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Corrosion of metals and alloys — Overview of metal corrosion protection when using disinfectants

Corrosion des métaux et alliages — Vue d'ensemble de la protection contre la corrosion des métaux lors de l'utilisation de désinfectants

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Foreword

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This document was prepared by Technical Committee ISO/TC 156, *Corrosion of metals and alloys*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document provides information on protection against metal corrosion risks when disinfectants are used in response to infectious diseases.

Governments, regulatory agencies and other professional organizations around the world have issued guidelines in response to pandemics, but these contain no specific information on metal corrosion protection when using disinfectants.

This document provides supplementary information intended to help organizations, families and individuals, as well as other stakeholders, take more effective actions to prevent users from being injured and reduce or avoid possible risks of metal corrosion during the use of disinfectants.

Corrosion of metals and alloys — Overview of metal corrosion protection when using disinfectants

1 Scope

This document provides an overview of the corrosivity of disinfectants and corrosion protection when using disinfectants, including an overview of test methods that can be used to determine their corrosivity.

This document is generic and applicable to organizations of all sizes in all industries, as well as to families and individuals, and it is intended to assist in determining appropriate health and safety measures regarding the use of disinfectants.

The resolution of security issues related to the use of disinfectants is outside the scope of this document.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
organization
company, corporation, firm, enterprise, authority or institution, person or persons or part or combination thereof, whether incorporated or not, public or private, that has its own functions and administration

[SOURCE: ISO 30000:2009, 3.10]

3.2
risk
combination of the probability of occurrence of harm and the severity of that harm

[SOURCE: ISO 15188:2001, 3.6]

3.3
disinfectant
agent capable of causing disinfection

[SOURCE: ISO 15190:2020, 3.8]

3.4
corrosivity
ability of an environment to cause corrosion of a metal in a given corrosion system

[SOURCE: ISO 8044:2020, 3.14]

3.5
corrosion protection
modification of a corrosion system so that corrosion damage is reduced

[SOURCE: ISO 8044:2020, 5.1]

3.6
common areas
spaces and amenities provided for the use of more than one person

Note 1 to entry: Canteens, lifts/elevators, stairs, reception areas, meeting rooms, areas of worship, toilets, gardens, fire escapes, kitchens, fitness facilities, store rooms, laundry facilities.

[SOURCE: ISO/PAS 45005:2020, 3.11]

4 Overview

4.1 Disinfecting is an important process of defending against infectious diseases, which can corrode metals. When disinfecting, avoid corrosion, injury and, if possible, discomfort to individuals, damage to the environment that can affect public health and damage to baggage, cargo, containers, vehicles, articles and mailbags.

4.2 Guidance on disinfection for the prevention of infectious diseases provided by public health agencies can include information on the corrosivity to metals.

4.3 Professional disinfectant-related institutions can provide detection methods of metal corrosion caused by various types of disinfectants under different testing or application conditions, and reports on corrosion tests for commonly used metals for public use or reference.

4.4 Disinfectant manufacturers can test the corrosivity of their products to metals and clearly note it on their instructions, provide corrosion data of their products to commonly used metals and put forward protective measures for reference.

4.5 When disinfecting, organizations, families or individuals, use disinfectants according to the relevant guidance documents and product specifications on metal corrosivity. Corrosion risks cannot be neglected and effective measures are important to avoid corrosion hazards; disinfection service providers are commonly required to receive training in the safe and effective use of disinfectants to avoid corrosion.

5 Corrosivity and main properties of commonly used disinfectants

Commonly used disinfectants can be classified by active ingredients into alcohol disinfectants, halogen disinfectants, peroxide disinfectants, guanidine disinfectants, phenol disinfectants, quaternary ammonium disinfectants and other disinfectants; classified by use into object surface disinfectants, disinfectants for medical items, air disinfectants, hand disinfectants, skin disinfectant, mucous membrane disinfectants, and disinfectants for infectious focus; classified by the microorganism killing ability into high-level disinfectants, intermediate-level disinfectants and low-level disinfectants.

Annex B provides an overview of the physical and chemical properties, types, disinfection mechanisms, application scope and methods of disinfectants commonly used in infectious disease disinfection.

Usually, peroxide disinfectants and halogen disinfectants are highly corrosive to metals in the range of their disinfection concentration. In general, the corrosivity increases with the strength of oxidation and acidity.

