MATERIAL COMPATIBILITY FOR BIOQUELL TECHNOLOGY

DETAILED INFORMATION REGARDING THE BIOQUELL HYDROGEN PEROXIDE VAPOUR PROCESS AND EFFECTS ON MATERIALS

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Bioquell has spent the last 20 years developing and optimising decontamination using Hydrogen Peroxide Vapour. The process involves producing the Hydrogen Peroxide Vapour in a generator and recirculating this through the enclosure being decontaminated. The air will reach saturation or dew point, at which point the air cannot carry any more Hydrogen Peroxide Vapour so it lays down a thin layer, ≈5µm, of micro-condensation on the surfaces. It is this Hydrogen Peroxide condensate which kills the micro-organisms.

The Hydrogen Peroxide Vapour is then removed either via the building or equipment extract system, or a catalytic filter which breaks it down into water and oxygen, or a combination of both.

Hydrogen Peroxide is an oxidiser and this can have a detrimental effect on some materials. This document aims to give advice to people selecting materials which will be exposed to Hydrogen Peroxide Vapour.

The quick links below will direct you to the specific materials you are interested in and the results associated with the testing.

Quick Links:

Testing of Materials

The data in this document is derived from many years of testing. The standard test involves running 40 cycles in a 27 to 30 m^3 room with a starting temperature of between 20 and 25°C and a relative humidity of 35% to 65%, and test samples are placed at high level, low level and a third outside as an unexposed control. The amount of liquid used is 14g/m^3, which equates to a total of 385g in the test room. The room is aerated to at least 10ppm. This test gives a high degree of confidence whether a material is compatible with Hydrogen Peroxide Vapour in a room environment. Additional considerations should be taken into account if the application has a high number of cycles, i.e. more than 1 a week, such as a pass-through chamber.

Pictured: *Example of high and low level placements for test samples*

Bioquell is able to conduct material compatibility testing for companies based on the method described.

It should be noted that other factors, apart from material compatibility can be important when choosing a material. The biggest of these is the materials propensity to absorb and then de-absorb Peroxide, as this can have significant effects on the total cycle time as it will extend the aeration phase.

Compatibility of Metals

Name	Standard	Compatible	Catalyst	Comments
Copper		Yes	Yes	Will oxidise producing a green deposit, ought to be coated with a protective layer
Mild Steel		Yes if coated	Not tested	Will be oxidised (rust) unless coated. See sections on paint systems & coatings, and cleanroom panels
Tool Steel	EN16T	Yes	Not tested	
	EN8	Yes	Not tested	
Stainless Steel	EN 10088-3:2005 type 1.4305 (303)	Yes	Not tested	
	EN 10088-3:2005 type 1.4301 (304)	Yes	Yes	Compatible but is a moderate catalyst.
	EN 10088-3:2005 type 1.4401 (316)	Yes	Yes	Very mild catalyst and so this effect can be ignored in most instances
	EN 10088-3:2005 type 14404 (316L)	Yes	Yes	Very mild catalyst and so this effect can be ignored in most instances
Galvanised Steel		Yes*	Yes	See further comments
Aluminium	6XXX series 5XXX series 1XXX series	Yes	No	Will get an oxide layer on the surface, if not desirable: paint or clear anodise.
Aluminium (Cast)	BS1490:1988 LM6 BS1490:1988LM25	Yes	No	
Aluminium (Cast)	BS1490:1988LM26	No	No	Produces a black deposit
Brass	CZ108	Yes	Not Tested	Will accelerate oxidisation, changing colour to more gold.
Brass	CZ121	Yes	Not Tested	Will accelerate oxidisation, changing colour to more gold.
Phosphor Bronze	BS1400:1985	Yes	Not Tested	Were signs of surface oxidation

*Galvanised steel may produce ‘white rust’, hydrated zinc carbonate/zinc hydroxide when exposed to Hydrogen peroxide. The galvanized steel should have been allowed to naturally build up its zinc oxide protective layer prior to exposure of Hydrogen peroxide.

Compatibility of Ceramics

All silica and glass ceramics which have ever been tested have been unaffected by Hydrogen Peroxide Vapour.

