Handling dangerous gases - Oxygen

Almost every ship in the world carries oxy-acetylene equipment. The uses for these versatile gases are almost infinite – cutting and welding a variety of metal and even non-metal surfaces. Wilhelmsen Ships Service produces a comprehensive welding manual which looks at how to get the best performance out of this equipment, which has proved invaluable to ships crews over many years.

However, how much do crew members know about the gases themselves? Over the next few issues, this magazine will take a look at gases, and the dangers that can face crews and the ships that carry them.

Oxygen in High Pressure cylinders

Welding oxygen and medical oxygen are often considered harmless compared with acetylene or other combustible gases. This is not the case. Oxygen gas makes up approximately 21% of the atmosphere, which is sufficient to cause metal to rust, fires to burn out of control, and certain foods to turn sour. Consider how much more dangerous the environment inside a compressed oxygen cylinder must be – a source of near-pure oxygen, at more than 150 times normal atmospheric pressure.

Oxygen enrichment

Fire hazard

Any air mixture with an Oxygen content of more than 21% is considered oxygen enriched. A content of 23% oxygen in air, only 2% above the normal atmospheric content, has to be considered an extreme fire and explosion hazard. The most common cause of oxygen enrichment on board a ship is a leak in one of the systems using compressed oxygen, and the most common of these is gas welding and cutting equipment. There is an increased risk of an explosion if the oxygen leak is in a confined space where the welder has stopped work for some time and restarts, creating a spark.

Compared with a fire in normal air, a fire in an enriched oxygen atmosphere is more intense, burns with higher temperatures, and has a greater heat output. In most circumstances an oxygen fire cannot be extinguished until the source of oxygen feeding the fire has been isolated.

Sources of ignition

In order to start a fire we need an ignition source, fuel and an oxidizing agent. A source of ignition can be a spark from a grinder or a welding process, electric equipment short-circuiting or machinery overheating or misfiring.

In an oxygen enriched atmosphere, this changes significantly. In general the same rule applies, but the amount of heat and fuel needed decreases dramatically. Even the smallest trace of grease or oil in an oxygen enriched atmosphere will have the potential to self-ignite. This effect creates hazards which are difficult to predict and prevent when working on board.

Clothing exposed to oxygen

Not many crew on board ship are aware that clothing absorbs oxygen. Consequently, the clothing of a person who has been exposed to any oxygen enriched atmosphere retains a high concentration of oxygen for some time and is highly susceptible to fire. They must avoid sources of ignition, and must refrain from smoking for at least 15 minutes until the oxygen in their clothing has been replaced by normal air. Many so-called 'non-flammable' textile materials will burn fiercely in oxygen-enriched air. Using clothing treated with a flame retardant can be useful only when the enriched oxygen concentration stays very low, but their retardant properties reduce considerably when the oxygen concentration increases. Above 25% oxygen concentration, they have no protective qualities at all.

Lack of Oxygen

Asphyxia

Lack of oxygen in the atmosphere is also extremely dangerous. In this case the danger is asphyxiation. Asphyxiation is usually associated with nitrogen and other inert gases, such as argon, CO2 and helium, since they do not support life and are capable of reducing oxygen concentration to very low levels through displacement and dilution. Most accidents occur due to crew entering rooms or tanks that are connected to a nitrogen supply and that have not been properly checked for oxygen levels before entry. Complete entry is not necessary for a fatal accident to occur: fatalities have occurred where crewmen have simply leaned in to inspect a tank with an oxygen depleted atmosphere. Inhalation of an oxygen depleted atmosphere can cause a person to immediately lose consciousness without warning and die from asphyxiation. Tragically, there have been many examples of fellow crewmen going to the aid of victims and becoming victims themselves because they were not aware of the cause of the initial incident.

Oxygen means life

Oxygen is the only gas that supports life. Any depletion of oxygen below 21% must be treated as hazardous and relevant precautions taken. The overall effects of reduced oxygen concentration is summarised as follows:

21-18%	No symptoms are detectable.
18-11%	Reduction of physical and intellectual performance.
11-8%	Possibility of fainting within minutes without prior warning.
8-6%	Fainting occurs after short time, resuscitation possible if carried out immediately.
6-0%	Fainting almost immediate, brain damage even if rescued.

No warnings

Inert gases such as nitrogen, argon and helium are odourless, colourless and tasteless and, as a result, give no warning of their presence and the inevitable reduction of oxygen content of the local atmosphere. For an unaware crew member,

the asphyxiation effect of inert gases takes place without any preliminary physiological signs. The action can be very rapid, only a few seconds for very low oxygen contents. In other words “you do not notice you are passing away”. For longer exposures to oxygen-depleted atmospheres the symptoms of asphyxia may present themselves as rapid breathing and shortness of breath, rapid fatigue as well as nausea and vomiting. However, it is not unusual for the person suffering from asphyxia to be totally unaware of the symptoms and they may even feel euphoric. It can take as little as two breaths in an oxygen deficient atmosphere to cause unconsciousness and death.

The solution: constant monitoring of air quality

The only way to prevent crew from entering into an oxygen enriched or depleted atmosphere is air sampling and analysis. The easiest way to achieve this by equipping the crew performing the work with portable oxygen detectors, enabling the crewmembers to monitor the air constantly even while working. And it is the constant monitoring which is of vital importance, as some processes may change the air composition in the room or tank either increasing or reducing the oxygen level.

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