The corrosivity, active ingredients, main properties, uses, application methods, etc., of commonly used disinfectants are shown in Table 1.

Table 1 — Corrosivity and main properties of commonly used disinfectants

Type	Active ingredients of commonly used products	Oxidizability	Alkalinity or acidity [a]	Corrosivity to metals [b]	Main uses	Application methods
Aldehyde	Formaldehyde	No	Acidic	The presence of small amount of formic acid in formaldehyde solutions can corrode metals.	Disinfection of object surfaces and medical devices, etc.	Immersion Fumigation
	Glutaraldehyde	No	Acid, neutral or alkaline	Corrosive to carbon steel	Disinfection of medical devices, etc.	Immersion Wiping
Peroxide	Peracetic acid	Yes	Acidic	Slightly corrosive to stainless steel, alloy steel and chrome-plated metal, and heavily corrosive to common metals such as iron, copper and aluminium.	Disinfection of object surfaces, medical devices, air and infectious focuses, etc.	Immersion Wiping Spraying Fumigation
	Hydrogen peroxide	Yes	Acidic	Corrosive to metals	Disinfection of object surfaces, medical devices, skin and mucosa, air and infectious focuses, etc.	Immersion Wiping Spraying
	Ozone	Yes	Neutral	Corrosive to metals	Disinfection of object surfaces, medical devices, air and water, etc.	Immersion Wiping Spraying
	Chlorine dioxide	Yes	Acidic	Strong corrosive to aluminium, low alloy steel and carbon steel, and moderately corrosive to stainless steel.	Disinfection of object surfaces, medical devices, air and infectious focuses, etc.	Immersion Wiping Spraying
	Electrolyzed oxidizing water (EOW)	Yes	Acidic	Corrosive to copper, aluminium and carbon steel, and not obviously corrosive to stainless steel	Disinfection of object surfaces, medical devices, skin, hands and infectious focuses, etc.	Immersion Wiping Spraying
	Potassium monopersulfate	Yes	Acidic	Corrosive to metals	Disinfection of object surfaces, medical devices, skin, water and infectious focuses, etc.	Immersion Wiping Spraying

[a] Alkalinity or acidity refers to that of commonly used disinfectant products.

[b] Metal corrosivity is usually graded as no obvious corrosion, mild corrosion, moderate corrosion and heavy corrosion; there is no unified corrosion classification standard for disinfectants so far, which will be developed in the future; in the table, "corrosive to metals" only indicates the existence of metal corrosion, as a warning when using disinfectants; the specific corrosion classification is related to the standards used in the test, the type of metal materials used, test conditions and the basis for evaluation.

Table 1 *(continued)*

Type	Active ingredients of commonly used products	Oxidizability	Alkalinity or acidity [a]	Corrosivity to metals [b]	Main uses	Application methods
Halogen	Sodium hypochlorite	Yes	Alkaline	Heavily corrosive to aluminium, steel and carbon steel, and moderately corrosive to stainless steel, which can cause hydrogen embrittlement or stress corrosion cracking of stainless steel.	Disinfection of object surface, water and infectious focuses, etc.	Immersion Wiping Spraying
	Calcium hypochlorite	Yes	Alkaline			
	Chlorinated sodium phosphate	Yes	Alkaline			
	Sodium dichloroisocyanurate	Yes	Acidic			
	Trichloroisocyanuric acid	Yes	Acidic			
	Iodophor	Yes	Alkaline	Slightly corrosive to aluminium and stainless steel	Disinfection of medical devices, skin and mucosa, etc.	Immersion Wiping
	Iodine tincture	Yes	Alkaline	Slightly corrosive to aluminium and stainless steel	Disinfection of medical devices, skin and mucosa, etc.	Immersion Wiping
	Dibromodimet-hylhydantoin (DBDMH)	Yes	Acidic	Slightly corrosive to copper, aluminium and carbon steel	Disinfection of object surfaces, medical devices, water and infectious focuses, etc.	Immersion Wiping Spraying
	Bromochlorodimethylhydantoin (BCDMH)	Yes	Acidic	Slightly corrosive to copper, aluminium and carbon steel, and almost corrosion-free to stainless steel	Disinfection of object surfaces and water, etc.	Immersion Wiping Spraying
Alcohol	Ethanol	No	Neutral	No obvious corrosivity	Disinfection of object surfaces, skin and hands, etc.	Wiping Spraying
	Isopropyl alcohol	No	Neutral	No obvious corrosivity	Disinfection of object surfaces, medical devices, skin and hands, etc.	Immersion Wiping
	Chlorhexidine-ethanol	No	Alkaline	No obvious corrosivity	Disinfection of object surfaces, medical devices, skin and hands, etc.	Immersion Wiping Spraying

[a] Alkalinity or acidity refers to that of commonly used disinfectant products.

