

**PIPELINES AND ACCESSOIRES FOR OXYGEN IN PRODUCTION PLANTS****PAGE DE GARDE / FRONT PAGE**

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a	20.02.98	Fano R Mathé		Voids and replaces GS.350.30 and GS350.21 Reaffirmed in Microsoft® WORD. § 3.1.2 welding neck flanges and § 3.1.3 flat gasket
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**PIPELINES AND ACCESSOIRES FOR OXYGEN IN PRODUCTION PLANTS**

## 1 INTRODUCTION

### 1.1 Scope

The aim of the present specification is to define the technical requirements concerning design and installation of pipelines for oxygen (gaseous or liquid) and enriched air with an oxygen content reaching or exceeding 35%. It applies to pipelines of this type which are part of the production plants for which L'AIR LIQUIDE provides engineering.

### 1.2 Particular risks related to oxygen

Being a very active comburant, oxygen revives or gives rise to all kinds of combustion, as soon as its content exceeds 25 %. Combined with oxygen, combustible gases form explosive mixtures.

In oxygen, all greasy matter, organic or metallic dust, may inflame extremely easily and enter into strong combustion, if ignition is provoked by impact, a sparkle, heating, etc...

Therefore, in the presence of oxygen, only chosen materials (with high combustion temperature and low calorific value) may be employed. Likewise, all cause of local temperature rise must be avoided.

Gaseous oxygen is slightly heavier than air, especially when cold. Attention to oxygen accumulations in pits and ducts!

### 1.3 Standard abbreviations

The following abbreviations are currently employed:

- GOX : Gaseous Oxygen
- LOX : Liquid Oxygen
- RL : Rich Liquid (enriched liquid containing more than 35% of oxygen)

In our installations, RL and LOX are treated according to the same rules.

## 2 RÉFÉRENCES

External documents issued by EIGA-IGC

- Pipeline transport system for oxygen IGC-13/82

Internal documents issued by the Technology Department (AL-DTEC)

- Information notice NI 256 (oil and greases).
- Information notice NI 319 (non metallic materials).



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### 3 DESIGN SPECIFICATIONS

#### 3.1 Materials compatible with oxygen

##### 3.1.1 General

Material have to be in solid form ( sheets, tubes, forged or cast samples...)

In the presence of oxygen, the use of the following metals and alloys is authorized:

- At low temperatures (-20 to -200°C):
  - Austenitic steels with high nickel-chromium content, such as 18-8 or 18-10
  - Nickel
  - Copper, brass, bronze
  - Aluminum and alloys (exclusively for static components, when there is no risk of friction)
  - Cupro-aluminum
  - Copper and silicon alloys
  - Monel, Inconel, "Invar"
  - Gold, silver
- At temperatures close to ambient temperature
  - Same metals and alloys as above, in addition:
  - Carbon and carbon manganese steels ( thickness > 2mm )
- At temperatures higher than ambient temperature
  - If operating temperature is  $\leq 180^{\circ}\text{C}$ , every kind of steel may be used ( carbon steel thickness > 2mm and stainless steel thickness > 1mm ). In case of temperatures of higher than  $180^{\circ}\text{C}$ , choice of the materials is subject to approval by the metallurgy specialist.

Utilization of aluminum and its alloys is prohibited above a steady temperature of  $+50^{\circ}\text{C}$ . Non metallic materials authorized in a special utilization context are treated at a later point.

##### 3.1.2 Piping components

For piping designed for operating temperatures of under  $-20^{\circ}\text{C}$ , stainless austenitic steels type Z3CN18.10 or equivalent (AISI 304L) shall be used. All grades of nickel stainless austenitic steels with low carbon content or stabilized (Ti, Nb) may be used.

For flanged connection, only welding neck flanges are to be used. Others types are allowed only when welding neck flanges cannot be used.

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### 3.1.3 Gaskets

Recommended practice consists to use flat gaskets agreed for use with O<sub>2</sub> (BAM or L'AIR LIQUIDE D.T) :

Flat gaskets consist of :

- Expanded carbon with S.S reinforcement (Klinger KGL SLS) or nickel (Supranite NG).
- Fiber PTFE (Klinger TopChem 2000 or Supranite PGAC).

