Humidity Measurements in H_2O_2

The use of resistant relative humidity sensors in hydrogen peroxide sterilization chambers

Sterilization with hydrogen peroxide:

Sterilization methods used around the world are changing. Hot steam morpholine or formaldehyde processes are being replaced by hydrogen peroxide sterilization techniques.

New methods such as the Dry Sterilization Process (DSP) and Vaporized Hydrogen Peroxide (VHP) offer distinct advantages over the older methods mentioned above.

The advantages are:

- Hydrogen peroxide is an effective sterilizing agent due to its highly toxic effect on bacteria and fungal spores. The combination of highly reactive hydroxyl with hydroxyl radicals from the hydrogen peroxide is an extremely reliable means of eliminating microorganisms.
- Contamination of H_2O_2 sterilized products is virtually impossible.
- In contrast to other sterilization methods, hydrogen peroxide decomposes into water and oxygen, leaving no toxic residues.
- Low process costs.
- Precise process monitoring ensures reliable sterilization results.
- Cycle times are short, the process is safe and environmentally friendly.

H_2O_2 sterilizers.

- Due to the above advantages, these dry aseptic sterilization processes are now used in the pharmaceutical, biotechnology, cosmetic and biomedical industries as well as in the food industry for the sterilization of surfaces and products. For example, it is used in the cold aseptic filling of beverages such as UHT milk and fruit juices in PET or HDPE plastic containers.

The four phases of a typical sterilization cycle:

Phase 1: Vacuum phase (conditioning)

Chamber pressure is reduced to about 0.4 bar resulting in a reduction of the relative humidity of the atmosphere contained in the chamber.

Phase 2: Injection phase (H_2O_2 evaporation)

Depending on the desired concentration of H_2O_2 a 30-55% hydrogen peroxide solution is used.

A mixture of hydrogen peroxide gas and water steam is introduced into the chamber insulator until the desired concentration level of H_2O_2 is obtained. The atmosphere in the chamber will become more and more humid until the condensation point is nearly achieved.

Phase 3: Diffusion phase (distribution and exposure to the sterilization)

The specified H_2O_2 concentration is maintained in the sterilizing chamber for a predetermined

continued

The four phases of a typical sterilization cycle:

Phase 3:
(continued)

length of time. The desired aseptic results can be calculated by multiplying the H_2O_2 concentration by the time.

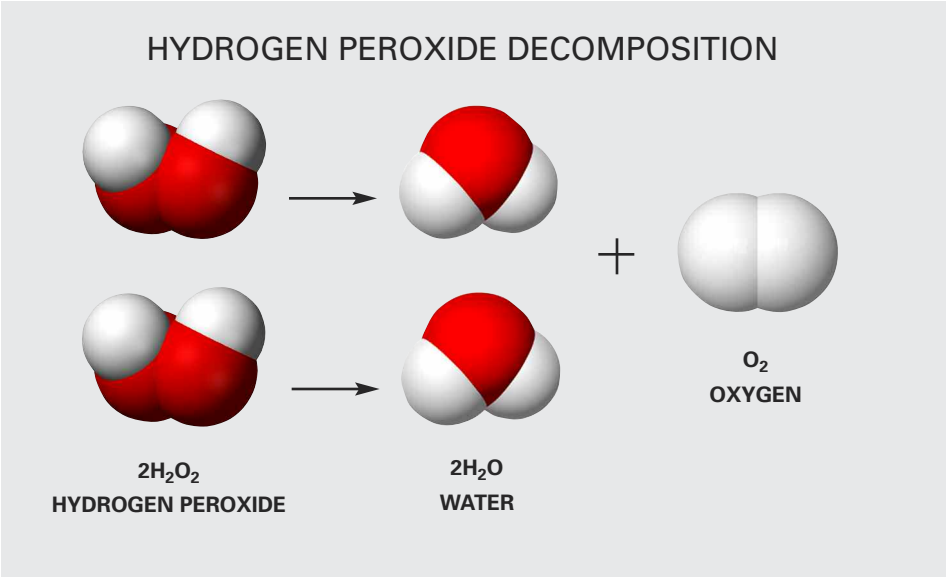
If the DSP technique is used, an intermediate step is added;

The diffusion phase progresses directly to the desired H_2O_2 concentration in the plasma phase and

High frequency (MHz range) radiation is used to convert the hydrogen peroxide into the plasma phase.

Phase 4: Aeration phase (removal of H_2O_2 from the sterilization chamber)

After removal of the gas, the pressure is reduced by the evaporation of the H_2O_2, The sterilization chamber is then aerated with sterile air. This process step results in a good and complete drying of the sterilization chamber and a complete removal of the toxic hydrogen peroxide. The chamber can be opened and emptied as soon as it has a pressure corresponding to that of the external environment.



Why the need for humidity measurement?

For the described method of sterilization using hydrogen peroxide, validation of the efficiency of the sterilization process, based on the H_2O_2 concentration of the amount of liquid evaporated is not reliable enough.

For critical applications, such as in biomedicine, the control of the sterilization process is achieved with chemical and biological indicators used in several places in the chamber insulator.

As can be seen from the process description, relative humidity is a key parameter requiring measurement. The design specification, testing and evaluation of each individual chamber insulator and sterilization cycle is crucial for assessing the effectiveness of the whole process.

For optimal process design, it is important to know the relative humidity at each of the phases, with precise measurement and humidity control.

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