Compatibility of Plastics

Name	Acronym	Compatible	Comments
Polypropylene	PP	Yes	Very good resistance, and can be used to store liquid H_2O_2.
High density Polyethylene	HDPE	Yes	Very good resistance, and can be used to store liquid H_2O_2.
Low density Polyethylene	LDPE	Yes	Very good resistance
Homo-polymer acetyl (Delrin)	POM	Yes	Is resistant to vapour, but not to liquid Hydrogen Peroxide
Co-polymer acetyl	POM-C	Yes	Is resistant to vapour, but not to liquid Hydrogen Peroxide
Polycarbonate (Lexan)	PC	Yes	Good, but ensure stresses are not induced during fabrication, e.g. hot forming
Acrylic Plexiglass/ Perspex)	PMMA	Yes*	Only resistant if stress free, most material is extruded which is highly stressed.
Polytetrafluoroethylene (Teflon)	PTFE	Yes	Very good resistance
Polyether ether ketone	PEEK	Yes	Good resistance
Nylon	PA	No	PA6 is particularly susceptible and will produce a white deposit on the surface and then crumble after repeated exposure, over 100 cycles. PA 66 will last significantly longer, over 500 cycles, and adding a filler such as glass may also increase its life. Eventually all Nylons will fail.
Polyester	PET/PETG	Yes	Good resistance
	ABS	Yes	Good resistance
Poly vinyl Chloride	uPVC	Yes	Good resistance
	uPVC-C	Yes	Good resistance
	PVDF	Yes	Good Resistance
Polybutylene terephthalate	PBT	Yes	Good Resistance
Polystyrene	PS	Yes	Good Resistance
Polypheylene Sulfide	PPS	Yes	Tested part had 65% glass content
Polyurethane	PU	Yes	Good resistance
Urea		No	Crumbles after repeated exposure, on thicker items crazing will be seen on the surface.

Compatibility of Elastomers

Name	Symbol	Compatible	Comments
Silicone	Si	Yes	Very good resistance, preferred gasket material
Neoprene		Yes	
	EPDM	Yes	
Viton	FPM/FKM	Yes	
Nitrile	NBR / Buna-N	Yes*	Nitrile will become brittle and weak after repeated exposures, requires more than 100 cycles.
	TPE/TPR	Yes	

Compatibility of Mastics and Sealants

Name	Compatible	Comments
Dow Corning 785	Yes	
Dow Corning 786	Yes	

Compatibility of Composites and Miscellaneous Items

Name	Compatible	Comments
Corian GW (DuPont)	Yes	
Igus A350	Yes	

Paint Systems and coatings

Often it is necessary to paint or treat materials, below advice is given in choosing appropriate coatings. Clean room panels are a special case and is covered in the next section.

Paint systems for metals

The best paint system for either steel or other metals is a powder coat. This is a polyester or epoxy powder which is sprayed onto the material and then oven baked. This produces an impervious layer which is completely resistant to Hydrogen Peroxide Vapour.
Wet paint systems on aluminium are generally without issue if a conversion coating has been applied. More care has to be taken when applied to steel especially galvanised steel, where in almost all cases is not compatible. See the following section for more details of this. Stainless steel ought to have its surface roughened by shot blasting prior to painting to provide a good key.

Aluminium coatings

Aluminium is often anodised, this has the advantage that it prevents aluminium oxide forming on the surface. Clear anodise should always be used, as coloured anodises will change quickly to become clear in very few exposures often transitioning through a purple colour. If the aluminium is to have just a conversion coating, then MacDermid Iridite NCP is known to be Hydrogen Peroxide Vapour compatible.

Plasterboard / Drywall

Most standard paints including emulsions will not be affected by Hydrogen Peroxide Vapour if they have been applied in accordance to manufacturer's instructions.

Gloss Paints

Gloss paints are prone to blistering and are not recommended.

Cleanroom Panels

Many cleanrooms are made from prefabricated steel panels for both the walls and ceilings. These panels are often made from pre-painted galvanised steel. Bioquell has done a lot of testing and research of such panels, and our advice is the following panels are compatible with Hydrogen Peroxide Vapour:

Panels which have a 120µm PVC film as the top layer (e.g. Tata Steel Advantica L Control)

Panels which have a PET film as the top layer (e.g. Tata Steel Advantica CL Clean)

Other pre-coating treatments involve the application of wet paint systems using: Polyester, PVDF, Polyurethane, or epoxy on the galvanise steel. These have varying degrees of resistance but over multiple cycles are shown to not be compatible with Hydrogen Peroxide Vapour.

