



LIQUID AIR

Doc 197/21

Revision of EIGA Doc 197/15

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Prepared by SAC

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Amendments to Doc 197/21

Section	Change
4.2	Prevention of accumulation of contaminants

Note Technical changes from the previous edition are underlined

1 Introduction

Starting from the 1990s a number of applications for the use of liquid air, particularly within the food industry, were identified and as such there was an increase in its production and use.

In recent years liquid air has been proposed as an “energy vector”, in both the electricity grid and in transport.

Liquid air can also be used as raw material to fill compressed air gas cylinders, for industrial and breathable applications.

Liquid air has properties that differ from those of other cryogenic liquids, such as liquid oxygen or liquid nitrogen, and which can give rise to specific safety hazards.

The European Industrial Gases Association (EIGA) has therefore recognised the need for a publication addressing safety in production, storage, distribution and use of liquid air.

2 Scope and purpose

2.1 Scope

This publication applies to the production, permanent storage and transportation of liquid air.

General guidelines for the application of liquid air are also covered, but it is not the intention of this publication to review specific applications.

Breathing applications may require additional safeguards or be covered by additional legislation.

2.2 Purpose

This document is intended to provide guidance to EIGA members and their customers for the safe production, storage, transportation and use of liquid air.

It is intended to explain the specific nature of this two-component product and the need for expert involvement in all aspects of production and use of liquid air.

3 Terminology and definitions

3.1 Publication terminology

3.1.1 Shall

Indicates that the procedure is mandatory. It is used wherever the criterion for conformance to specific recommendations allows no deviation.

3.1.2 Should

Indicates that a procedure is recommended.

3.1.3 May and need not

Indicates that the procedure is optional.

3.1.4 Will

Used only to indicate the future, not a degree of requirement.

3.1.5 Can

Indicates a possibility or ability.

3.2 Definitions

3.2.1 Liquid air

Air in a cryogenic liquid state, having a typical composition of 21% (by volume) oxygen, with the balance essentially nitrogen.

3.2.2 Tank

Thermally insulated tank that can be filled with a cryogenic liquid for storage purposes.

3.3 Tanker

Vehicle used for the transport of cryogenic liquid in an insulated vessel.

4 General

4.1 Physical properties of liquid air

The properties of liquid air vary slightly depending on the exact percentages of the components.

The table below gives the properties for a typical mixture.

Properties of mixture of 20% Oxygen, 80% Nitrogen, mixture by volume	
Boiling point (bubble point) at 1.013 bar absolute	78.7 K
Vapour Density at 0°C	1.29 kg/m ³
Molecular weight	28.81

Table 1: Properties of Liquid Air

4.2 Precautions

Because liquid nitrogen has a lower boiling point than liquid oxygen, if liquid air is stored in a closed vessel (tank or tanker) with a headspace containing gas above the liquid, the gas phase will have a higher concentration of nitrogen and the liquid phase will have a higher concentration of oxygen. When a release of gas occurs the oxygen content of the liquid phase will increase.

In a similar way, the concentration of contaminants such as hydrocarbons, carbon dioxide and nitrous oxide can increase in the liquid phase when the liquid is vaporized since the gas leaving the system does not contain the contaminants. Precautions should be taken to prevent accumulation of these contaminants to unacceptable levels. One common way to avoid high levels of enrichment is to ensure a withdrawal of some of the liquid air from time to time. This purge provides a way for the contaminants to leave the system.

It is because of these specific properties that liquid air shall be handled with care at any point where it is or may be liquid, since oxygen enrichment of the liquid and oxygen deficiency of the vaporised gas, can occur.

Precautions shall also be taken against the hazards associated with the low temperatures of cryogenic liquids. These precautions are detailed in documents such as:

Doc 44 - *Hazards of Oxygen Deficient Atmospheres* [1] ¹

Doc 224 - *Static Vacuum Insulated Cryogenic Vessels Operation and Inspection* [2]

Doc 33 - *Cleaning of Equipment for Oxygen Service*. [3]

Doc 04 - *Fire Hazards of Oxygen and Oxygen Enriched Atmospheres*. [4]

¹ References are shown by bracketed numbers and are listed in order of appearance in the reference section