[b] Metal corrosivity is usually graded as no obvious corrosion, mild corrosion, moderate corrosion and heavy corrosion; there is no unified corrosion classification standard for disinfectants so far, which will be developed in the future; in the table, "corrosive to metals" only indicates the existence of metal corrosion, as a warning when using disinfectants; the specific corrosion classification is related to the standards used in the test, the type of metal materials used, test conditions and the basis for evaluation.

Table 1 *(continued)*

Type	Active ingredients of commonly used products	Oxidizability	Alkalinity or acidity [a]	Corrosivity to metals [b]	Main uses	Application methods
Phenol	Phenol	No	Acidic	No obvious corrosivity	Disinfection of object surfaces and skin, etc.	Immersion Wiping Spraying
	Halogenated Phenols	No	—	No obvious corrosivity	Disinfection of object surfaces, skin and hands, etc.	Immersion Wiping
Guanidine	Chlorhexidine	No	Acidic	No obvious corrosivity	Disinfection of object surfaces, skin, hands and mucosa, etc.	Immersion Wiping Spraying
	Polyhexamethylene guanidine (PHMG)	No	—	No obvious corrosivity	Disinfection of object surfaces, skin, hands, air and water, etc.	
Quaternary ammonium salt	Double-chain quaternary ammonium salt	No	—	Not obviously corrosive to copper and stainless steel sheets, and slightly corrosive to carbon steel and aluminium sheets.	Disinfection of object surfaces, medical devices, skin and mucosa, etc.	Immersion Wiping Spraying
	Single-stranded quaternary ammonium salt	No	—	Corrosive to metals		
Others	Ethylene oxide	No	Neutral	No obvious corrosivity	Disinfection of object surfaces, medical devices, skin, hands and mucosa, etc.	Fumigation
	Potassium permanganate	Yes	Alkaline	Corrosive to metals	Disinfection of object surfaces, skin and mucosa, etc.	Immersion Wiping
	Compound lysostaphin disinfectant	—	—	—	Disinfection of object surfaces, medical devices, skin, hands and mucosa, etc.	Immersion Wiping Spraying
	Plant extracts based disinfectant	—	—	—	Disinfection of object surfaces, air, skin and hands, etc.	Immersion Wiping Spraying

[a] Alkalinity or acidity refers to that of commonly used disinfectant products.

[b] Metal corrosivity is usually graded as no obvious corrosion, mild corrosion, moderate corrosion and heavy corrosion; there is no unified corrosion classification standard for disinfectants so far, which will be developed in the future; in the table, "corrosive to metals" only indicates the existence of metal corrosion, as a warning when using disinfectants; the specific corrosion classification is related to the standards used in the test, the type of metal materials used, test conditions and the basis for evaluation.

6 Good practice for metal corrosion protection when using disinfectants

6.1 General

6.1.1 It is important that relevant management and disinfection personnel, as well as the general public have adequate knowledge of the physical and chemical properties, corrosivity, corrosion protection measures and application methods of disinfectants.

6.1.2 Before planning and implementing disinfection, testers assess the corrosion degree of disinfectants to metals. This can be based on relevant international, regional, national or industrial standards. See also the overview of test methods that can be used to determine the corrosivity of disinfectants in Annex A.

6.1.3 According to the assessment results and the importance of metal equipment or components in the disinfected area, corrosion risks can be assessed in order to take measures to reduce the corrosion hazards.

6.1.4 Before disinfecting important facilities, vehicles or equipment, personnel obtain the corrosivity data of the proposed disinfectants to the corresponding metals, or select appropriate methods to test their corrosivity. When disinfecting other metal objects, reference is made to the relevant disinfectant corrosivity description or data, or relevant experience of correct use of disinfectant.