The spiral-wound gaskets contain a stainless steel web with amorphous graphite insert and double centering ring.

The annular metallic gaskets for flanges may be made of soft iron (armco), copper or stainless steel.

Other materials authorized:

- Teflon, Kel F, Viton, adapted to oxygen contact
- Copper and certain copper alloys
- Aluminum and certain aluminum alloys
- Lead and lead-tin alloys
- Nickel

These materials may be combined, e.g. metal/plastic gasket, reinforced Teflon (the reinforcement must be compatible with oxygen).

### 3.1.4 Lubricants, sealing compound

Exclusively tolerated are :

- clean water
- "Rectoseal 15" (pressure <10 bar - prohibited by L'AIR LIQUIDE on liquid oxygen)
- pure graphite
- All other authorized products are enumerated on a list which is periodically updated by the Technology Department. It is therefore necessary to consult the specialists for each specific case.

All products except for water must, in any case, be used sparingly.

### 3.1.5 Filtering elements

They may be made of copper, bronze or non combustible material under defined application conditions.

Austenitic stainless steel may only be applied under certain circumstances :

- Operating temperature < to 100 °C,
- Diameter of the fibres > to 0,8 mm



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### 3.1.6 Insulating material

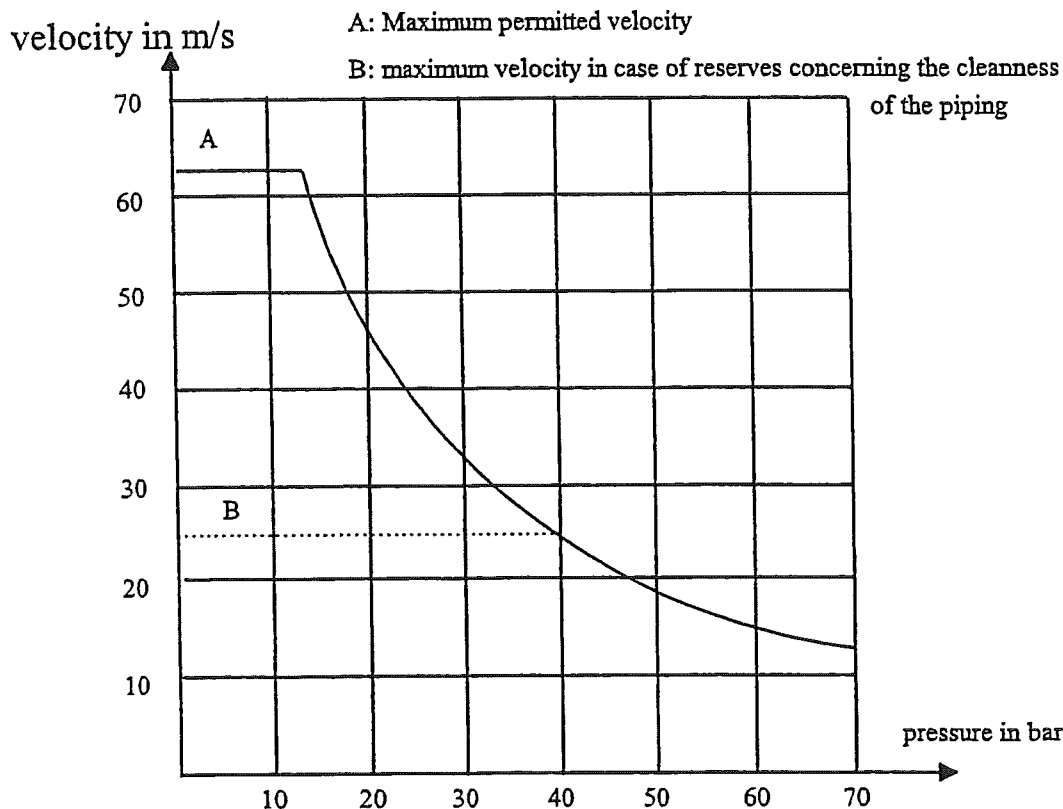
Authorized material :

glass wool (maximum oil content permitted : 0,175% of the weight),  
mineral wool (maximum oil content permitted : 0,175% of the weight),  
expanded silica (Perlite),  
diatomite (Kieselguhr),  
magnesia carbonate,  
foamglass, used without combustible sealing compound  
vacuum space

