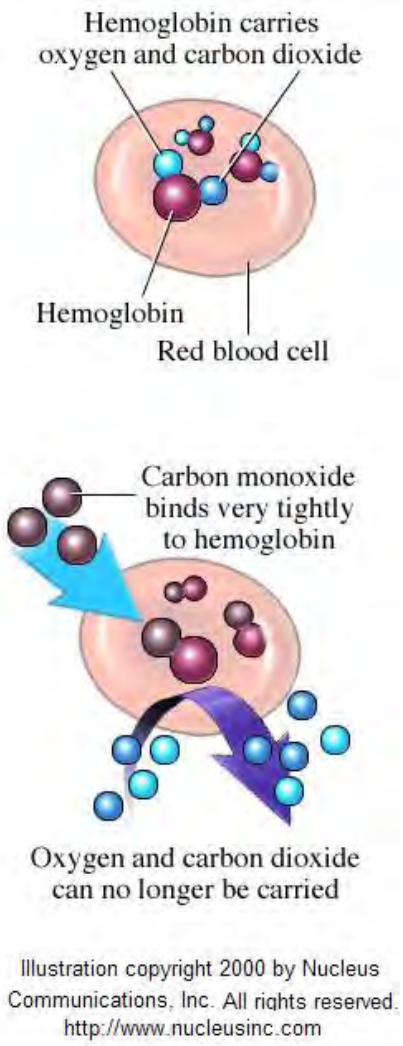
Carbon Monoxide: A Poisonous Gas

Carbon monoxide (CO) is a poisonous gas responsible for hundreds of deaths and numerous non-fatal poisonings each year in the United States.

It is a colorless, odorless, and tasteless gas that is produced as a by-product of incomplete combustion of carbon-based fuels such as natural gas, liquefied propane (LP) gas, kerosene, oil, gasoline, wood, or coal.

Absorption and Mode of Action

Hemoglobin, a protein on red blood cells, functions to carry oxygen in the blood stream throughout the body. CO is absorbed through the lungs into the blood and will also combine with hemoglobin to form carboxyhemoglobin (COHb). CO binds to hemoglobin more strongly than does oxygen. COHb cannot transport oxygen, therefore depriving tissues and organs of oxygen. The organs most easily injured by oxygen deprivation are the heart and brain.



http://des.nh.gov/organization/commissioner/pip/factsheets/ard/documents/ard-ehp-20.pdf

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Fatal CO Poisoning

The number of fatal CO poisonings has generally been declining since the 1980's however, there are still hundreds of unintentional deaths per year in the U.S. from CO, with many of these deaths occurring at home (CPSC, 2004).

According to the U.S. Consumer Product Safety Commission (CPSC) staff, from 1999 to 2001, the total number of unintentional non-fire CO poisoning deaths associated with the use of consumer products under the jurisdiction of the CPSC, excluding those associated with fire or motor vehicles, averaged about 126 annually (CPSC, 2004).

Fatal CO Poisoning

These deaths were associated with various consumer products, with the majority caused by CO emissions from heating systems.

The majority (66%) of these deaths occurred in the home. The remainder occurred in temporary shelters, such as campers, seasonal cabins and trailers (26%), or other places including inside automobiles, motels, etc. (8%).

Fatal CO Poisoning

Beyond CO fatalities associated with consumer products, many additional unintentional deaths occur each year as a result of CO poisoning from motor vehicle exhaust, including some deaths in homes from motor-vehicle exhaust infiltration into the living space from an attached garage.

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Non-Fatal CO Poisoning

In addition to CO poisoning fatalities, it is estimated that thousands go to hospital emergency rooms for treatment of non-fatal CO poisoning each year (Hampson, 2000).

According to Consumer Product Safety Commission staff, it is not uncommon for CO incidents involving one or more fatalities to also result in one or more non-fatal CO poisoning injuries.