Powder coating systems on top of galvanised steel are compatible as well as the films.

Cleanrooms can also be made of, or have an external surface made from: solid PVC panels, high quality HPL (High pressure laminate) and GRP (Glass reinforced polyester) panels.

Particular care should be taken over doors, door and window frames as these can also be made from incompatible pre painted galvanised steel material.

Instruments, Computers and Other Equipment

Being residue free, Hydrogen Peroxide Vapour has excellent materials compatibility with a wide range of electronic equipment. Generally, equipment should be clean (free from dust / grease), dry, the shutdown and opened up in order to allow free ingress of Hydrogen Peroxide Vapour and maximise the exposed surface area.

Computers however, should be left running in order to allow the internal cooling fan to draw the vapour into the unit to bio-decontaminate the internal surfaces. Recently, on a few rare occasions, computer monitors have been affected by Hydrogen Peroxide Vapour exposure, by the front protective screen forming some bubbles. These bubbles can start to appear up to few weeks after exposure to Hydrogen Peroxide Vapour.

Many optical instruments have a specialist, proprietary coating on their lenses. Whilst we have not seen any issues with lens coatings, Bioquell recommend that any accessible lenses are wiped down, in line with any manufacturer's instructions, and covered during the bio-decontamination process.

Equipment that removes air from a facility, e.g. ducted microbiological safety cabinets, should be shutdown during the bio-decontamination process however the work chamber should be opened to allow exposure to the Hydrogen Peroxide Vapour process.

Larger equipment (filling machines, rack washers) should be fully isolated, and where safe to do so, all electrical cabinets / service voids should be opened to allow ingress of Hydrogen Peroxide Vapour.

A study[1] was carried out on Physiological Monitors in a hospital which showed a reduction in call outs for repair of the equipment for the 8 years after the introduction of regular Bio-decontamination with Bioquell equipment, compared to the previous 5 years.

For any specific advice please contact Bioquell directly. Area preparation details are listed on the following page.

[1] Boyce et al, "Compatibility of Hydrogen Peroxide Vapor Room Decontamination with Physiological Monitors" *Infection Control and Hospital Epidemiology,* Vol. 35, No. 1 (January 2014), pp 92-93

Area preparation

Bioquell's Hydrogen Peroxide Vapour technology is a surface decontamination process. Therefore it is critical that all surfaces are exposed so preparation is important. The following points give an overview of how an area should be set-up prior to bio-decontamination.

DRY SURFACES: In order to avoid dilution of the hydrogen peroxide and affect the dew point of the vapour then the surfaces of the room, including equipment, should be dry.

CLEANING: Bioquell Hydrogen Peroxide Vapour technology does not replace manual cleaning. If there is gross contamination – e.g. high levels of dust – then the efficacy of the process will be severely reduced. It should also be noted that certain bacteria can remain viable in dust for long periods. Hence, for the bio-decontamination cycle to work well the rooms should be subject to rigorous cleaning; it is not possible to over emphasise the importance of thorough cleaning of the room prior to decontamination.

EXPOSING SURFACES: Bioquell's HPV system is a surface bio-decontamination process and therefore if the vapour cannot penetrate into a particular place then no bio-deactivation will occur. As a result, all cupboards and drawers should be opened to allow ingress of Hydrogen Peroxide Vapour, whilst absorbent items e.g. cardboard boxes or consumables, should be removed, if possible.

MINIMISE OCCLUDED SURFACES: Large volumes of materials (consumables, PPE, etc.) present a challenge when ensuing all surfaces are exposed to the process. Where possible, stocks should be run down prior to the bio-decontamination and any materials remaining should be spread on racking or similar to maximise exposure.

AVOIDING EXTREMES OF TEMPERATURE: Very hot or cold equipment (i.e. incubators and refrigerators) should be turned off as temperature gradients may affect the Hydrogen Peroxide Vapour process. Ideally the room temperature will be >15 and <30 °C.

NORMALLY ACTIVE AIRPATHS: With the exception of the HVAC system and dedicated fume hoods (which should be bio-decontaminated separately), equipment which has normally active air paths (such as computers) should be left running to ensure a good vapour distribution within the equipment. Bioquell's research has shown that our process achieves a full deactivation within items with cooling / recirculation fans ensuring that recontamination of the area does not occur through this type of equipment.

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