6.1.5 Alternative measures to mitigate or eliminate corrosion risks, on the premise of satisfying the disinfection effect, include but are not limited to the following:

— replacement of disinfectants with less corrosive or non-corrosive ones;

— protection of the surface of the disinfected objects before disinfecting, such as plugging or coating the parts or cracks where disinfectants are easy to accumulate, or painting or spraying anticorrosive coatings;

— use of inhibitors that cause no damage to the disinfected objects during disinfecting;

— wiping or rinsing the surface of the disinfected objects with clean water to remove the residual disinfectant after the contact time of disinfection.

6.2 Corrosion hazards

6.2.1 Halogen and oxidizing disinfectants can cause serious corrosion hazards during disinfecting.

6.2.2 If the disinfected objects contain metals and alloys prone to stress corrosion or hydrogen embrittlement, halogen disinfectants are not permitted to disinfect key components in aviation industry and important facilities. In other cases, through technical and economic comparison, halogen disinfectants can be used with appropriate corrosion protection measures based on 6.1.5.

6.2.3 Oxidizing disinfectants usually corrode commonly used metals to varying degrees with incorrect usage.

6.3 Corrosion protection measures

6.3.1 Under normal circumstances, alternative corrosion protection measures can be used when disinfecting different metals.

6.3.2 Alloy steel is often used as a key component of vehicles or important facilities, while carbon steel is often used for guardrails in common areas, steel structure components or concrete reinforcement,

etc. When disinfecting alloy steel or carbon steel without a surface protective layer, the disinfectant can corrode it to varying degrees. Even if there is a surface protection layer, when there are defects on the surface of the protection layer (such as pinholes, cracks, or scratches) that exposes the substrate, the substrate can be corroded, eroded or interface corroded, leading to peeling and debonding, and finally affected by chemical corrosion. Commonly used anti-corrosion methods include using low-corrosive or non-corrosive disinfectants, setting up a complete and corrosion-resistant protective layer, and thoroughly rinsing after disinfection.

6.3.3 Aluminium alloys are commonly used in vehicle parts, building doors and windows, etc. Disinfectants usually corrode them to varying degrees. Generally, corrosive disinfectants are not used to disinfect the aluminium alloy parts of vehicles to avoid possible accidents; when used in other less hazardous environments such as building doors and windows, in addition to choosing less corrosive disinfectants, it can also be wiped or rinsed with clean water after the disinfectant contact time has passed.

6.3.4 Stainless steel is the commonly used type of metal. The classes of stainless steels have relatively good corrosion resistance, but some of them can also be corroded by exposure to some oxidizing or halogen disinfectants. Corrosion forms of stainless steels usually include but not limited to the following:

— Pitting corrosion can be caused by exposure to halide disinfectant solution. It is a kind of local corrosion, resulting in shallow to deep penetration. Halide-induced pitting corrosion is a typical corrosion phenomenon of corrosion-resistant austenitic stainless steel.

— Crevice corrosion occurs in small, shielded crevices, which are prone to corrosion when the equipment is immersed in the non-flowing corrosive disinfectant solution.

— Stress corrosion cracking and hydrogen embrittlement can cause serious harm. Increasing corrosion cracks on stainless steel are caused by residual stresses applied to the steel and exposure to the corrosive disinfectant solution. Relieving stress or reducing the corrosivity of disinfectants is helpful to slow down or avoid corrosion cracking.

6.3.5 Titanium has outstanding corrosion resistance, and conventional disinfection concentration does not cause titanium metal corrosion.

6.3.6 When disinfecting other metals, the corrosivity of the disinfectant is a major factor to consider, including confirmation that its corrosion does not cause safety hazards, or the corrosion does not affect its appearance or function.

6.3.7 When disinfection is conducted in different environments, alternative protection measures can be taken based on the possible risk levels caused by corrosion, including but not limited to the following.

— When disinfecting aircraft including its components, corrosivity tests of disinfectants are carried out according to aviation-related standards and disinfectants are selected that meet the industry requirements or disinfectants without obvious corrosivity.

— When disinfecting other vehicles (such as ships, trains and automobiles), related standards and technically and economically feasible disinfectants are selected. See also the overview of test methods that can be used to determine the corrosivity of disinfectants in Annex A.

