Why Hydrogen Peroxide Gas Sterilizers Should Be Monitored for Worker Safety

Introduction
Hydrogen peroxide (H₂O₂) gas is widely used in healthcare as a low temperature sterilant for heat and moisture sensitive items that come in contact with patients. Hydrogen peroxide gas is very effective since it is a strong oxidizing agent that rapidly breaks down to oxygen and water leaving no harmful residues. However, if hydrogen peroxide vapor is inhaled there is a significant risk of harm to those people exposed.

Hydrogen Peroxide Concentrations
Low concentrations of hydrogen peroxide (3%) are used as a household chemical and is generally considered safe under normal conditions, 6% hydrogen peroxide is used to bleach hair. Above 10% is considered hazardous. 30 to 50% is commonly used in industry. 30 to 50% is used in medical sterilizers (some internally concentrate it up to 90%). 90% hydrogen peroxide is used as rocket fuel (monopropellant).

Hydrogen Peroxide Gas Sterilizers Are Well Engineered
Most modern hydrogen peroxide sterilizers are very well engineered and carefully manufactured and these sterilizers are designed not to leak. However, with any complex equipment problems sometimes can and do occur, whether due to equipment failure, lack of maintenance, work practices or human error.

Why Monitor for Hydrogen Peroxide Vapor?
Hydrogen peroxide has almost no odor. If a fugitive leak does occur, it may be undetectable until too late. For example, most people have carbon monoxide detectors in their homes, and many cities/municipalities require them, not because they expect a carbon monoxide leak, but because carbon monoxide has no odor and if a leak occurs, it may result in a serious problem. Similarly, a hydrogen peroxide vapor leak is not expected, but in the case that it does occur, it is important to detect it before it creates a risk to sterile processing technicians’ safety and health.

Do Hydrogen Peroxide Gas Sterilizers Leak?
As discussed above, most modern hydrogen peroxide sterilizers are well engineered and with regular preventative maintenance should not leak. However, there is mounting evidence that hydrogen peroxide sterilizers can and do sometimes leak. ChemDAQ has many customers whose sterilizers have leaked and in some cases hydrogen peroxide exposure has measured 25 to 40 ppm when the door was opened at the end of the cycle.

It is not just ChemDAQ customers who experience leaks, a study¹ from Japan measured over 100 ppm coming from a hydrogen peroxide medical sterilizer. This sterilizer is the exception; it had not been properly maintained. However, it does illustrate what can happen if things go wrong.

¹ "Problems on Hydrogen Peroxide Sterilisation — New Proposal for Safety and Effective Use," presented at the 2012 13th World Sterilization Congress held by the organization, World Forum for Hospital Sterile Supply (WHFSS) and Japanese Society of Medical Instrumentation (JSMB), in November in Japan; Rika Yoshida, and Hiroyoshi Kobayashi, division of infection prevention and control, Tokyo Healthcare University Postgraduate School.
The Load Can Affect the Hydrogen Peroxide Vapor Concentrations

Some loads absorb hydrogen peroxide more than others, especially certain plastics such as silicones can absorb hydrogen peroxide during the sterilization cycle and later off-gas it. Thus even though the sterilizer is operating normally, the final concentration of hydrogen peroxide in the sterilizer chamber after the cycle when the door is opened may vary with the load being sterilized and so may affect the hydrogen vapor concentration the operator is exposed to.

Shorter Sterilization Cycles May Increase Worker Exposure to Hydrogen Peroxide Vapors

In a busy sterile processing department, technicians may be reach into one or more hydrogen peroxide gas sterilizers many times each day to unload its contents. If there is fugitive hydrogen peroxide vapor leaking from a sterilizer due to malfunction or off-gassing at the end of a cycle, then there is increased risk of repeated exposure to sterile processing technicians due to the short cycle time.

How Can I Ensure That My Sterile Processing Technicians are Not Exposed to Hydrogen Peroxide Vapor?

Continuous monitoring for hydrogen peroxide vapor at the sterilizer is the best way to ensure the safety and health of sterile processing technicians. With a hydrogen peroxide vapor sensor mounted just above the door of the sterilizer and a real-time display of H₂O₂ vapor readings, the technician will be immediately warned of any fugitive vapor leaks due to sterilizer failure or malfunction. In the case of elevated H₂O₂ vapor levels remaining in the chamber after the completed cycle, the technician can be trained to take a step back when opening the sterilizer door until the hydrogen peroxide vapor readings indicate that it is safe to reach in and unload the sterilizer.

Hazards of Hydrogen Peroxide

Hydrogen peroxide is a strong oxidant, and can promote combustion. Contact of skin with liquid hydrogen peroxide > 10% concentration can cause bleaching of the skin and chemical burns and cause permanent damage if it contacts the eye. H₂O₂ vapor is also irritating to the eyes and respiratory system and prolonged exposure to even a few ppm of the vapor can produced permanent lung damage and exposure to high concentration may cause pulmonary edema (fluid in lungs).

Hydrogen peroxide is mutagenic, and the ACGIH classifies it as a known animal carcinogen with unknown relevance to humans.

Further information on the hazards of hydrogen peroxide can be found at:

- New Jersey Department of Health Hazardous Substance Fact Sheet.²
- NIOSH Pocket Guide to Chemical Hazards³
- Hydrogen Peroxide General Information, Public Health England⁴
- RTECS Hydrogen Peroxide 20 to 60%⁵

³ http://www.cdc.gov/niosh/npg/npgd335.html
⁵ http://webapp1.dlib.indiana.edu/virtual_disk_library/index.cgi/5678550/FID2757/nioshdbs/rtecs/mdb9ac.htm
**Occupational Exposure Limits**

As a consequence of the hazards of exposure to hydrogen peroxide vapor, *the OSHA permissible exposure limit (PEL) for hydrogen peroxide, is the same as the PEL for ethylene oxide*, 1 ppm calculated as an 8-hour time weighed average (TWA).\(^6\)

The ACGIH has a threshold limit value (TLV) for hydrogen peroxide, also 1 ppm calculated as an 8 hour TWA.

According to NIOSH, higher concentrations of *hydrogen peroxide become immediately dangerous to life and health (IDLH) at 75 ppm*.\(^7\)

**Hydrogen Peroxide has Little or No Odor**

*Hydrogen peroxide has almost no odor*,\(^8\) and the odor threshold is well above 100 ppm, so if there were hydrogen peroxide vapor present at the IDLH level, most people would not even know it.

**STEL for Hydrogen Peroxide**

There is no US federal Short term exposure limit (STEL), i.e. a 15 min TWA, for hydrogen peroxide. Two states (Hawaii\(^9\) and Washington\(^10\)) have a STEL or 3 ppm. Several other countries have a STEL for hydrogen peroxide, e.g. United Kingdom 2 ppm\(^11\).

\(^6\) 29 CFR 1910.1000, Table Z-1.
\(^7\) [http://www.cdc.gov/niosh/idlh/inridh4.html](http://www.cdc.gov/niosh/idlh/inridh4.html)


