CGA G-4.9—2014

SAFE USE OF BRAZED ALUMINUM HEAT EXCHANGERS FOR PRODUCING PRESSURIZED OXYGEN

FOURTH EDITION

CGA
Compressed Gas Association
The Standard For Safety Since 1913

PLEASE NOTE:

The information contained in this document was obtained from sources believed to be reliable and is based on technical information and experience currently available from members of the Compressed Gas Association, Inc. and others. However, the Association or its members, jointly or severally, make no guarantee of the results and assume no liability or responsibility in connection with the information or suggestions herein contained. Moreover, it should not be assumed that every acceptable commodity grade, test or safety procedure or method, precaution, equipment or device is contained within, or that abnormal or unusual circumstances may not warrant or suggest further requirements or additional procedure.

This document is subject to periodic review, and users are cautioned to obtain the latest edition. The Association invites comments and suggestions for consideration. In connection with such review, any such comments or suggestions will be fully reviewed by the Association after giving the party, upon request, a reasonable opportunity to be heard. Proposed changes may be submitted via the Internet at our web site, www.cganet.com.

This document should not be confused with federal, state, provincial, or municipal specifications or regulations; insurance requirements; or national safety codes. While the Association recommends reference to or use of this document by government agencies and others, this document is purely voluntary and not binding unless adopted by reference in regulations.

A listing of all publications, audiovisual programs, safety and technical bulletins, and safety posters is available via the Internet at our website at www.cganet.com. For more information contact CGA at Phone: 703-788-2700, ext. 799. E-mail: customerservice@cganet.com.

Work Item 13-012
Atmospheric Gases and Equipment Committee

NOTE—Technical changes from the previous edition are underlined.

NOTE—Any ambiguities or interpretive differences between an authorized translated version and the CGA English version of this publication shall be construed and applied to preserve the meaning set forth in the official English version which is available from CGA.

FOURTH EDITION: 2014
THIRD EDITION: 2009
SECOND EDITION: 2004
FIRST EDITION: 1996
© 2014 The Compressed Gas Association, Inc. All rights reserved.
All materials contained in this work are protected by United States and international copyright laws. No part of this work may be reproduced or transmitted in any form or by any means, electronic or mechanical including photocopying, recording, or any information storage and retrieval system without permission in writing from The Compressed Gas Association, Inc. All requests for permission to reproduce material from this work should be directed to The Compressed Gas Association, Inc., 14501 George Carter Way, Suite 103, Chantilly VA 20151. You may not alter or remove any trademark, copyright or other notice from this work.

Contents **Page**

Figures

Tables

This page is intentionally blank.

1 Introduction

Over the past fifteen years, a new process for producing pressurized oxygen has become the industry standard. In this process, liquid oxygen (LOX) is extracted from the separation column, pumped to higher pressure, and boiled in a heat exchanger to directly provide the elevated pressure gaseous oxygen (GOX) product. Another method still being used for producing pressurized oxygen is to remove the oxygen as a gaseous product from the separation column, warm the GOX to ambient temperature, and then raise its pressure with a GOX compressor.

Brazed aluminum heat exchangers (BAHXs) are normally used as oxygen product vaporizers. Their use creates substantial contact between high pressure oxygen (both as LOX and GOX) and aluminum material.

This publication reviews issues pertinent to the safe fabrication, installation, and operation of BAHXs used for boiling oxygen to dryness at elevated pressures.

A substantial portion of this publication is based on CGA G-4.8, *Safe Use of Aluminum-Structured Packing for Oxygen Distillation* [1].[1] Questions initially raised for aluminum packing were extended later by analogy to BAHXs used as product oxygen vaporizers. Therefore, a significant amount of information from CGA G-4.8 is incorporated into this publication in Sections 6, 7, 8 and 10 [1].

2 Scope

This publication addresses BAHXs used for boiling product oxygen at elevated pressures. The oxygen enters the BAHX as a subcooled liquid (or supercritical fluid) and leaves as a superheated vapor. Other BAHX uses in oxygen applications are not addressed, although incidents involving aluminum in oxygen service are discussed.

This publication contains a summary of current knowledge and industrial practices used in the safe application of BAHXs for the boiling of oxygen at elevated pressures.

This publication is not intended to be a mandatory standard. It is based upon the combined experimental work, operating experience, and design practices of major producers and operators of air separation plants.

3 Summary

The industrial gas industry has used aluminum components extensively in oxygen service for almost 50 years. This has included piping, heat exchangers, vaporizers, pressure vessels, distillation trays, and packing. Overall, the safety record of aluminum in oxygen services has been very good. BAHXs have been used in cryogenic air separation service since 1950.

The information assembled for this publication provides the background to conclude that the use of BAHXs for the production of pressurized oxygen can be safely practiced. In particular, this process reduces the possibility of hydrocarbon accumulation in the main reboiler/condenser when there is a high liquid withdrawal rate from the reboiler sump.

With respect to the use of BAHXs for elevated pressure product oxygen boiling, there has been one reported combustion incident.

The experimental work (Section 9) on the flammability of BAHX samples has shown they are flammable in boiling oxygen (9.3) and can combust with considerable intensities; however, combustion can be arrested or inhibited by fluids in alternate passages under conditions normally encountered in elevated pressure product oxygen boiling applications. Condensed or cold supercritical inert fluid or air in BAHX alternate passages is more effective than gaseous inert fluid or air from the standpoint of combustion inhibition (see 9.4 and 9.5). However, there are some locations in the BAHX where LOX is present and the alternate passages contain either two-phase fluid or vapor only. This is most likely in locations where the oxygen vapor fraction is high.

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