SILVER PEROXIDE

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1. INTRODUCTION

1.1. Silver peroxide

Silver peroxide has been developed over the last twenty years. It is a process that offers the possibility of stabilising hydrogen peroxide, an element that is safe for humans and the environment. The result: a long lasting and effective disinfectant.

The advantages of silver peroxide:

- ✓ Long term effectiveness
- ✓ Effective even in low concentrations (disinfection will require a long time) .
- ✓ Effective in a wide range of temperatures up to the boiling point.
- ✓ Gentle to the skin.
- ✓ Biodegradable with the exception of silver-nitrate
- ✓ No build-up of resistance by micro-organism
- ✓ Colourless, odourless and tasteless.

The disadvantages of silver peroxide:

- ✓ Silver in the form of silver-nitrate (most toxic form of silver)
- ✓ Silver precipitates out in contact with chlorites (salts/minerals)
- ✓ Restriction on use of silver in drinking water
- ✓ Poor disinfection at temperatures of 10^{o}C and lower.
- ✓ Slow disinfection at low dosage
- ✓ Silver remains in system and/or environment.

SILVER PEROXIDE fulfils not only all the requirements which are placed on disinfectants but is also superior to conventional products in it's ability to eliminate bacteria, viruses, mould, fungi, amoeba, spores as well as remove biofilm.

SILVER PEROXIDE disinfects reliably all areas where reduction of germs and sterility are a prime necessity.

2. Composition and activity

Silver peroxide is a disinfectant based mainly on hydrogen peroxide. Silver peroxides are a combination of silver-nitrate, hydrogen peroxide and numerous other components all of which are kept highly secret by the various manufacturers. The reason for this is that there is no patent on silver peroxide so that they have to kept the formula secret or else everybody would be making it…. So although most manufacturers claim their products to be a combination of silver-nitrate and hydrogen peroxide, there may be 5, 10 or even 20 other substances present.
The other substances are necessary to keep the formula stable. A combination of only silver-nitrate plus hydrogen peroxide does not have the disinfecting ability nor the stability associated with the major silver peroxides available on the market.

Depending on the manufacturer the silver content varies between 36 g/l to twice that amount or more. It is a colourless and odourless liquid that – in contrast with most traditional disinfectants – doesn't contain halogens or quaternary ammonium compounds.

2.1) What's so special about Silver peroxide?

The main difference between silver peroxide and ordinary hydrogen peroxide lies in the presence of the silver-nitrate which can be seen as a 'stabiliser and activator' at the same time. The function of the silver is to stabilise and activate the hydrogen peroxide.

2.1.a) Silver-nitrate as 'stabiliser'

As already mentioned H_2O_2 isn't stable which means that it slowly decomposes in oxygen and water. To solve this problem silver-nitrate is added to the hydrogen peroxide as stabiliser. This stabiliser prevents the slow decomposition of the hydrogen peroxide.

2.1.b) Silver-nitrate as 'activator'

The silver-nitrate also performs as an **activator**. The singularity of this silver activator is that it only activates the hydrogen peroxide when it is exposed to pollution (organic material,…). In contact with organic material the silver loses its stabilising function and starts to activate the hydrogen peroxide. The capacity of the silver to activate the hydrogen peroxide is preserved until the hydrogen peroxide is exposed to organic material. When all organic material has been oxidised by the generated active oxygen compounds, the silver once again acts as stabiliser for the remaining and non-reacted hydrogen peroxide. This is called a 'store' or **'depot action'**!

In this respect this activator differs from all the others (metals, UV-radiation, alkali,…) which completely decomposes all present hydrogen peroxide into active oxygen compounds, so that only water, oxygen and silver-nitrate remains after the reaction.

Under the influence of the silver the hydrogen peroxide becomes strongly activated in contact with organic material. This strong activation can be explained by the apparent interaction between the silver and hydrogen peroxide in the silver peroxide solution.

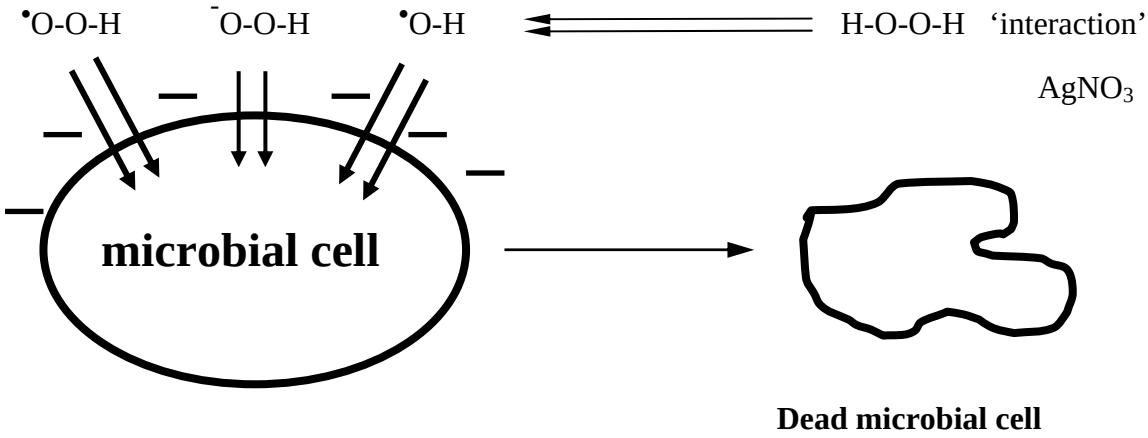
In case of contact with organic material one of the oxygen atoms from the peroxide group will tend to release itself from the H_2O_2 molecule. Therefore certain interaction forces between the

