

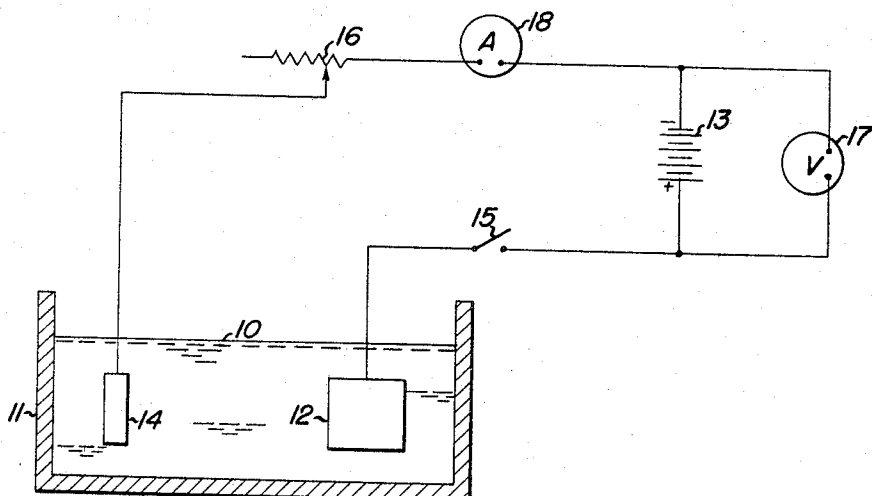
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PROCESS FOR STERILIZATION WITH NASCENT HALOGEN

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PROCESS FOR STERILIZATION WITH
NASCENT HALOGEN

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ABSTRACT OF THE DISCLOSURE

A process for the sterilization of a spore contaminated substrate by the formation of nascent halogen on its surface which comprises, inserting the substrate in a solution of a halogen compound, making the substrate a positive electrode and causing a flow of electric current between the substrate and a cathode.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment to us of any royalty thereon.

This invention relates to a process for sterilizing contaminated substrates with a nascent halogen. More particularly the invention relates to a process of sterilizing spore contaminated substrates with a nascent halogen produced by electrolysis.

The term "sterilization" denotes an absolute destruction of all forms of microbial life such as bacteria, spores, fungi and viruses. In distinction to sterilization, the term "disinfection" denotes destruction of infectious agents but not necessarily the destruction of resistant forms of microbial life such as the spore forms of organisms. Traditionally, sterilization is effected by means of heat, radiation or physical removal of the contaminating organisms such as by filtration, for example. Chemical agents, while suitable for disinfection of contaminated materials, have not proven to be satisfactory in effecting sterilization. Only ethylene oxide and certain glycols have achieved any degree of success as sterilizing agents, but their range is rather limited. Both of these materials have to be used in the vapor form, and ethylene oxide has the additional disadvantage of forming a wide range of explosive mixtures (3-80%) with air. Other disadvantages of conventional attempts at chemical sterilization, aside from the relative ineffectiveness of chemicals against the spore forms of organisms, are the difficulty of removal of the chemical from the material attempted to be decontaminated and the corrosiveness of many of these chemicals.

It is an object of this invention therefore to provide a method of chemical sterilization that is rapid and subject to none of the aforementioned difficulties.

This and other objects will be apparent from the following description and by reference to the drawing, which is a schematic view of the basic circuitry of a nascent halogen decontamination chamber.

Briefly, the process of this invention comprises inserting an article to be sterilized into a solution of a halogen compound, making the article a positive electrode, and causing a flow of electric current between the article and a cathode. The article to be decontaminated may be metal or any conductive material. By this electrolysis, halide ions are transported to the anode (the contaminated article) at which point an electron is best, forming nascent halogen on the surface of the contaminated article. The nascent halogen thus formed effects a rapid and thorough sterilization of the contaminated article.

Referring now to the drawing, a halogen compound solution 10, which acts as an electrolyte, is placed into a

suitable container 11. The article 12 to be decontaminated is connected to the positive terminal of a D.C. source 13, and inserted into the solution 10. A cathode 14 is connected to the negative terminal of D.C. source 13. The spatial relationship of the cathode to the anode and the cathode shape may be optimized for each particular article to be decontaminated to provide decontamination in a minimum of time. Switch 15 is used to start and stop the electrolysis. A variable resistance 16 is used to control the current. A voltmeter 17 and ammeter 18 may be connected as shown to measure the voltage and current, respectively, of the system.

