Improving Personnel Safety and Shortening Cycle Time with Accurate Calibration of Low-level Hydrogen Peroxide Vapour Instruments

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Abstract / Executive Summary

It is important that any low-level hydrogen peroxide sensor, used to determine the end of a decontamination cycle, is accurate. This is to ensure both the safety of the personnel entering the area as well as to optimise the cycle time. The present calibration methods used by sensor manufacturers are not performed with hydrogen peroxide vapour, nor are they conducted at a vapour concentration at the critical value of 1ppm. Testing and experience have shown that inaccuracies can unnecessarily prolong decontamination cycles by up to 20%. Bioquell now have a calibration capability able to expose these sensors to a 1ppm hydrogen peroxide vapour concentration verified accurately using the published OSHA 1019 Method. This improves the safety of personnel and optimises the cycle time.

Introduction

By ensuring that the concentration of a room or enclosure has reached its Occupational Exposure Limit (OEL), also known as Permissible Exposure Limit (PEL), the area can be safely released and the cycle time is optimised. Testing and experience have shown that many instruments read higher concentration values than the true value, thus leading to cycle times that are longer than necessary.

Background

When decontaminating a room, entry should be prohibited until the OEL concentration has been reached. The OEL is the safe exposure level which is advised or legally required in the particular country. This level is based on a time-weighted average over 8 hours (TWA).

Most the world including most of EU, USA[1], UK[2]	1.0ppm
Germany[3]	0.5ppm
Poland[4]	0.3ppm
Forthcoming EU limit[5]	0.9ppm

In some countries, including the UK[2], there is a Short Term Exposure Limit (STEL) of 2ppm which is a TWA over 15 minutes.

The predominant technology employed for these sensors is the electro-chemical cell which work on the same principle as a battery, where a current is generated by a chemical reaction. In the case of these sensors the hydrogen peroxide enters the cell through a membrane which allows the chemical reaction to occur, producing a current which is proportional to the vapour concentration.

These cells can be calibrated by two methods: exposure to a known concentration of hydrogen peroxide vapour, or by using a surrogate gas to which the cell is cross sensitive. In the case of hydrogen peroxide sensors sulphur dioxide is commonly used. As with the calibration of every device it is important to set the point or range at which the calibration is performed in keeping with the intended use. In this case as 1ppm is the most common OEL this is the critical level at which to ensure the calibration is accurate.

To calibrate at 1ppm the best method is to produce an accurate and steady hydrogen peroxide vapour stream at this concentration. The Occupational Safety and Health Administration (a US Governmental Agency) has published a number of validated methods for accurate measurement of low-level hydrogen peroxide vapour concentrations around the 1ppm OEL. Their Method 1019 specifies drawing a calibrated sampling flow of 1 l/min through a cartridge containing two 25mm quartz-fibre filters pre-impregnated with titanium oxysulphate. The sampling is performed for a duration of four hours for each reading. The hydrogen peroxide vapour reacts with the titanium oxysulphate to form an orange complex. This complex is subsequently extracted from the filters and analysed using UV / visible spectrophotometry by comparison to known working standards.

The major manufacturers of low-level electrochemical hydrogen peroxide sensors do not use this method. One calibrates with a range of concentrations of between 20-30ppm of hydrogen peroxide vapour with a stated accuracy of ±14% or uses 10ppm sulphur dioxide as a surrogate which is stated as equivalent to 8ppm of hydrogen peroxide. Also they state that the use of the surrogate gas increases measurement uncertainty. Another manufacturer calibrates with hydrogen peroxide vapour at a concentration of ≈10ppm with a stated accuracy of ±10%.

The manufacturer's methods lead to inaccurate calibrations as can be seen by the test results below, where a controlled solution was used to create an accurate vapour concentration. The concentration, on the Y-axis, was increased, and the readings of five new manufacturer-calibrated sensors were taken along with a measurement using the OSHA Method 1019 (blue).