## 3.2 Permitted flow velocity

### 3.2.1 Gaseous oxygen

With the exception of pressure reducing valves, in which case it is generally incontrollable, the flow velocity permitted for gaseous oxygen under steady flow is defined by the document IGC 13/82, according to the below-mentioned diagram. For components of reduced cross section, the smallest cross section shall not be less than 1/3 the cross section of the pipeline.





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### 3.2.2 Liquid oxygen and "rich liquid"

The flow velocity generally permitted in cold pipelines, at steady flow, is not limited for safety reasons, but because of possible pressure drop and vaporization risks. Current flow velocity: in cold box, LOX and RL are currently circulating at a velocity of 1 to 2 m/s.

## 4 INSTALLATION RULES

### 4.1 Routing of piping

Oxygen piping and its support system (anchors, free support, deformable components) must be designed in view of avoiding formation of local stresses.

For circuits at temperatures of  $> -50^{\circ}\text{C}$ , dead ends at the extremities of the piping must be avoided, which entail:

- risk of stationary waves, which are heat generating
- low points in which impurities might accumulate, which are liable to cause fire.

Furthermore, protrusions (set-in branch pipe, collapse of weld seam at the root) in the interior of the piping must be avoided at maximum, as they might be stricken by solid particles in movement, thus causing sparks.

### 4.2 Components

Pipeline components are defined by the document "classes of piping"; nevertheless, certain rules must be described in more detail:

#### 4.2.1 Junctions

Junctions consisting of flanges or connecting elements entail always the risk of leakage. They are to be avoided inside of buildings, and their use in channels, pits and tunnels is to be prohibited.

#### 4.2.2 Valves

Only shutoff valves may be manual and answer to the requirements of IGC-13/82 §3.6.1. In case of a fluid temperature of  $> -50^{\circ}\text{C}$ , the operator must be protected when handling them, e.g. by using an extensible angle rod and a fire protection screen..

A minimum distance of 0,5 m must be left between two valving elements.

No valves may be installed in channels or pits. If a valve is installed in a closed space, measures for remote handling must be taken: extensible rod and fire protection screen or, even better, handling by remote control.

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### 4.2.3 Filters

The filtering cartridge must be such as to resist to the total incoming static pressure, in order to avoid all risk of breaking of this cartridge. Only the following materials may be used:

- sintered bronze
- copper alloy
- nickel alloy

### 4.2.4 Vents and silencers

Venting gas must be evacuated outside of buildings, pits and channels, in an adequately ventilated place, in order to avoid dangerous local oxygen increase of the air. Outlets have to be protected against air pollutants (leaves ...). Isolation of mineral wool or glass wool have to be without non O2 compatible bonding agent or/and reinforcing material, perforated sheets should be free of barbs.

## 4.3 Grouping of pipelines

### 4.3.1 Above-ground piping

It is preferable to instal oxygen piping at the edge of the racks, protected from impact and vibrations.. They have to be kept at a distance of at least one meter from pipelines containing a combustible fluid or a fluid at high temperature. In case of a hot pipe, insulation must be provided in such a manner as to avoid temperature rise of the oxygen pipeline of more than 10°C.

An oxygen pipe must never be used as support for another pipeline. The pipelines must be protected from accidental impacts of vehicles or handling devices.

No high voltage or medium voltage line may ever pass over oxygen pipelines without appropriate protection (e.g. insulating net).

### 4.3.2 Underground piping

Tunnelled piping (passage of routes or railways) may be in the vicinity of power cables, under the condition that

- the portion of the pipe which is in the vicinity of the power lines is not fitted with any flange or valve
- the power lines be insulated with a lead insulator and do not comport any pigtail or connections; furthermore, the entire length of the power line which is in the vicinity of the piping must be supported.

