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Close Your Eyes and Breathe Deeply

Methods for delivering safe, pure medical gases

BY ANDREW G. KIRETA JR.

As I'm flying across the country writing this, I'm again reminded of the different sections of the flight safety briefing. The part that stands out goes something like this, "In the case of a loss of cabin pressure, oxygen masks will drop from the panel above your seat. Reach up, grab the mask fully extending the plastic tubing, place the mask over your nose and mouth and breathe normally."

What if we actually

have to use those masks?

I suspect, like most probably do, that when I place that mask over my nose and mouth, that I'll be breathing clean, safe oxygen but smelling plastic, since I'll have a plastic mask, bag and tube connected to my nose. Though I believe that will be the least of my worries.

What about when visiting a hospital and we receive the medical gases necessary for treatment or recovery — what do we expect? The same thing — I suppose — that

gases are clean and safe.

But in the healthcare setting, perhaps the bar is set just a little bit higher. If we notice an odor, we're probably going to question the quality of the treatment or equipment being used.

Whether or not odor plays a role in the safety of the gas being supplied is beside the point; it is the perception that matters. Healthcare facilities have taken great care to ensure the safety of the systems delivering medical gases. However, they are now

beginning to target some of the harder-to-quantify issues, such as odor. From NFPA 99–15: Section 5.1.12.3.6.4

No pronounced or objectionable odor shall be discernible from any positive pressure outlet.

More information of an explanatory nature is given in Annex A: A.5.1.12.3.6.4

Odor is checked by sniffing a moderate flow of gas from the outlet being tested. Specific measure of odor in gas is impractical.



Medical gas piping being installed. All joints and open pipe ends are sealed until installation is complete.



Gas might have a slight odor, but the presence of a pronounced odor should render the piping unsatisfactory.

In North America, the model codes for healthcare facility construction include the NFPA 99, Health Care Facilities Code in the U.S. and CSA Z 7396.1 Medical Gas Pipeline Systems in Canada. Chapter 5 – Gas and Vacuum Systems of NFPA 99 (the CSA document contains similar provisions)

– covers the requirements for the materials, methods and designs for the piping systems that deliver medical gases. It also contains provisions for the tube to be specially cleaned, dried and capped to ensure the tube is of the highest quality and safe for delivering medical gases.

If placing the tube to your nose, you could probably detect a metallic odor. Nearly every physical product has an odor. The issue is if the product can impart that

odor to other materials it comes into contact with.

In this regard, copper is an excellent choice for medical gas systems. When used with clean, dry gases, copper’s inner surface does not react with these gases and will not impart an odor to the gas being conveyed, unless installed incorrectly.

Copper tube in medical gas systems is joined to fittings and components by brazing, a process that requires heating the copper components being joined to temperatures in excess of 840 F (usually in the range of 1,200-1,500 F) and adding a brazing filler metal to the joint. To ensure the tube and components remain clean and free of oxides during and after brazing, a “purge” gas is inserted into the un-joined tube and fitting system.

During this installation and brazing process, a high potential exists to render the specially cleaned copper tube no longer suitable for service. Several factors can contribute to the contamination:

- » failure to purge, or purge correctly
- » loss of purge gas during brazing
- » failure to continue to purge until the system is cool
- » failure to protect open ends and un-brazed joints in the system until the system is completed

Contamination may lead to “detectable” odors during system verification. In addition, failure to use appropriately clean gases in the final system blow-down prior to

verification and, in some cases, failure to remove the tube caps prior to brazing (think burned rubber/plastic) can also lead to detectable odors in the system.

Once the system is installed and reaches the point of final verification testing, there is virtually no way of identifying how/why an odor was created within the system. Therefore, these steps should be followed:

- 1** Specify only ASTM B819 copper tube and copper fittings that are cleaned and delivered in accordance with the NFPA 99 requirements.
- 2** Inspect all tube, fittings and components upon delivery and throughout installation to ensure ends/openings remain sealed to protect the internal cleanliness of the components.
- 3** On installation, visually inspect the internal surfaces to ensure cleanliness and cleared of plugs, cover seals and that no physical dirt or debris is present. The copper surfaces are cleaned using liquid solutions and then dried prior to capping/sealing. During this process, the surface can react to the liquid leaving minor spotting – cleanliness test requirements for the copper are conducted after this step to ensure the cleaning process does not leave residue on the tube/fitting surfaces.
- 4** When the tube, fitting or component is installed – and prior to fabricating the brazed joints – tape or seal all joints and open ends

to ensure that oxygen (ambient air) or other contaminants are not drawn into the system.

5 Only use oil-free, dry nitrogen, intended for use as a medical gas during all testing and installation. Not all nitrogen gas is equal. Nitrogen supplied for medical purposes is created using equipment and processes to ensure it is clean, dry and oil-free. It is stored and transported in cylinders and containers that are cleaned to maintain the purity of the gas. Nitrogen not processed, stored and transported in this manner can contain trace amounts of medically unacceptable impurities that can deposit on the interior surfaces of the piping system, which then can create odors in the system.

Proper purging procedures

It's crucial to follow the proper purging procedures. First, ensure the initial purge prior to brazing any joints is on for a sufficient amount of time and at a sufficient flow rate. All oxygen or other gases will be displaced from the system as confirmed by the use of an approved

oxygen analyzer per section 5.1.10.4.5.5 of NFPA 99-15.

Ensure that the purge gas remains flowing at a positive pressure and with sufficient flow during brazing so that outside gases are not drawn through the joint, per section

5.1.10.4.5.6 of NFPA 99-15.

Maintain the flow of purge gas at a positive pressure and flow until all completed brazed joints are cooled to ambient temperature and cool to the touch. Also, seal/tape any un-brazed joints or

open ends to maintain a positive nitrogen pressure within the system, per sections 5.1.10.4.5.8 and .9 of NFPA 99-15. The positive pressure nitrogen purge must be maintained at all times until the final system connection is completed.

Once all joints have been made, the system verification test is performed and the system is put into service, ensure the system remains sealed. It may be beneficial to charge the system with medical-grade nitrogen at a low-positive pressure. For any blow-downs/purges prior to system verification, continue to use only medical-grade nitrogen.

Knowing that appropriate steps are being taken to maintain the internal cleanliness of system components will help ensure clean, safe and odor-free medical gas distribution in all healthcare facilities.



Medical gas piping being purged with nitrogen during installation.



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