— When disinfecting metal parts of important infrastructures or structures that can affect safety (such as steel structure bridge and their metal accessories, airports, stadiums, amusement facilities and other metal structures, etc.), non-oxidative or non-halogen or non-obvious corrosive disinfectants are preferred, or other corrosion protection measures as listed in 6.1.5 are taken.

— When disinfecting metal parts of medical apparatus and instruments or important equipment, appropriate disinfectants and disinfection methods are selected that are comprehensively in

accordance with the corrosion resistance of the metal material to be disinfected, the corrosivity of disinfectants, disinfection methods and other conditions. When there is no reference data or experience, a specific test evaluation is required.

— When disinfecting other environments or objects with less risk of corrosion (such as common areas, streets, shopping malls, hospitals, tourist attractions, non-motor vehicles, etc.), oxidation disinfectants or halogen disinfectants or non-obvious corrosive disinfectants can be used without causing health hazards and corrosion safety hazards. When using oxidizing or halogen disinfectants, clean water is used to wipe or rinse after the disinfection contact time has passed, or less corrosive disinfectants are chosen, or alternative measures are adopted as mentioned in 6.1.5.

Annex A
(informative)

Overview of test methods to determine the corrosivity of disinfectants

An overview of test methods used to determine the corrosivity of disinfectants is given in Table A.1.

Table A.1 — Test methods to determine the corrosivity of disinfectants

No.	Test method	Scope of application
1	Full immersion	a) Use full immersion to disinfect metal products, such as immersion disinfection of medical instruments or other articles. b) Factory inspection of disinfectants. c) Evaluation of corrosivity of chemical agents involved in transportation. d) Disinfectant corrosivity comparison experiment, etc.
2	Spraying	The environment in which metal products are disinfected by spraying, such as the disinfection of an enclosed space or an open environment (e.g. airplane, vehicle, road, steel structure, and public area).
3	Fumigation	The metal products are disinfected in a closed environment by fumigation with disinfectant.
4	Wiping	a) Corrosion test when metal products are disinfected by wiping b) Corrosion test of disinfection towel
5	Corrosion evaluation	Evaluation of corrosion degree based on the test results of various disinfectants
6	Study on corrosivity test of disinfectants	It is useful to study corrosion behaviour or test corrosion data of various disinfectants under different test conditions, so as to provide a reference for the prevention and control of infectious diseases when using disinfectants.
7	Other methods	Other situations where test methods can be developed for specific purposes. For example, for ships, high-speed railways, motor vehicles and other transportation tools, as well as important infrastructure or structures.
NOTE It is useful to consider and include limiting values, such as disinfectant effective concentration, test parameters, dosage of disinfectants, treatment time and metal corrosion rate.		

Annex B
(informative)

Commonly used disinfectants for disinfection of infectious disease

B.1 Aldehyde disinfectant

B.1.1 Formaldehyde disinfectant

B.1.1.1 Physical and chemical properties and forms

Formaldehyde is a colourless gas with a strong pungent smell and can be burned. It has a boiling point of -21 °C, an ignition point of 300 °C and a relative density of 1,067 (given that of air as 1). It condenses into a solid formaldehyde polymer at normal temperature. It is easily soluble in water, alcohol and ether, and its solubility in water at room temperature is about 37 %.

The chemical formula for formaldehyde is CH_2O. Formaldehyde has active chemical properties and is easy to polymerize. Formaldehyde is moderately toxic and has strong irritation to skin and mucosa. The carbonyl group of formaldehyde is easy to undergo an addition reaction with sodium bisulphite, alcohol, ammonia, and derivatives of ammonia. Formaldehyde can be easily oxidized into formic acid, which can be synthesized into dioxymethylene or paraformaldehyde under different conditions, but it can be depolymerized and regenerated into formaldehyde when heated (especially heated with acid).

Formaldehyde used for disinfection is usually composed of 35 % to 40 % formaldehyde aqueous solution or solid paraformaldehyde. The former, also known as formalin solution, is acidic and miscible with water and ethanol; the latter is a white powdery polymer, containing 91 % to 99 % formaldehyde, which continuously breaks down to formaldehyde gas at normal temperature (formaldehyde gas is hardly soluble in water but soluble in hot water or alkali solution).

