

## Safety Guidelines

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## Safety guidelines for working with cold media

### Introduction

Working with cold media implies a number of specific safety risks.

The products concerned are basically nitrogen, oxygen, argon and helium. By taking into account the characteristics of these products in a cold condition, and to realise what effect they have on humans and their environment, the chances of an accident can be minimised.

The information below enables you to identify the dangers and shows you how you can protect yourself and others.

### 1. Coldness

The liquids most frequently used in the industry at low temperatures are liquid oxygen, nitrogen argon and helium. Oxygen, nitrogen and argon are liquid from approx. 186 °C below zero while helium is liquid from 269 °C below zero. Exposing the body to products with such a low temperature leads to freezing of tissue and so called cold burns.

Cold burns can also occur when touching un-insulated machines and piping through which these extreme cold products are flowing.

#### *Steps to be taken*

1. The frozen tissue must be defrosted as soon as possible. This can be realised by submerging the frozen body part in water with a temperature of 40 °C until it has regained its original colour.  
NOTE: In case clothing is frozen onto the skin, NEVER TRY TO REMOVE THIS CLOTHING! By doing that, also the skin below it is removed. The skin acts as protective layer, even if frozen!
2. Bandage the burnt part with sterile dressing.
3. Consult a doctor.

Breathing the extremely cold vapours that can be released with liquid products at low temperatures can lead to freezing of the bronchi and the lungs.

If one has been exposed to this, a doctor must be contacted immediately.

If one has been exposed to cold during a prolonged period of time, hypothermia can occur.

In such a case the victim must be wrapped in a warm blanket before being transported to hospital.

Should a splash of a cold product end up in the eye, medical assistance must be called immediately.

### **Precautions**

Many of the problems described above can be prevented by taking the correct precautions such as:

1. Screening off those areas in which work is performed with extremely cold products.
2. Wearing protective clothing with which the body is covered to a maximum, wearing leather work gloves and safety glasses.

#### *Influence on materials*

Other materials that become extremely cold due to e.g. leaking liquids, can become hard and brittle and break, becoming as sharp as glass. Concrete exposed to low temperatures for a prolonged period of time can disintegrate and turn to powder.

Carbon steel becomes brittle at temperatures below 20°C below zero, and applications of these materials must be avoided in such situations as much as possible.

Plastics and rubbers become hard and brittle at lower temperatures and break easily.

#### *Liquid air*

Air becomes liquid at 193°C below zero. Liquid air can occur around non insulated machines and piping with a temperature lower than 193°C below zero. The surrounding air can condense on the cold material. The liquid air flows off the piping as if it were water and can for example come into contact with persons.

#### *Vapour clouds*

During leakage or blow-off of an installation in the case of over pressure, vapour clouds can occur.. In these clouds the water is freezing and ice patches can occur on the floor. Also the view is obscured. Entering these clouds can result in danger of suffocation (See next chapter).

## **2. Suffocation**

Suffocation can be described as the loss of life due to lack of oxygen. Normal air consist for 21 % of oxygen. For a safe living environment, the oxygen percentage in the ambient air must lie between 19,5% and 22% .

The danger in working with gasses lies in the fact that most gasses are:

- ▶ invisible
- ▶ odourless
- ▶ tasteless
- ▶ not tangible

They can therefore not be detected by our senses.

Nitrogen, argon and helium are so called inert gasses, i.e. the do not chemically react and therefore do not support oxidation. For that reason they are used for flushing vessels and piping, for high-tech welding and leakage detection. Thus situations can occur in which piping, vessels etc. are filled with these gasses whilst they can not be detected.

Machines in which gasses or liquids under pressure are processed are fitted with an overpressure safety. Via this overpressure safety gasses can be blown off in the environment as a result of which situations can occur in which

the oxygen concentration no longer meets the norm.

During evaporation of liquid argon, nitrogen or helium one part liquid will form about 800 parts gas. When one of these liquids evaporates in a particular space, then the oxygen concentration can drop to a level whereby a life threatening situation will exist.

#### ***Measures to be taken***

If you see someone collapse, do not try to rescue this person, but leave the area or room as soon as possible and alert someone in possession of a breathing apparatus.

Many suffocation accidents have two victims; the person that collapsed and the one who has assisted him or her.

#### ***Preventive measures***

1. Ensure there is proper ventilation in all spaces where gas or liquid argon, nitrogen or helium is used.
2. Connect any blow off valves to piping that leads to the outside air. Ensure that this blow off point is sufficiently far away from the inlet point of the ventilation system.
3. In case of doubt, fit oxygen sensors that measure the oxygen in the environment and raise an alarm in case of danger.

#### ***Fire hazard***

Oxygen is necessary for combustion. The higher the oxygen concentration, the lower the energy necessary to realise ignition. The warmth of the discharge sparks of static electric energy, or rapid compression of oxygen gas can be sufficient to start a fire.

Air can condensate against very cold surfaces. At this point, extremely high concentrations of liquid oxygen occur. When working on these cold surfaces of for example liquid nitrogen or helium piping the same safety guidelines must be used as with oxygen. Therefore, when oxygen is released, there is a high fire hazard.

#### ***Precautions***

1. Fuel, an ignition source and oxygen are required for a fire. In case of uncontrolled release of oxygen one can only control the ignition source. Consider e.g. sparks caused by static electricity generated by clothing and sparks generated by electrical equipment such as switches and phones.
2. Ensure there is maximum ventilation.
3. Keep the working environment free from combustible materials as far as is practically feasible.
4. Let the oxygen vent from your clothing for a period of about 15 minutes when you have worked on locations where high concentrations of oxygen might have been present.
5. Valves in oxygen systems must be opened slowly to ensure the pressure increases slowly.
6. Ensure that all parts are degreased to ensure trouble free use in oxygen.
7. NEVER apply non-approved grease in oxygen environment.

#### 4. Disassembling piping and fittings

The above described risks, and the measures to be taken in that respect, are also important when working on cryogen systems where piping sections or fittings have to be disassembled.

Personal protection means, such as gloves, safety glasses and safety shoes must always be worn.

Ensure when disassembling that the system is not pressurised and bear in mind that cold liquids and gasses can escape. Before starting the disassembly, the product supply must be shut off.. Usually this will be done by closing the valve to the storage tank. This valve must be locked in such a way that it can not be opened by unauthorised persons during the disassembling.

Piping can be under pressure as a result of the still existing system pressure, or by build up of pressure due to evaporation of the medium. The pressure that is created because the liquid evaporates due to heat ingress, can rise considerably. After closing the supply, the piping will have to be depressurised.

This can be done in various ways:

- ▶ When a valve is fitted on the end of the piping which is directly venting to the ambient air, it can be opened carefully.
- ▶ When the piping system is constructed in sections with removable couplings, one of the couplings can be disassembled in steps. When the coupling halves are held together with a clamp, then the nut on the clamp will have to be partly unscrewed. Then the clamp can be tapped loose using a hammer, in such a way that a small space is created between the clamp and both coupling halves. Now both piping sections can be slightly moved apart. The nut is released a little more, and the piping can be separated a little more again. Repeat until the entire clamp is loose. When the coupling halves are connected using bolts, then all bolts must be partly unscrewed and both piping sections can be moved apart a little. This is repeated several times until the bolts are completely. The above also applies to removing the end caps.
- ▶ When a safety is build-in in the piping system, it can be carefully disassembled.

During all these procedures, one must be aware that cold liquid and cold gas can escape under high pressure and can squirt in unexpected directions.