# Technical Note

## Health and environmental effects of aerosolised hydrogen peroxide in room disinfection

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# 1 Introduction and context

The use of hydrogen peroxide-based disinfection processes in the form of aerosols or cold fogging represents an established approach to room decontamination. In contrast to conventional wiping procedures, the active substance is deliberately introduced into the room air, enabling complete penetration of the room volume. However, this form of application inevitably leads to inhalation and potentially systemic exposure, which differs fundamentally from exposure during liquid applications.

Against this background, the assessment of health-related and environmental effects becomes central. Although hydrogen peroxide is often regarded as comparatively unproblematic due to its rapid decomposition, aerosolisation creates specific exposure scenarios that must be considered in a differentiated manner.

The purpose of this report is therefore to present the effects on humans, animals and the environment in greater depth, while also showing the conditions under which safe and controlled application is possible.

# 2 Exposure to aerosolised hydrogen peroxide

Aerosolisation fundamentally changes the exposure characteristics of hydrogen peroxide. While liquid application primarily involves skin or contact effects, nebulisation distributes very fine droplets in the air, which can be inhaled and at the same time deposited on surfaces.

Inhalation is the most critical exposure pathway. It is important to note that the effect depends not only on concentration, but also on the duration of exposure and on particle size. Finer aerosols remain airborne for longer and can penetrate deeper into the respiratory tract, whereas larger droplets sediment more quickly and mainly result in surface exposure.

A key reference value in this context is the concentration of 1 ppm, which is used in many regulatory contexts as a threshold for acute irritation effects. Above this value, irritation of the mucous membranes and respiratory tract is to be expected, particularly in sensitive individuals. In practice, this limit value therefore often serves as guidance for the safe re-release of a treated room.

# 3 Effects on human health

The health effects of hydrogen peroxide are primarily attributable to its oxidative action. In aerosolised form, this particularly affects exposed tissues such as the respiratory tract, the eyes and, to a lesser extent, the skin.

In the case of inhalation exposure, irritation of the upper respiratory tract typically occurs first. This manifests as a burning sensation in the nose and throat, an urge to cough or a feeling of airway irritation. With increasing concentration or exposure duration, the lower respiratory tract may also be affected, which can manifest as increased inflammatory reactions or temporary restrictions in lung function. These effects are generally reversible, provided there is no extreme or repeated exposure.

The eyes react particularly sensitively to oxidative stress. Even relatively low concentrations can cause irritation, tearing and redness. Higher concentrations carry the risk of serious corneal damage. Skin contact plays a subordinate role in aerosolised applications, but direct exposure can cause local irritation or temporary whitening of the skin.

From a toxicological perspective, it should be emphasised that hydrogen peroxide is not considered carcinogenic. The risks are primarily acute in nature and are directly related to the level of exposure. The decisive factor is therefore not solely the intrinsic hazard of the substance, but the control of exposure conditions during and after application.



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# 4 Effects on animals

The effect of aerosolised hydrogen peroxide on animals corresponds in principle to the mechanisms described for humans, but may vary in its extent. Smaller animals have a relatively higher uptake per unit of time due to their higher respiratory rate and lower body weight. This can lead to increased sensitivity to inhalation irritants.

This is particularly relevant in enclosed rooms in which animals would be present during a disinfection treatment. Even moderate concentrations can cause stress reactions, respiratory irritation or behavioural changes in sensitive animal species. In practice, this results in the clear requirement that rooms must be completely free of animals during application.

After treatment, it must also be ensured that the concentration has fallen sufficiently before animals are allowed access again. The same principles apply here as for humans, although conservative safety margins are advisable.

# 5 Environmental compatibility and ecological aspects

The environmental assessment of hydrogen peroxide is largely based on its rapid decomposition into water and oxygen. This means that no persistent residues remain after completion of the application, which is a clear advantage over many other disinfectant active substances.

At the same time, it must not be overlooked that locally elevated concentrations may occur during the application phase, which can have oxidative effects on sensitive microorganisms in the immediate surroundings. However, these effects are limited in time and localised in space, as the active substance is rapidly degraded.

A further aspect concerns indirect environmental effects through material interactions. Repeated exposure to oxidative substances can lead to material ageing, potentially releasing particles or degradation products. These effects are generally long-term in nature and depend strongly on the materials used and the application conditions.

Overall, hydrogen peroxide can be classified as environmentally compatible when used in a controlled manner, although the short-term local effects must be taken into account as part of an overall assessment.

## 6 Specific risks of aerosolisation

Compared with conventional applications, aerosolisation introduces additional challenges that primarily result from the spatial and temporal distribution of the active substance. A central difficulty lies in achieving sufficient disinfection efficacy without simultaneously maintaining safety-relevant concentrations for an extended period of time.

One significant risk lies in uncontrolled exposure, particularly if rooms are re-entered too early or if ventilation is inadequate. In addition, inhomogeneous distribution may result in certain areas being underdosed while other areas exhibit higher concentrations.

These aspects make it clear that aerosolisation cannot be viewed as a purely chemical application, but rather as a process requiring control, in which physical, chemical and safety-related factors interact.

## 7 Solution approaches and safe application

Despite the risks described, established and effective strategies exist to ensure safe application. The decisive factor is a systematic approach that includes both technical and organisational measures.

At the centre is precise control of the disinfection process. Modern aerosolisation systems enable defined dosing and distribution of the active substance, thereby improving both efficacy and safety. In addition, monitoring the room air plays a central role. Measurement of the hydrogen peroxide concentration allows the point of safe re-release to be determined objectively, with the reference value of 1 ppm serving as a practice-relevant guide.

Controlled ventilation after application is equally important. Targeted ventilation measures can accelerate degradation of the active substance and rapidly reduce exposure. In combination with defined contact times, this creates a reproducible process that is both effective and safe.

From an organisational perspective, it must be ensured that no access occurs during application and that clear protocols exist for all process steps. Staff training is of central importance here, as a sound understanding of the interrelationships contributes substantially to risk minimisation.

Overall, it becomes apparent that the risks of aerosolisation primarily result from uncontrolled or improper applications. When implemented professionally and using suitable systems, however, these risks can be effectively controlled.



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# 8 Conclusion

Aerosolised applications of hydrogen peroxide represent an effective method for room disinfection, but they bring specific requirements regarding the control of exposure. The health risks for humans and animals are primarily acute in nature and are directly related to the concentration and duration of exposure.

The reference value of 1 ppm provides practical guidance for the safe use and re-release of treated rooms. In combination with suitable technical systems, controlled ventilation and clearly defined processes, an application can be implemented that is both effective and safe.

From an ecological perspective as well, hydrogen peroxide shows a favourable profile when used properly, as it leaves no persistent residues and decomposes rapidly. The remaining risks are primarily process-related and can be minimised through suitable measures.

Overall, it can be stated that aerosolisation of hydrogen peroxide is not an inherently high-risk technology, but one whose safety depends substantially on the quality of its implementation.



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