B.1.1.2 Mechanism of killing microorganisms

Through a competitive reaction, formaldehyde and cysteine interact to prevent the synthesis of the essential methionine (one of the amino acids) in bacteria, while the synthesis of methionine is a fundamental metabolism of the cytoplasm of microorganisms. Thus, the death of microorganisms is caused by inhibition of the synthesis of the nucleus and the cytoplasm. Through nonspecific alkylation of formaldehyde, formaldehyde molecules directly act on amino, sulfhydryl, hydroxyl and carboxyl on protein molecules of the bacterium to produce methyl derivatives, destroy bacterial proteins and lead to the death of microorganisms.

B.1.1.3 Application in the disinfection and sterilization of infectious diseases

a) Scope of application

When applied for disinfection of infectious diseases, formaldehyde has obvious toxicity, which affects its application in sterilization. Low-temperature steam formaldehyde sterilizer and formaldehyde gas fumigation disinfection cabinet are commonly used for disinfection. The low-temperature steam formaldehyde sterilizer is mainly used for sterilization of some medical apparatus and instruments that are afraid of humidity and heat. The formaldehyde gas fumigation disinfection cabinet is used in the disinfection of medical supplies. Formaldehyde solution can be used for disinfection of contaminated

articles, treatment of pathological anatomic specimens, disinfection of medical apparatus and instruments and formaldehyde gas fumigation disinfection.

b) Application methods

1) Low-temperature steam formaldehyde sterilizer: Formaldehyde gas is filled with pressure steam under the condition of lower than 90 °C, so that formaldehyde and low-temperature steam are mixed to sterilize medical apparatus and instruments which can be protected from humidity and heat under vacuum.

2) Formaldehyde fumigation disinfection cabinet: Completely closed containers or special formaldehyde fumigation disinfection cabinets are used under normal temperature and pressure, with a relative humidity of 70 %, and then the formaldehyde gas is released by the chemical method or by heating to fumigate and disinfect completely exposed articles.

3) Disinfection of contaminated articles by immersion in formaldehyde aqueous solution: The general contaminated articles can be soaked in the solution with the concentration of 40 g/l for 1 h, and the seriously contaminated articles can be soaked in the solution with the concentration of 80 g/l for 6 h to 8 h.

4) Disinfection of medical apparatus and instruments: The immersion in 70 % ethanol containing 8 g/l formaldehyde for 18 h to 24 h can meet the sterilization requirements; Immersion in the formula composed of 40 g/l formaldehyde and 50 g/l borax for more than 12 h can meet the sterilization requirements.

B.1.2 Glutaraldehyde disinfectant

B.1.2.1 Physical and chemical properties and forms

Glutaraldehyde disinfectant is a 5-carbon diacetal compound (1,5-glutaraldehyde), which molecular formula is $C_5H_8O_2$. Acetal, cyanohydrin, oxime, hydrazone, etc. can be formed from it through addition or condensation reaction. Its two active aldehyde groups can crosslink with protein.

Glutaraldehyde disinfectant stock solution is a colourless or light-yellow oily liquid, neutral and soluble in water, alcohols and other organic solvents in any proportion. Its aqueous solution is relatively stable under acidic conditions, while glutaraldehyde monomer is easy to polymerize into butanol unsaturated polymer under alkaline conditions.

The addition of cationic surfactants to the glutaraldehyde solution can significantly increase its bactericidal effect and is known as a potent glutaraldehyde compound sterilant, with a concentration of 1,0 % to 1,2 % equivalent to the bactericidal effect of 2 % original glutaraldehyde.

The forms of glutaraldehyde disinfectants are as follows:

— 2 % alkaline glutaraldehyde aqueous solution: It is made by adding 0,3 % sodium bicarbonate to a 2 % glutaraldehyde aqueous solution. As soon as glutaraldehyde is alkalized, its stability is greatly reduced. Therefore, in recent years, when producing glutaraldehyde aqueous solution in China, sodium bicarbonate is mixed in proportion and packed in small plastic bags. It is then put into the glutaraldehyde aqueous solution before use to make it become alkaline glutaraldehyde with the pH above 8,0.

— 2 % potentiated acid glutaraldehyde: It is made by adding 0,25 % primary alcohol ethoxylate in 2 % glutaraldehyde aqueous solution. With the pH value of about 5,0, it has strong stability, and can be used for one month. Its disadvantage is that its spore-killing effect is inferior to that of alkaline glutaraldehyde, and it is corrosive to metals.