silver activator and the hydrogen peroxide have to be broken first. The oxygen atoms released from the hydrogen peroxide in that way possess a high kinetic energy. Via intermediate reactions all kinds of high kinetic intermediary products (radicals, anions,…) are formed which efficiently oxidise the organic material.

2.1.c) Microbial activity of Silver peroxide

Just as with normally activated hydrogen peroxide all sorts of active oxygen compounds are formed (radicals, anions, …). But because of the interaction forces between the silver activator and the hydrogen peroxide molecules the formed radicals and anions possess a high kinetic energy. This enables them to penetrate the cell wall easier, so that the internal oxidation of the microbial cell can occur much more efficiently (see Ill. 1.2).
Therefore silver peroxide disinfects much better then ordinary hydrogen peroxide. Compared with ordinary hydrogen peroxide one needs less silver peroxide to obtain the same result!

Ill. 1.2: Oxidation of microbial cell by silver peroxide

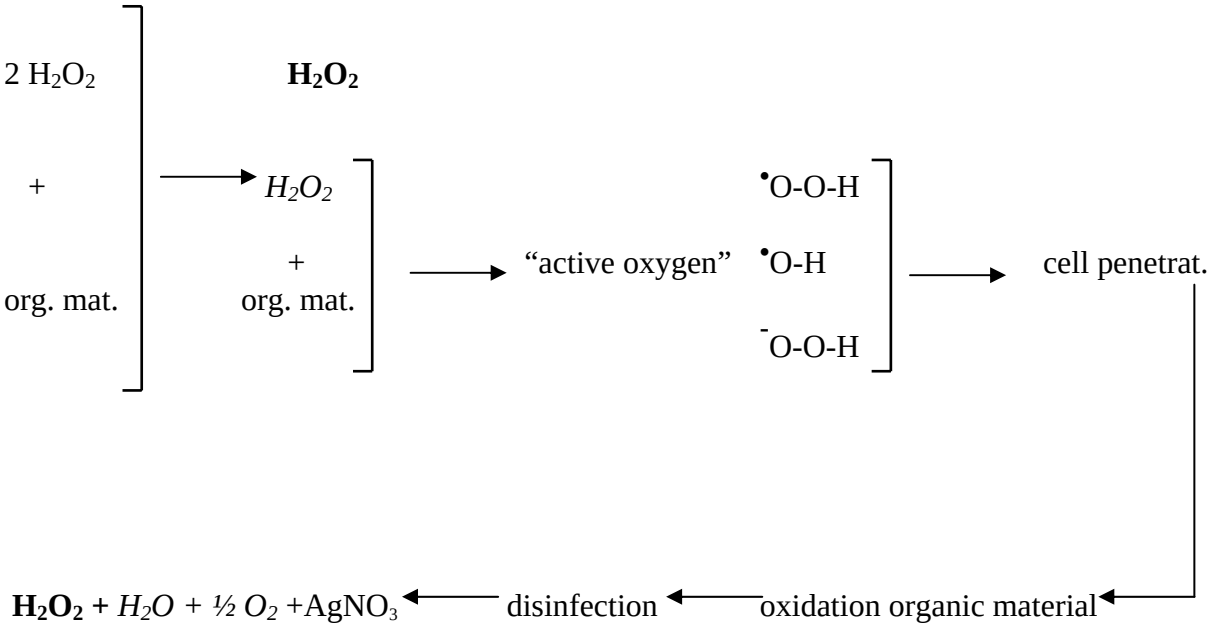


2.1.d) What remains after the reaction?

As reproduced in Ill. 1.2 the activation of the hydrogen peroxide stops when all the organic material is oxidised. At the end of the oxidative reaction the non-reacted hydrogen peroxide remains stabilised (H_2O_2). On the other hand the reacted hydrogen peroxide which is converted in active oxygen decomposes in water (H_2O) and oxygen (O_2) after the oxidation of the organic material.
In contrast with normally activated hydrogen peroxide the reaction isn't irreversible so that only the hydrogen peroxide, required for the complete oxidation of the present organic material, is broken down. The residual non-reacted hydrogen peroxide remains stabilised and preserved (depot action).

Because of the depot action an excellent disinfection can be assured during a long period, if dosed correctly.

Ill.1.2: Overview of the reaction of Silver peroxide with organic material



H_2O_2: non reacted, stabilised hydrogen peroxide

H_2O_2: hydrogen peroxide that has reacted with organic material

After the reaction has taken place, the residuals are: O_2, H_2O and silver-nitrate.