2.3 The Human Need for Oxygen

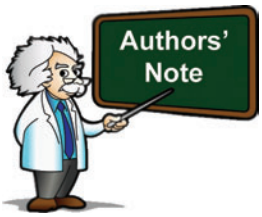
The earlier statement that two thirds of the human body is made up of oxygen is slightly misleading as the oxygen is combined with other substances, such as water and fat.

Molecular structures in body tissues store oxygen and require a constant supply of oxygenated haemoglobin to refresh them. As an illustration, a marathon runner must develop stamina to effectively respire air, providing oxygen to the blood, then transporting it to every cell in the body. As the respiration system tires and becomes less efficient, the runner starts to burn fat, extracting oxygen from the cellular fats. As a result, the body needs oxidised sugars or glucose at the end of the marathon, along with water to rehydrate the body.

To put into context the human need for oxygen, and the damage any lack of it can cause, the brain is the one organ of the body that contains little fat. A person entering a space with less than 20.9% oxygen rapidly experiences a lack of oxygen to the brain cells. The first symptoms of a lack of oxygen are lightheadedness, confusion, disorientation and difficulty in thinking. There is a danger of entrapment as escape may require more oxygen than is available.

The danger of confusion is a major point of this guide. Concern over other issues, such as the presence of toxic or corrosive substances and hydrocarbon gases causing a dulling of the senses, is also of interest. However, these issues are usually chronic and longer term rather than the immediately acute oxygen starved confusion that occurs in the majority of confined space entry incidents.

A person entering or caught in an atmosphere that does not have 20.9% oxygen could be described as having entered an ‘immediate confusion trap’. The atmosphere could also be soporific, ie causing drowsiness.



Brain cells die rapidly without oxygen, although the bloodstream may continue. This is known as anoxia or hypoxia. Notes taken from medical sources[1] elaborate further, 'cerebral hypoxia refers to a condition where the oxygen supply to the brain is decreased, though there is adequate blood flow. Drowning, strangling, choking, suffocation, cardiac arrest, head trauma, carbon monoxide poisoning can all lead to this'.

The words anoxia and hypoxia are often used interchangeably. In severe cases, a person may become stuporous or comatose, remaining unconscious for periods of time that range from hours to days, weeks and longer. Seizures, muscle spasms and neck stiffness may also occur.

Accurate measurement of the oxygen content in any space to be entered is of prime importance.

[1] Office of Communications and Public Liaison, National Institute of Neurological Disorders and Stroke, National Institutes of Health, Bethesda, MD20892, NINDS/NIH, January 2006

2.4 Nitrogen

While emphasis is on the oxygen portion of fresh air, nitrogen is its larger constituent, at 78% by volume.

Nitrogen does not support life and a person would asphyxiate typically in less than a minute if breathing an atmosphere rich in nitrogen.

Nitrogen, N_2, is a colourless, odourless and tasteless gas at ambient temperatures. Discovered by Rutherford in 1772, as an isolated gas, it is slightly lighter than the air that it is a component of.

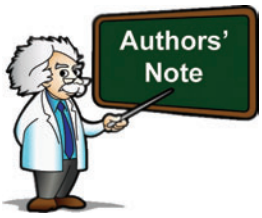
Nitrogen is unreactive with both air and water. It partially dissolves in water and this should be remembered when assessing a space as dry and fit for entry. A major point regarding the nitrogen content of air is that the concentration of 78% volume is a fine balance and this volume suits human respiration.

A reduction of the oxygen content can be caused by an unexpected release of nitrogen in a space. Several shipboard activities may create this situation, for example using high purity nitrogen gas in confined holds, tanks and pipelines as an inerting and positive pressure anti-contamination medium. The asphyxiating effect of nitrogen gas at a supply point or in a space may deplete the oxygen supply to the brain, with a sudden and possibly fatal result.

Nitrogen is not the only gas that can asphyxiate by diluting the oxygen content to lower than 20.9% by volume. For example, carbon dioxide, CO_2, may also prevail, depending on the operations that were previously carried out in the space.

2.5 Carbon Dioxide

Carbon dioxide (CO_2) is not usually seen as reactive, flammable, corrosive or toxic, but it should not be considered as safe. CO_2 exhaled by humans and other mammals is present all around us. CO_2 is also one of the products of combustion. It has a vapour density at STP of 1.5 times the density of air and it is similar to nitrogen in that it can displace other components in air, eg oxygen.



A more immediate hazard associated with both personnel and management should be recognised - the human weakness of blind determination. This is discussed in the next chapter.

CHAPTER 3

The Adrenalin Rush and Feeling Superhuman

Fully understanding the need for a healthy oxygen supply in fresh air, it is appropriate to look at the sensation experienced by many people in times of crisis or high excitement, that of 'adrenalin rush'.

Adrenalin is a hormone released in the body at times of fear, stress, high demand and determination. Imagine someone caught in a trap who seems to gain superhuman strength, allowing him to escape. A person who experiences this may feel an emotional effect after the event, ranging from a shudder of fear at the thought of what just happened to some form of pride in actually dealing with the crisis.

When adrenalin rush is discussed in incident reports, there are repeated occasions when senior and experienced personnel are involved, ie people with plenty of training and decision making powers who should know better. This either happens when confined

space entry was not prepared for or when a crew member gets into difficulty. The senior person, who is often alone, enters the space to carry out a rescue, with few safety precautions. The history of this topic is littered with such events.

How does this sensation occur?

In circumstances of sudden fear or fright, adrenalin is released from the adrenal glands, located near the kidneys, causing an increase in heart rate, pulse and blood pressure. The smaller breathing tubes, bronchioles, in the lungs become dilated and the oxygen supply to the muscles is increased, while feeling is reduced in peripheral areas such as the fingers. These may become cold to the touch.

An increased rate of oxygen-carrying blood flow goes to the muscles and the affected person becomes immediately more reactive, with