CGA G-4—2015
REAFFIRMED 2020

OXYGEN

ELEVENTH EDITION

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The Standard For Safety Since 1913

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NOTE—Technical changes from the previous edition are underlined.

NOTE—No technical information has been changed from the 2015 edition. This reaffirmed edition may include minor editorial changes.

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1 Introduction

This publication is one of a series of publications compiled by the Compressed Gas Association, Inc. (CGA) to satisfy the demand for information concerning the transportation, handling, and storage of compressed gases.

2 Scope

This publication provides information regarding the characteristics and safe handling of oxygen. Requests for specialized technical information should be directed to any one of the manufacturers of this gas. This publication is intended primarily for users of oxygen and some of the requirements do not apply to manufacturers or distributors of this gas.

3 What is oxygen?

3.1 Physical and chemical properties

Oxygen (O_2) is a molecule that exists at atmospheric temperatures and pressures as a colorless, odorless, tasteless gas. About one-fifth of the atmosphere is oxygen (20.95% by volume).

The outstanding property of oxygen is its ability to sustain life and to support combustion. Although oxygen is nonflammable, materials that normally do not burn in air can burn in an oxygen-enriched atmosphere. Materials that burn in air will burn more vigorously and at a higher temperature in an oxygen-enriched atmosphere. Some combustibles such as oil burn in oxygen with near explosive violence if ignited by flame, impact, or some other energy source. As a result of these properties, caution shall be exercised and precautions taken when entering areas or confined spaces where an oxygen-enriched atmosphere can exist. See CGA P-45, *Fire Hazards of Oxygen and Oxygen-Enriched Atmospheres* and National Fire Protection Association (NFPA) 53, *Recommended Practice on Materials, Equipment and Systems Used in Oxygen-Enriched Atmospheres* for more information regarding the hazards of oxygen-enriched atmospheres [1, 2].[1]

As a gas, oxygen is 1.1 times heavier than air. It can be compressed and cooled to a pale blue liquid that, under atmospheric pressure, boils at –297.3 °F (–182.9 °C). As a liquid (at normal boiling point), oxygen is 1.14 times heavier than water. When heated above its critical temperature of –181.4 °F (–118.6 °C), oxygen can exist only as a gas, regardless of the pressure that is exerted upon it.

Oxygen is denoted according to type and grade or quality verification level (QVL). Gaseous oxygen is denoted as Type I and liquefied oxygen as Type II. The QVLs specify the maximum amount of various impurities (also termed limiting characteristics) that can be present. Further details are given in CGA G-4.3, *Commodity Specification for Oxygen* [3].

Physical constants of oxygen are listed in Table 1.

3.2 Manufacture

The primary method of manufacturing oxygen is by fractional distillation after the liquefaction of air. Improved efficiency in utilization has led to a generally recognized industry standard of purity, which exceeds the 99% required by the *United States Pharmacopeia* and *National Formulary* (*USP–NF*) [4]. Oxygen of lower purity can be used in some chemical and metallurgical processes. Other methods of manufacturing oxygen include pressure swing adsorption, vacuum swing adsorption, membrane separation, electrolysis, and chemical reaction. These processes produce oxygen at lower purities than that obtained by fractional distillation at cryogenic temperatures.

For more information on the manufacture of oxygen, see CGA P-8, *Safe Practices Guide for Cryogenic Air Separation Plants* and CGA P-8.1, *Safe Installation and Operation of PSA and Membrane Oxygen and Nitrogen Generators* [5, 6].

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