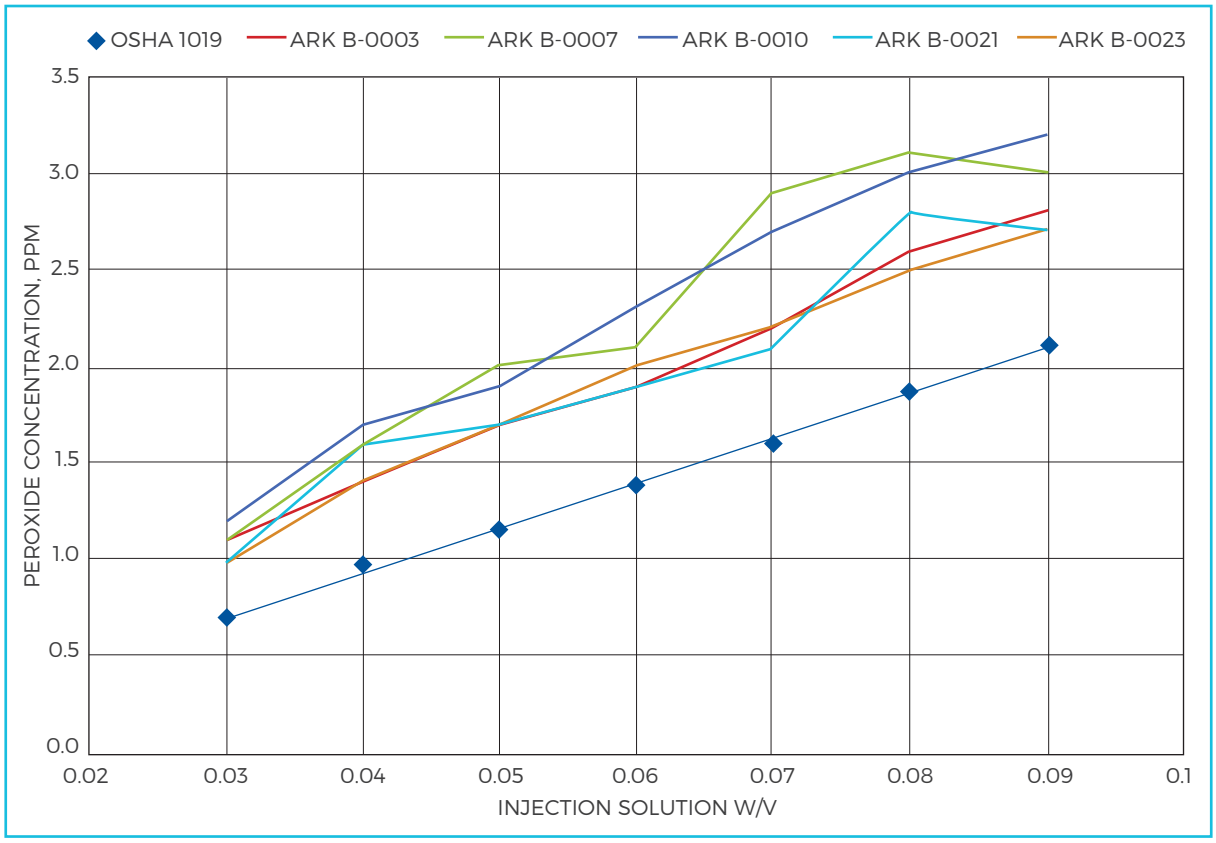


Figure 1. *As can be seen, where the vapour concentration was 1ppm, as measured by OSHA Method 1019, the sensors were reading between 1.5 and 1.75ppm.*

The removal of hydrogen peroxide from an enclosure is a logarithmic process, meaning that it takes a disproportionally long time to reduce from 2 to 1ppm compared to earlier in the cycle. Thus, an inaccuracy of 0.5ppm can have a significant effect on the cycle length.

