

What's in your hydrogen peroxide vapour?

John Chewins, BSc, MBS
Director, Scientific and Regulatory Affairs, Bioquell UK Ltd

There is a large amount of inaccurate and assumed data when comparing different hydrogen peroxide-based decontamination systems. This paper helps to explain some of the key differences observed between different hydrogen peroxide systems and the affects that mixtures of silver and hydrogen peroxide could have when using them to decontaminate an enclosed space.

What is hydrogen peroxide vapour?

The term hydrogen peroxide vapour was originally developed to identify a micro-condensation based process using a 30-35% w/w hydrogen peroxide solution; and, to differentiate it from a VHP® (vaporised hydrogen peroxide) process, which uses a 30% hydrogen peroxide solution, but does not claim the formation of micro-condensation.

Over the past decade, the use of true 30-35% hydrogen peroxide vapour systems has grown within hospitals, pharmaceutical and defence industries, due to the continually expanding body of peer-reviewed scientific literature supporting its efficacy and 'real world' ability to reduce nosocomial infection rates. The term hydrogen peroxide vapour has become accepted and commonplace within hospital infection control teams – however, in recent years, its definition has been hijacked.

Fogger, mister, sprayer or vaporiser – which are you?

A number of manufacturers supply bio-decontamination equipment as 'hydrogen peroxide vapour systems' when they are not. Often these systems use an atomisation nozzle to produce a mist, fog or spray of hydrogen peroxide liquid. This is not a vapour and does not produce the micro-condensation effect that is critical to achieving the high levels of kill efficacy associated with true 30-35% hydrogen peroxide vapour systems. The majority of these 'aerosolised hydrogen peroxide' systems, to give them their collective, common name, use much lower concentrations of c.5% hydrogen peroxide and often have added substances. They claim to be 'hydrogen peroxide vapour' systems so as to make use of the efficacy data within the scientific literature associated with hydrogen peroxide vapour – even though this is based on the application of much more powerful 30-35% peroxide. The confusion this 'hijacking' of the term hydrogen peroxide vapour has produced can be clearly seen in a recent article published in the Journal of Hospital Infection¹. The author identifies that the Guidelines on the prevention and control of multi-drug-resistant Gram-negative bacteria published in 2016² state that hydrogen peroxide vapour should be considered as an adjunctive decontamination method in vacated isolation rooms / areas, but argues against this conclusion referencing the poor efficacy results in the scientific literature for 'hydrogen peroxide vapour at 6%'³. The system referenced in the literature was a nozzle-based sprayer / fogger – an aerosol generator, not a hydrogen peroxide vapour generator. The Guidelines clearly distinguish between 'hydrogen peroxide vapour' and 'aerosolised hydrogen peroxide' systems, associating the conclusion for implementation and use only with the hydrogen peroxide vapour system.

What's in your hydrogen peroxide vapour (mist, fog, spray)?

A number of manufacturers of aerosolised hydrogen peroxide systems claim to achieve superior efficacy effects through the use of 'added silver' compared to hydrogen peroxide alone. The jury is very much out as to whether the small concentrations of silver within the product have any significant biocidal effect; but, this will be clearly examined when these solutions undergo authorisation under the European Biocidal Products Regulations (assuming that silver and silver compounds are eventually authorised for use in hospital biocides – at present the European Competent authority is yet to make a decision). The decontamination solutions provided by these manufacturers claim to contain 'colloidal silver complex', 'silver cations', '50ppm silver (Ag)' or 'silver ions'. However, in at least one case (and I would suspect the majority) the silver is present as silver nitrate – a toxic compound used to chemically burn off warts (i.e. in caustic pencils). The EU and US time weighted average (TWA) exposure limit for silver nitrate is 0.01mg/m³ over an 8 hour period. This is a very low level and it is anticipated that any aerosolised system containing silver nitrate will breach this level during its decontamination cycle. Unlike hydrogen peroxide, silver nitrate does not autonomously break down, it remains in the environment, ultimately depositing onto surfaces as a grey powder. Users should ensure that the levels of silver nitrate within an enclosure are beneath 0.01mg/m³ before allowing themselves or patients to reoccupy the room.

The difficulty faced by healthcare workers is determining whether or not the system they are using contains toxic silver nitrate. In the case presented below (Image 1), the manufacturer claims that the product contains 'Silver'. However, the associated chemical registry number (CAS: 7761-88-8) is for silver nitrate, not silver. This is confusing and potentially dangerous for users and hospital professionals tasked with conducting chemical risk assessments.