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Non-Fatal CO Poisoning

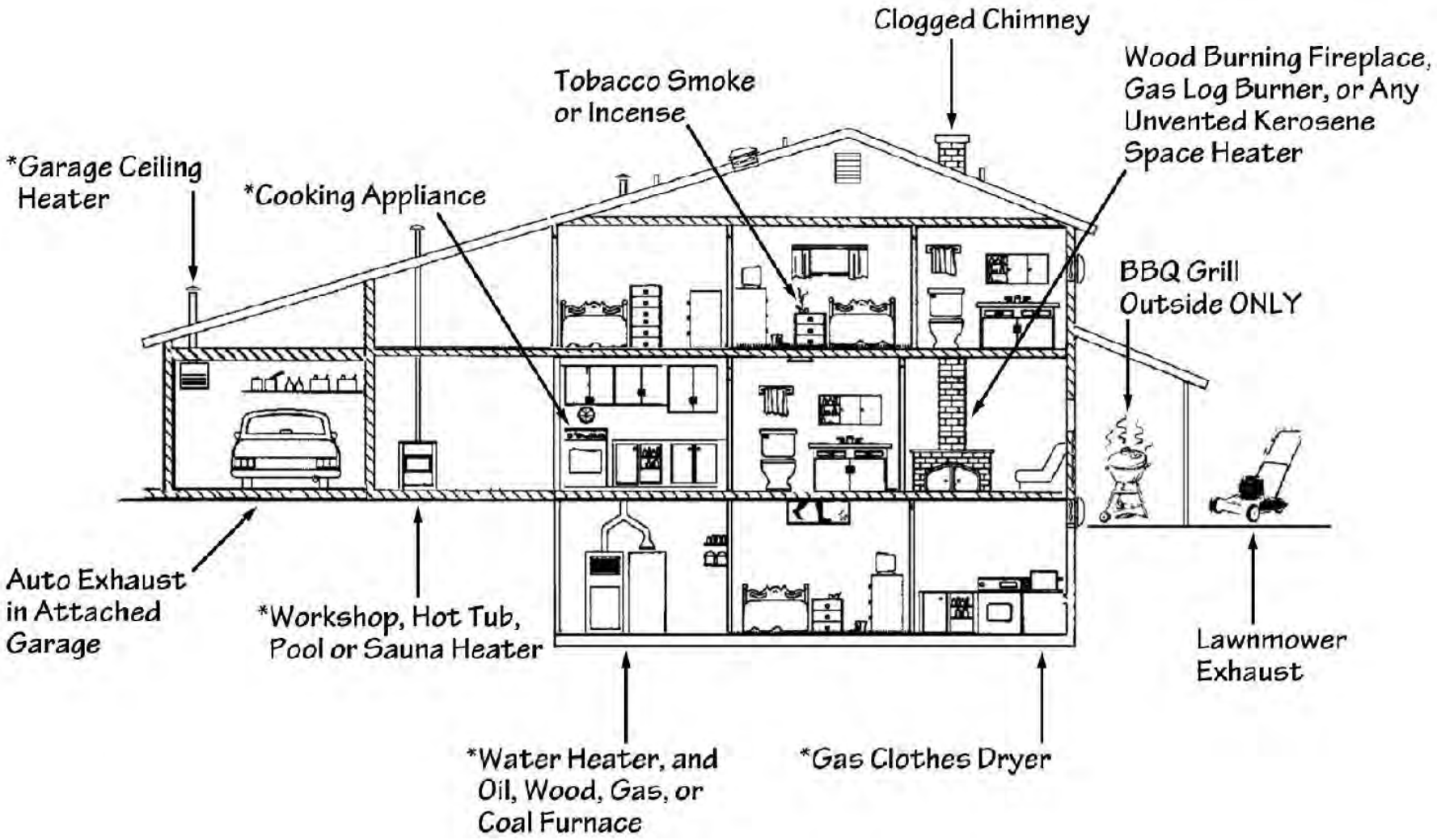
During 2001- 2003, an estimated 15,200 persons with confirmed or possible non-fire-related CO exposure were treated annually in hospital emergency departments, with most (64%) of the nonfatal CO exposures occurring at home (CDC/MMWR, 2005a).

Non-Fatal CO Poisoning

Some researchers suggest that CO poisoning commonly goes unreported or is medically misdiagnosed because symptoms can be easily mistaken for other illnesses such as the flu* and chronic fatigue syndrome** (Penney, 2000; Hampson, 2000; Comstock et al., 1999*, Knobeloch and Jackson, 1999**).

Therefore, although there is no reliable method for estimating the number of individuals who suffer from symptoms of CO poisoning, it may be considerably larger than reported.

Common Sources of Elevated CO in Homes



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Health Impacts of CO

The elderly, pregnant women, fetuses, young infants, and those with certain pre-existing health problems (e.g., those with cardiac or lung conditions) are most susceptible to health effects from CO exposure (EPA, 2000).