New Calibration Capability

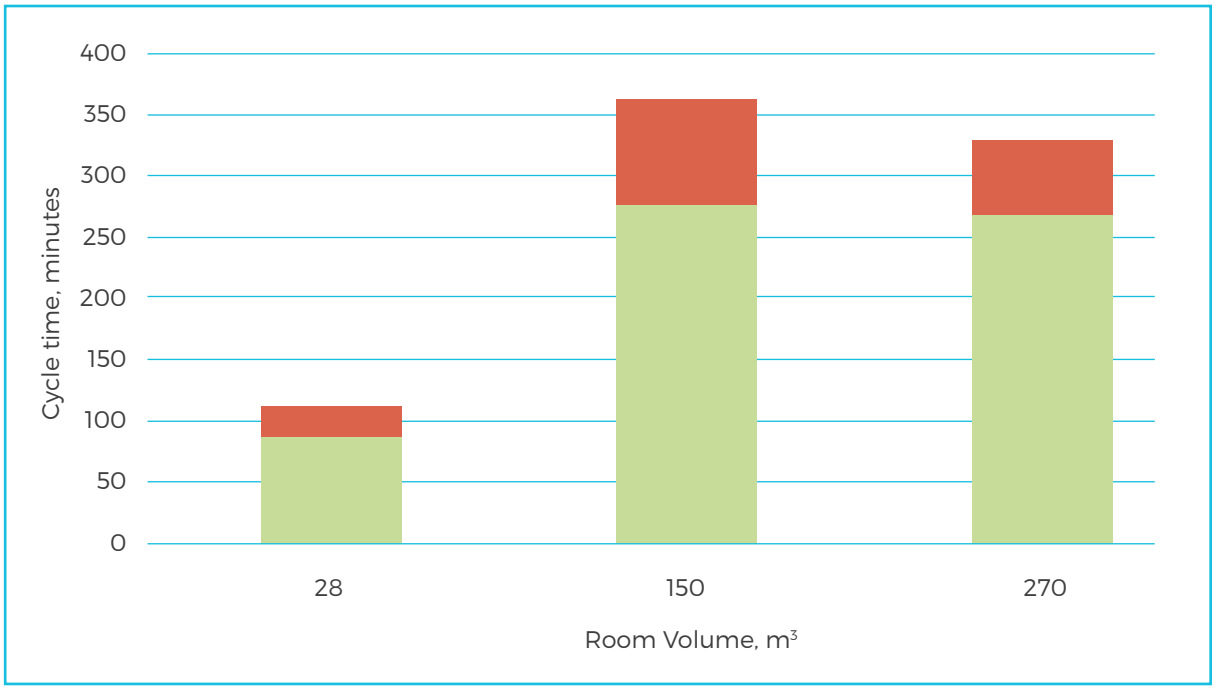
To resolve this issue, Bioquell has created the capability to calibrate accurately at 1ppm. The calibration instrument produces a highly accurate stream of hydrogen peroxide vapour at 1ppm concentration, with better than ±0.1ppm accuracy. Note that this is the accuracy of the calibration system, unrelated to the accuracy or repeatability of the sensor itself. The calibration process is highly automated to ensure accuracy, repeatability and cost-effectiveness. The calibration process is checked frequently against the OSHA method to ensure continuing accuracy. In addition, the sensors response time is checked to be within the manufacturer's specification as well as confirming that the alarms work correctly.

At present Bioquell can calibrate one major manufacturer of hand-held low-level sensors, with another manufacturer following shortly.

The accurate calibration will shorten cycle times by approximately 20%. Some examples of cycles are shown below where the red section shows the additional cycle time required if the low-level sensor's calibration is out by 0.5ppm.

Conclusion

Bioquell's new calibration capability ensure customers low-level sensors have been correctly calibrated to a published method at the critical concentration point, ensuring safety of their employees while optimizing the cycle.



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