→ 3. Composition/ information on ingredients

CAS No. Designation:
7732-18-5 water, distilled, conductivity or of similar purity

Identification number(s): EINECS Number: 231-791-2
Mixture of the substances listed below with harmless additions.

Dangerous components:

CAS: 7722-84-1	Hydrogen Peroxide solution 2.5-10%
EINECS: 231-765-0	Acute Tox. 2 (Inhalation vapour), H330
Ox. Liq. 1, H271	Acute Tox. 4 (Dermal), H312
Skin Corr. 1A, H314	Acute Tox. 4 (Oral), H302
Eye Dam. 1, H318	STOT SE 3, H336
CAS: 7761-88-8	Silver <0.2% EINECS: 231-853-9

Image 1. Extract from aerosolised hydrogen peroxide system Material Safety Data Sheet for a product containing silver nitrate.

Silver nitrate – it will get a reaction

Silver nitrate is a reactive compound and takes part in a type of chemical reaction called a displacement reaction – in fact, it is so good at showing displacement that it is used to teach this type of reaction to children in schools⁴. When silver nitrate is added to copper, the copper displaces the silver to form copper nitrate and crystalline silver (Image 2). Electronic circuit boards operate by allowing the flow of electricity down copper tracks. If the copper within a circuit board track undergoes a displacement reaction to form copper nitrate and silver, the electrical resistance of that track changes, potentially affecting the operation of the circuit board. This raises serious questions over the use of silver nitrate containing solutions in any area where there is electrical equipment, but particularly in Intensive Care Units where people's lives depend on the correct and consistent operation of specialised and highly sensitive equipment. Users employing silver nitrate containing decontamination solutions should liaise with their medical engineering and facilities management departments to evaluate their electrical equipment failure rates and ascertain whether silver nitrate displacement reactions may be involved.

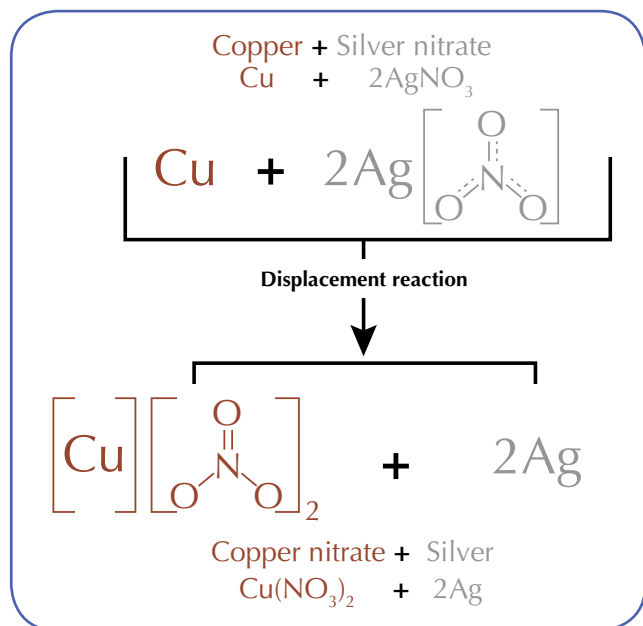


Image 2. Displacement reaction of copper and silver nitrate.

Key summary

- Aerosol generating hydrogen peroxide systems are not hydrogen peroxide vapour systems. True hydrogen peroxide vapour systems, produce a vapour from a flash evaporation process using 30-35% w/w hydrogen peroxide solution.
- Efficacy data generated by, and associated with, 30-35% hydrogen peroxide vapour systems cannot and should not be used as proof of efficacy for lower concentration (i.e. 5-12%) aerosolised hydrogen peroxide systems.
- Users should confirm that solutions which claim to contain 'Silver' do not contain toxic silver nitrate. If their decontamination solution does contain silver nitrate, users should ensure that they confirm the silver nitrate concentration within the enclosure is beneath the legal exposure limit (0.01 mg/m³) before reoccupying the enclosure.
- Users of solutions containing silver nitrate should evaluate their electrical equipment failure rates to ensure silver nitrate + copper displacement reactions are not affecting their equipment.

References

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E: info@bioquell.com
W: www.bioquell.com

Bioquell UK
T: +44 (0)1264 835 835

Bioquell USA
T: +1 (215) 682 0225

Bioquell Germany
T: +49 (0)221 168 996 74

Bioquell Ireland
T: +353 (0)61 603 622

Bioquell Asia Pacific
T: +65 6592 5145

Bioquell France
T: +33 (0)1 43 78 15 94

Bioquell China
T: +86 755 8631 0348