Underground pipes are coated with a tissue on fiber glass base and epoxy resin or tar (quality C - thickness 4 mm) ensuring an electric insulation of at least 10000 ohms per square meter of installed piping. They are fitted with a cathodic protection.

### 4.3.3 Surrounding ground

In the proximity of the oxygen system, the use of asphalt, bitumen, wood and combustible materials is prohibited.





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#### 4.4 Metering and distribution station for gaseous oxygen

- Installation of the station at an adequately ventilated emplacement, sufficiently away from buildings and surrounding facilities (refer to AL-GR.204.41)
- Installation of a shutoff valve at inlet and outlet of the station.
- Make provisions for remote control of the shutoff valves and important components of the station.

#### 4.5 Distribution station for liquid oxygen

- Installation at an adequately ventilated and sufficiently isolated emplacement.
- No above-ground piping for inflammable matter may ever cross the station. In case of such a piping in proximity of this zone, it must neither include flanges nor connections and must be protected against possible spilling.
- The ground must not be asphalted.

#### 4.6 Safety measures

##### 4.6.1 Protection screens

Protection screens of non porous material and at sufficient height (at least 2,5 m) must be installed at emplacements known as being dangerous. They must provide at least two exit directions in case of emergency.

##### 4.6.2 Safety shower

Safety showers may be installed at proximity of points with fire risk, in particular:

- the oxygen compressor,
- the distribution and pressure reduction station of GOX,
- LOX pumps.

If a safety shower is installed, it must be placed close to the source of the hazard, but sufficiently protected, e.g. by a protection wall. Furthermore, it must be installed towards the exit. For design of the safety shower refer to AL-SE.285.12

##### 4.6.3 Fire extinguishers

Appropriate fire fighting equipment must be installed at adequate emplacements (refer to AL-GS.284.01).

**PIPELINES AND ACCESSOIRES FOR OXYGEN IN PRODUCTION PLANTS****4.6.4 Safety instructions**

They have to be posted in the premises of the plant and treat the following items:

- prohibition to smoke,
- prohibition of all open flame,
- ventilation of pits and confined places,
- elimination of grease and waste material (clothing, tools, rags),
- as soon as the plant is in operation, a fire permit is to be obligatorily issued by the site manager, prior to any intervention involving open flame or an electric arc.

Furthermore, while installations are in operation, it is recommended:

- to avoid staying at proximity of the oxygen system,
- to handle with caution sectioning valves (if possible, after pressure balancing.) Incomplete balancing is prohibited

**5 SETUP INSTRUCTIONS****5.1 Cleaning, degreasing and verification of the components**

All pipeline components must comply with the requirements specified in standard AL-CS.274.01

**5.2 Flat gaskets**

Flat-surface flange gaskets must not protrude inside the piping, and their interior diameter must be slightly larger than the diameter of the assembled tubes.

**5.3 Welds**

All welds on piping must be completely penetrated and as regular as possible. They must not present any surface irregularity or noticeable raise at the interior of the piping. The weld accessible from the inside of the pipe shall be carefully ground off from the inside of the pipe, and the particles caused by the grinding eliminated. For the other welds, a first TIG layer shall be carried out, followed by filling with fuse electrode, or on copper backing strip which shall be withdrawn after welding operation.

Weld on permanent backing strips are prohibited.

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## 5.4 Electrical continuity of the gas pipelines outside cold box

In order to avoid accumulation of electrical charges on the pipelines, the set of flanges shall be fitted with equipotential connections, according to standard AL-GR.358.15.

For the same reason, the electrical continuity must be ensured between valve casings and their driveline assemblies.

## 5.5 Cathodic protection

Underground pipings must be protected against corrosion, as a rule by cathodic protection.

Protection of above-ground pipelines for gaseous oxygen must be ensured by the installation of a seal insulator, in conformity with standard AL-SD.358.11

# 6 VERIFICATION AND TESTING

## 6.1 Verification of the weld

Workmanship and procedures applicable to welding of piping elements, as well as the verification of the welds, shall be determined according to standard AL-GS.350.10.

## 6.2 Pneumatic test

Pneumatic tests, if occurring, must be carried out with perfectly dry and oilfree gas.