

ENGINEERING BULLETIN #148

No Simple Solutions When It Comes to Oxygen Service Cleaning

A bit like asking someone to quote an expansion joint and sharing only the required ID, a request to clean for oxygen service without additional information is similarly vague.

Defined as a system conveying gaseous O₂ in concentrations of at least 23 percent, oxygen service applications are as diverse as they are numerous. Without knowing precisely how the hose will be used, any recommendation around special cleaning requirements would more accurately be defined as a guess.

NECESSITY OF CLEANNESS

Regardless of whether the hose is intended for industrial or medical oxygen service, cleanliness is critical to the safety of those working in and around the piping system. From greases, oils, dust and fibers to metal chips, burrs, weld slag and oxidation, contaminants in the assembly bore present potential ignition sources and possible combustion fuel.

Remember, fire requires oxygen, heat and fuel, and in these applications, oxygen is non-negotiable. Beyond being a very effective oxidizer, oxygen lowers the ignition temperature of other materials. This coupled with the many opportunities for generating heat within a piping system means the stage for oxygen explosion could easily be set.

It's the fuel—or the contaminants—that we have to control in order to minimize this risk.

CONSIDERATIONS FROM DESIGN TO DELIVERY

While this bulletin focuses on cleaning for oxygen service, cleanliness should be top of mind throughout design, fabrication, packing and shipping.

For instance, higher pressure and higher velocity applications are better served with copper or nickel alloys rather than with stainless steel. Hose should be trimmed at the half corrugation to eliminate a crevasse between the full corrugation lip and fitting which could trap contaminants. Other considerations include carrying out braid trimming processes in a way that prevents braid segments from entering the hose and purging welds to prevent oxidation.

AN OVERVIEW OF OXYGEN CLEANING PROCEDURES

Cleaning specifications, inspection and cleaning methods, and recommended solvents are provided in literature and standards published by the Compressed Gas Association (CGA) and the American Society for Testing Materials (ASTM), along with several oxygen producers, government entities, and individual users.

A Selection of Oxygen Cleaning Specifications

Source	Source Website	Spec. No.	Specification Title
Air Products and Chemicals Inc.	www.airproducts.com	4WPI-SW70003	Class AA Cleaning Inspection and Acceptance Requirements
ASTM (American Society for Testing and Materials)	www.astm.org	G93/G93M - 19	Standard Practice for Cleaning Methods and Cleanliness Levels for Material and Equipment Used in Oxygen-Enrich Environments
CGA (Compressed Gas Association)	www.cganet	G-4.1	Cleaning Equipment for Oxygen Service
NAVSEA - U.S. Navy	www.serrnc.surfor		Navy Oxygen Cleaner Aqueous Oxygen Cleaning Process
NAVSEA	navy.mil		Aqueous Oxygen Cleaning Products and Processes

Most standards are similar for industrial oxygen service, but there is greater differentiation and precision required for medical oxygen service.

Given the range of standards, it's important to establish which specification the cleaning must conform to with a customer prior to accepting an order.

CGA G-4.1 CLEANING EQUIPMENT FOR OXYGEN SERVICE

The cleaning standard most referred to in the metal hose industry is "CGA G-4.1 Cleaning Equipment for Oxygen Service." It provides a set of minimum requirements for industrial oxygen service.

CGA G-4.1 lays out the solutions, equipment, procedures and post-cleaning contaminant levels for the following cleaning methods: steam or hot-water cleaning, caustic cleaning, acid cleaning, solvent washing (including ultrasonic cleaning), vapor degreasing, and mechanical cleaning. The kinds of contaminants and hose materials determine which method to use.

Hoses are typically submerged in the cleaning solution or positioned at a downward angle to allow the solution to be swapped along the inside and then flushed out. Drying the hose is the next critical step and may be achieved through baking or blowing the moisture out, though the simple configuration, or shape, of the corrugations complicates this process.

Inspections follow to determine whether post-cleaning contaminant levels meet CGA G-4.1.

"An acceptable contamination level for oxygen service equipment is approximately 47.5 mg per ft² (500 mg/m²) but could be more or less depending on the specific application (state of fluid, temperature and pressure). If the purchaser's requirement includes a particle and fiber count, a representative square foot section of surface shall show no particle no larger than 1000 microns (.0384") and no more than 20 particles per ft² (215 particles/m²) between 500 and 1000 microns. Isolated fibers of lint shall be no longer than 2000 microns and there shall be no accumulation of lint fibers."

Acceptable contaminant levels after cleaning differ between the various regulatory and industrial cleaning specifications, but even the most stringent cleaning procedures and methods will leave some level of contaminants in the hose.

In conclusion, more often than not, cleanness requirements are developed between the buyer and the seller to meet a particular need rather than an objective standard.

For a product such as a metal hose assembly, the care and cleanness used in fabrication can include a wide range of practices and techniques to reduce contamination, even if the presence of contaminants can never be eliminated completely. Each additional process will add to the cost of the final product as delivered and at some point, the buyer will need to determine the value it brings.