

Safetygram-17

Dangers of Oxygen-Deficient Atmospheres

General

Workers have lost their lives or been overcome by high concentrations of nontoxic, inert gases, such as nitrogen. Oxygen is the only constituent of the air that we breathe capable of supporting life. The normal oxygen content in air is approximately 21%. Nitrogen is the other primary component of air at 78%, with other trace components totaling approximately 1%. The presence of any additional gas in the air, with the exception of oxygen, dilutes the oxygen concentration and can create an oxygen-deficient atmosphere. As the oxygen concentration in the air diminishes, certain physiological effects take place in the human body. They can range all the way from giddiness, mental confusion, loss of judgment, loss of coordination, weakness, nausea, fainting, and up to and including death.

What Happens When We Breathe An Oxygen-Deficient Atmosphere?

As blood passes through the lungs, it gives up carbon dioxide and accepts oxygen through the thin walls of tiny air sacs. Oxygen-rich blood from the lungs takes less than 10 seconds to reach the brain. If an individual takes a few breaths of gas containing no oxygen (for example, pure nitrogen or helium), oxygen is washed from the lungs as it is replaced by the gas. Blood flowing through the lungs receives insufficient oxygen because no oxygen has been inhaled. In fact, the blood gives up what little oxygen it is carrying in an effort to equalize the oxygen content in the lungs.

Blood, severely depleted of oxygen, then travels to the brain, where tissues rapidly become oxygen-deficient. The result is swift unconsciousness because brain tissue is the body component most sensitive to the lack of oxygen. Within five seconds after inhaling only a

few breaths of oxygen-free gas, there is a rapid drop in the oxygen content of the blood. Mental failure and coma follow a few seconds later. Symptoms or warnings are generally absent, but even if present, the loss of mental competence and the weakness, loss of coordination, or fainting prevent victims from helping themselves or even summoning help. Death follows in just two to four minutes.

Effects of Continued Breathing of Oxygen-Deficient Atmospheres

The effects of continued exposure to oxygen-deficient atmospheres depend on several factors:

- Degree of oxygen deficiency
- Degree of physical exertion
- Individual susceptibility (e.g., smoker vs. nonsmoker)
- Individual health (e.g., emphysema)
- Altitude (e.g., locations above 2,000 ft. elevation)

Table 1 lists signs and symptoms for persons *at rest* exposed to various degrees of oxygen deficiency.

Any exercise increases the body's requirement for oxygen. Consequently, symptoms of oxygen deficiency will occur more rapidly, or at lesser degrees of oxygen deficiency in those who are actively exercising, than would be the case among persons at rest.

Air at higher altitudes contains the same concentration of oxygen, but the air is "thinner" and personnel tire more quickly. In a similar manner, personnel working strenuously will show signs and symptoms of low blood oxygen at air oxygen levels above those indicated on the table.



Precautions

Use of a continuous oxygen monitor is strongly recommended in work areas where significant quantities of an inert gas, such as nitrogen, are being used in systems that are not gas tight.

Workers in such areas should know and understand the physical properties of the gas being used. Gases that are lighter than air, such as helium, can collect near the ceiling. Conversely, gases that are heavier than air or very cold may tend to collect at or near the floor, or in low spots or depressions such as culverts, ditches, or manholes. These areas may contain little or no oxygen, while surrounding areas have normal air composition.

Always provide adequate air movement and ventilation, such as exhaust or floor fans, when using inert gas systems. Be aware that increases in production rates or gas consumption rates may require additional ventilation.

A vapor cloud or plume, created by condensing water vapor in the air, can be evidence of the release of cold gas vapors such as nitrogen, argon, or helium. As the gas warms up to ambient temperature, the danger is still present, without the warning of the visible plume, unless adequate dilution of the inert gas has occurred. **Do not rely on the absence of a visible cloud as evidence of a normal air atmosphere.**

No one must work in or enter atmospheres containing less than 19.5% oxygen*, unless equipped with self-contained breathing apparatus (SCBA) or a breathing air-supplied face mask. **This is also true for rescue personnel who can be overcome by the same oxygen-deficient atmosphere as the initial victim.**

Table 1. Signs and Symptoms of Oxygen-Deficient Exposure

Oxygen Content of Air	Signs and Symptoms of Persons at Rest
15%–19.5%	Decreased ability to work strenuously. May impair coordination and may induce symptoms in persons with coronary, pulmonary, or circulatory problems.
12%–15%	Respiration deeper, increased pulse rate, and impaired coordination, perception, and judgment.
10%–12%	Further increase in rate and depth of respiration, further increase in pulse rate, performance failure, giddiness, poor judgment, and blue lips.
8%–10%	Mental failure, nausea, vomiting, fainting, unconsciousness, ashen face, blue lips.
6%–8%	8 minutes, may be fatal in 50–100% of exposures; 6 minutes, may be fatal in 25–50% of exposures; 4–5 minutes, recovery with treatment.
4%–6%	Coma in 40 seconds, convulsions, respiration ceases, death.

Basic Rules

- Remember, oxygen-deficient atmospheres are an invisible danger. They have no warning properties. Never enter a suspected oxygen-deficient area without a source of supplied air.
- The only way to detect an oxygen-deficient atmosphere is with monitoring. Monitoring should be continuous.
- Provide adequate ventilation in areas where large volumes of inert gas are used.
- Review the Material Safety Data Sheets (MSDS) and train workers on the properties and safe handling of inert gases.
- When it is necessary to work in oxygen-deficient atmospheres, supplied air must be provided. Air can be supplied with either an air-supplied face mask or self-contained breathing apparatus (SCBA).
- When working in confined spaces, all the requirements of OSHA's Confined Spaces Regulations must be strictly followed.

First Aid

Anyone suffering from lack of oxygen should be quickly moved to an area with a normal atmosphere. If the victim is not breathing, artificial respiration should be administered immediately. Give supplemental oxygen with respiration if oxygen is available.

A coma resulting from the lack of oxygen is not always fatal. Know, practice, and use cardiopulmonary resuscitation (CPR) techniques.

** Standard recommended by the Compressed Gas Association, the National Institute for Occupational Safety and Health, and the Occupational Safety and Health Administration.*

Emergency Response System

- Call: **+1 (800) 523-9374** (Continental U.S. and Puerto Rico)
- Call: **+1 (610) 481-7711** (Other locations)
- 24 hours a day, 7 days a week
- For assistance involving Air Products and Chemicals, Inc. gases and equipment.

Product Safety Information

- Call: **+1 (800) 245-2746**
- Fax-on-Demand
- 24 hours a day, 7 days a week
- For Material Safety Data Sheets and Safetygrams
- Enter Index No. 1000 for a list of available safety literature.

Technical Information Center

- Call: **+1 (800) 752-1597** (U.S.)
- Call: **+1 (610) 481-8565** (Other locations)
- Fax: **+1 (610) 481-8690**
- E-mail: **gasinfo@apci.com**
- Monday–Friday, 8:00 a.m.–5:00 p.m. EST