The halogen compound may be any that will yield nascent halogen upon an anode during electrolysis. Examples of such compounds are the alkali metal hypochlorites and alkali metal halides. The alkali metal hypochlorites have been found to be especially effective due to the rapid deposition of nascent chlorine upon the anode. This rapid deposition prevents the salt solution from deleteriously affecting the substrate (anode).

The following specific examples illustrate the process of this invention.

Example 1

A study was made of the effect of nascent chlorine upon a contaminated metallic surface. One inch square blanks of stainless steel and aluminum were thoroughly cleaned and purposely contaminated with one drop of a 10% suspension of spores of *Bacillus subtilis* var. *niger* spread over each one inch square blank. The contaminated blanks were air dried overnight. The contaminated blanks were exposed to five minutes of treatment in the apparatus shown schematically in the drawing. The cathode 14 was a carbon rod. Carbon was chosen as the cathode material because it doesn't introduce extraneous ions into the system. Tests were performed at two voltages, three pH levels, and with two different chlorine-yielding electrolytes. Following treatment, swabs were taken of the previously contaminated surfaces and streaked on Tryptose agar (Difco) contained in petri dishes. The petri dishes were incubated for 48 hours at 37° C. The results of these tests are given in the following tables:

TABLE I.—SODIUM CHLORIDE ELECTROLYTE

pH	1% Solution			2% Solution		
	6 v. DC	20 v. DC	Control*	6 v. DC	20 v. DC	Control*
5.....	—†	—†	—†	—†	—†	—†
7.....	—†	—†	—†	—†	—†	—†
11.....	—†	—†	—†	—†	—†	—†

*No Electrolysis.
†= Viable Cells Recovered.
—=No Viable Cells Recovered.

TABLE 2.—SODIUM HYPOCHLORITE ELECTROLYTE
[2,500 p.p.m.]

pH	6 v. DC	20 v. DC	Control*
5.....	—	—	—†
7.....	—	—	—†
11.....	—	—	—†

*No Electrolysis.
†= Viable Cells Recovered.
—=No Viable Cells Recovered.

Control tests were made using plates of each metal contaminated with spores of *Bacillus subtilis* var. *niger* immersed in to the electrolyte solution, but not connected to the electrical source. These control plates were removed periodically and tested for the presence of viable cells.

Viable cells were recovered from the control plates after fifteen minutes immersion in each electrolyte solution.

During electrolysis the extent of corrosion of the contaminated metal substrates appeared to be inversely proportional to an increase in pH, and directly proportional to an increase in voltage and an increase in electrolyte concentration. At high voltages (20 v. DC) and at high current densities (effected by higher electrolyte concentration, such as 2% sodium chloride), voluminous bubbling occurred at the anode, yielding a condition not conducive to the formation and retention of a film of nascent chlorine on the anode surface. Also, the higher voltages accelerated corrosion of the metal blanks.

The results of these tests indicate that sterilization was most effectively achieved using sodium hypochlorite as the electrolyte. The addition of a wetting agent (quaternary ammonium chloride) to the electrolyte did not increase the bactericidal action of the chlorine.

Example 2

A series of tests were performed on one gallon paint cans, the exterior surfaces of which had been purposely contaminated with spores of *Bacillus subtilis* var. *niger*. The sterilization process was essentially the same as that described in Example 1. The can was immersed into sodium hypochlorite solution contained in a round metallic container, which said container served as the cathode. Decontamination was attempted using six volts and twenty volts alternating current. Alternating current was used by itself and also as a lower impressed voltage over a direct current source. These techniques did not decontaminate as effectively as the use of direct current alone, and the subsequent corrosion was more severe.

From the foregoing it is seen that sterilization of microbiologically contaminated substrates is rapidly and

completely effected by causing the formation of nascent halogen on the substrate. It is obvious that variations may be made in the process disclosed, and applicants intend to be bound only by the scope of the appended claims.

We claim:

1. The process of chemically sterilizing a substrate contaminated with a bacillus having a viability substantially equal to *Bacillus subtilis* var. *niger* comprising immersing said substrate into a solution of a hypochlorite salt, and causing electrolysis to occur so that nascent chlorine is formed upon said substrate and for a time sufficient to effect sterilization thereof.

2. The process of chemically sterilizing a substrate contaminated with a bacillus having a viability substantially equal to *Bacillus subtilis* var. *niger* comprising immersing said substrate into a solution of an alkali metal hypochlorite, connecting said contaminated substrate to the positive terminal of a direct current source thereby constituting said substrate an anode, and causing current to flow between a cathode and said anode for a time sufficient to effect sterilization of said substrate due to the deposition of nascent chlorine thereon.

3. The process of claim 2 wherein the substrate is contaminated with the spores of *Bacillus subtilis* var. *niger*.

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