Some research has found that repeated exposures to CO, even at levels previously believed to be low, are capable of producing numerous, and persistent, adverse physical, cognitive, and emotional health effects in humans.

Populations at Special Risk

Sensitive populations include fetuses, those with chronic heart disease, young children, and the elderly, as well as people with chronic bronchitis or asthma.

Medical evidence suggests that aggravation of angina (chest pain) and other symptoms of heart disease could occur at CO levels below 70 ppm, an exposure level that usually does not cause symptoms in healthy individuals.

http://des.nh.gov/organization/commissioner/pip/factsheets/ard/documents/ard-ehp-20.pdf

Teratogenic Effects

In pregnancy, the fetus may be susceptible to the effects of CO, suffering serious and even permanent damage to the central nervous system.

- Infants born to women acutely exposed to high concentrations of CO while pregnant can have brain damage.
- Persistent fetal exposure to low levels of CO may result in a decrease in an infant's mental capacity.
- Prolonged exposure to a high level of CO, for example 100 ppm or greater, during gestation may produce a decrease in birth weight and delayed brain development.

http://des.nh.gov/organization/commissioner/pip/factsheets/ard/documents/ard-ehp-20.pdf

Hazards Identification

Exposure limits

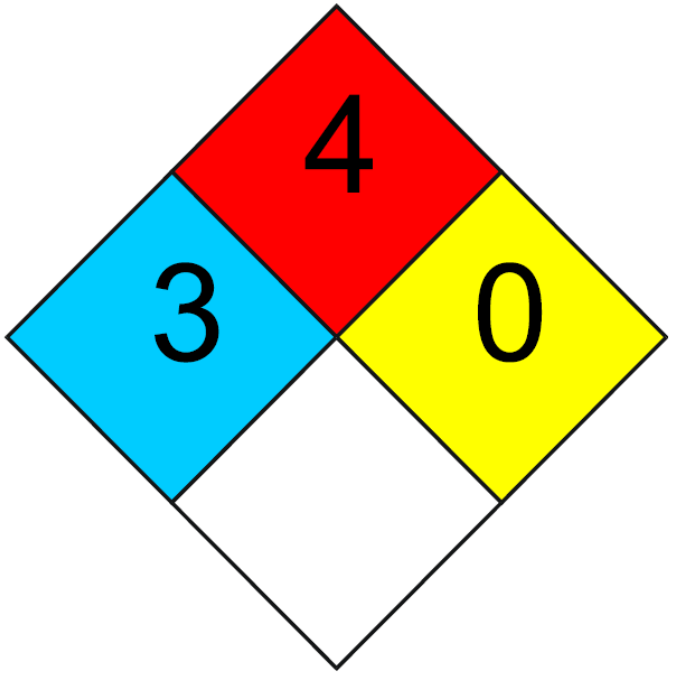
ACGIH TLV (United States, 2/2010).
TWA: 25 ppm 8 hour(s).

NIOSH REL (United States, 6/2009).
CEILING: 200 ppm
TWA: 35 ppm 10 hour(s).

OSHA PEL (United States, 6/2010).
TWA: 50 ppm 8 hour(s).

OSHA PEL 1989 (United States, 3/1989).
CEILING: 200 ppm
TWA: 35 ppm 8 hour(s).

NFPA RATINGS (SCALE 0-4):
HEALTH=3 FIRE=4 REACTIVITY=0



MAY BE FATAL IF INHALED. MAY CAUSE TARGET ORGAN DAMAGE, BASED ON ANIMAL DATA. FLAMMABLE GAS. MAY CAUSE FLASH FIRE.

http://www.airgas.com/documents/pdf/001014.pdf

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Carbon Monoxide: Properties

Should the placement of carbon monoxide (CO) detectors be influenced by the weight of carbon monoxide gas relative to air?

Numerous states and localities have recently passed legislation mandating the installation and use of residential carbon monoxide (CO) detectors/alarms. Interestingly, there seems to be confusion about the optimal placement, if any, of CO alarms inside the home.

National Center for Biotechnology Information, U.S. National Library of Medicine

Brownian motion, any of various physical phenomena in which some quantity is constantly undergoing small, random fluctuations. If a number of particles subject to Brownian motion are present in a given medium and there is no preferred direction for the random oscillations, then over a period of time the particles will tend to be spread evenly throughout the medium.

J Emerg Med. 2012 Apr;42(4):478-82. doi: 10.1016/j.jemermed.2011.03.015. Epub 2011 May 4.
Hampson NB1, Courtney TG, Holm JR.

Carbon Monoxide: Properties

It was the goal of this study to demonstrate the behavior of CO in air and to help provide a data-based recommendation for CO alarm placement.

CO was calculated to be slightly lighter than air. An 8-foot-tall airtight Plexiglas chamber was constructed and CO monitors placed within at the top, middle, and bottom. CO test gas (15 L, 3000 parts per million) was infused at each of the three heights in different trials and CO levels measured over time.

Diffusion is the physical process in which a substance tends to spread steadily from regions of high concentration to regions of lower concentration. Diffusion can therefore be considered a macroscopic manifestation of Brownian motion on the microscopic level.

Carbon Monoxide: Properties

RESULTS:

Contrary to a significant amount of public opinion, CO did not layer on the floor, float at the middle of the chamber, or rise to the top. In each case, the levels of CO equalized throughout the test chamber. It took longer to equalize when CO was infused at the top of the chamber than the bottom, but levels always became identical with time.

The Second Law of Thermodynamics is concerned with entropy. Entropy is produced by all processes and associated with the entropy production is the loss of ability to do work. The second law says that the entropy of the universe increases. An increase in overall disorder is therefore spontaneous. If the volume and energy of a system are constant, then every change to the system increases the entropy.

http://www.engineeringtoolbox.com/law-thermodynamics-d_94.html

Carbon Monoxide: Properties

CONCLUSIONS:

As would have been predicted by the Second Law of Thermodynamics, CO infused anywhere within the chamber diffused until it was of equal concentration throughout. Mixing would be even faster in the home environment, with drafts due to motion or temperature. It would be reasonable to place a residential CO alarm at any height within the room.

Entropy is defined as a measure of unusable energy within a closed or isolated system (the universe for example). As usable energy decreases and unusable energy increases, "entropy" increases. Entropy is also a gauge of randomness or chaos within a closed system. As usable energy is irretrievably lost, disorganization, randomness and chaos increase.

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UL 2075 and UL 2034

For products that are Listed to UL standard 2075 for the Standard For Safety for Gas and Vapor Detector and Sensors and Tested to UL 2075 using UL 2034 Sensitivity limits for carbon monoxide gas:

- The alarm points are: 70 ppm of CO after 60 to 240 minutes, 150 ppm of CO after 10 to 50 minutes, and 400 ppm of CO after 4 to 15 minutes, in accordance with the provisions of UL Standard 2034.
- They are not designed to measure compliance with Occupational Safety and Health Administration (OSHA) commercial or industrial standards.

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UL 2075 and UL 2034

These products are intended for use in ordinary indoor locations of family living units and office workspaces.

- To help avoid false alarms, these products are not intended for low level detection (below 30ppm) of carbon monoxide, per UL 2034.
- Individuals with certain medical problems may consider using warning devices that provide audible and visual signals for carbon monoxide concentrations below 30 ppm. (UL 2034)

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Symptoms of Carbon Monoxide Poisoning

Many cases of reported carbon monoxide poisoning indicate that while victims are aware they are not well, they become so disoriented they are unable to save themselves by either exiting the building or calling for assistance. Young children and household pets may be the first affected.

- Mild exposure: Slight headache, nausea, vomiting, fatigue (often described as “Flu-like” symptoms).
- Medium Exposure: Severe throbbing headache, drowsiness, confusion, fast heart rate.
- Extreme Exposure: Unconsciousness, convulsions, cardio respiratory failure, and death.

Symptoms of Carbon Monoxide Poisoning

CO Level in Air	Health Effects
0 ppm	Fresh Air
100 ppm	Slight headache after 1-2 hours.
200 ppm	Dizziness, headache, nausea after 2-3 hours.
400 ppm	Dizziness, headache, nausea after 1-2 hours / life threatening after 3 hours.
800 ppm	Dizziness, headache, nausea after 45 minutes, unconscious after 1 hour, death within 3 hours.
1,600 ppm	Dizziness, headache, nausea after 20 minutes, death within 2 hours.
3,200 ppm	Dizziness, headache, nausea after 10 minutes, death within 60 minutes.
6,400 ppm	Dizziness, headache, nausea after 1-2 minutes, death within 30 minutes.
12,800 ppm	Instantaneous effects, death within 3 minutes.

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