— 2 % neutral glutaraldehyde: It is made by adjusting the pH value of 2 % potentiated acid glutaraldehyde to 7,0 with sodium bicarbonate. Its advantages are that its spore-killing effect is similar to alkaline glutaraldehyde and its stability is equivalent to that of the acid glutaraldehyde, and it can be used for 4 weeks at room temperature.

— Compound synergistic glutaraldehyde: It contains 1,0 % to 1,2 % glutaraldehyde, surfactant, sodium bicarbonate and sodium nitrite. The pH value of its aqueous solution is 6 to 7, which has the advantages of a strong bactericidal effect and small corrosiveness to metal instruments. It can be used for endoscope disinfection and instrument sterilization, and can achieve the bactericidal effect of 2 % alkaline, neutral and acid glutaraldehyde.

B.1.2.2 Mechanism of killing microorganisms

The bactericidal effect of glutaraldehyde mainly depends on the alkylation of two active aldehyde groups, which directly or indirectly act on different groups of biological protein molecules, resulting in the loss of biological activity and the death of microorganisms. Glutaraldehyde directly acts on bacterial protein and enzyme protein molecules. It destroys peptidoglycan and changes protein molecular structure, making it lose its original biological activity and leading to bacterial death due to cell respiratory metabolism disorder. Glutaraldehyde prevents the release of dipicolinic acid from the outer layer of bacterial spores, thus preventing the germination of bacterial spores; at the same time, the crosslinking can close the spore wall, resulting in the death of spores and fungal spores.

B.1.2.3 Application in the disinfection and sterilization of infectious diseases

a) Scope of application

When applied for disinfection of infectious diseases, glutaraldehyde is applicable to the disinfection and sterilization of endoscopes, surgical instruments, oral cavity, gynaecology and other heat-sensitive medical apparatus and instruments and precision instruments in medical and health units. It can also be used for disinfection and sterilization of cosmetology and hairdressing appliances, and knives, scissors and other articles for pedicures.

b) Application methods

Immersion or wiping is generally adopted. The cleaned and dried medical apparatus and instruments and articles to be disinfected can be immersed in the glutaraldehyde disinfectant for 30 min to 60 min, then rinsed with sterile water and dried.

For the disinfection of large equipment and precision instruments, it can be achieved by wiping the surfaces with glutaraldehyde disinfectant 2 times, and then wiping with clean water after 20 min. Generally, immersion is adopted for sterilization treatment. The cleaned and dried medical apparatus and instruments and articles to be treated can be immersed in the 2 % glutaraldehyde disinfectant or compound synergic glutaraldehyde disinfectant for 10 h, and then taken out sterilely, rinsed with sterile water, and wiped sterilely before use. When applied for disinfection of infectious diseases, glutaraldehyde disinfectant is mainly used for the following:

— Sterilization of beauty, hair and foot bath supplies: The instruments used for pedicures and cosmetology can be sterilized. The sterilization can be achieved by immersing them into the compound synergic glutaraldehyde, such as 2 % alkaline, acidic or neutral glutaraldehyde for 10 h, and then taking them out, washing them with sterile water, and drying them with a sterile towel before use.

— Sterilization of surgical instruments: 2 % glutaraldehyde, 1 % or 1,2 % compound synergistic glutaraldehyde disinfectant can be used for sterilization of surgical instruments. Generally, surgical instruments are immersed and disinfected for 10 h. After sterilization, they are rinsed with sterile water.

— Sterilization and disinfection of endoscopes in medical and health units: Glutaraldehyde is a common disinfectant for endoscope disinfection and sterilization. It has the advantages of high efficiency and rapid killing microorganisms, little influence by organics, generally no damage to the endoscope, low surface tension and easy rinsing. Generally, 2 % alkaline, potentiated acidic or compound synergistic glutaraldehyde disinfectant can be used for disinfection for 15 min immersion, and the sterilization is usually immersed for 10 h.

B.2 Peroxide disinfectant

B.2.1 Peracetic acid disinfectant

B.2.1.1 Physical and chemical properties and forms

Peroxyacetic acid or peroxyacetic acid, with molecular formula CH_3COOH, includes acetyl group and peroxy group in its structure. Therefore, peroxyacetic acid has both acid and peroxide properties, which is different from general organic acids and peroxides. It is a colourless transparent liquid, with acidity and a pungent smell. It is volatile and soluble in a variety of organic solvents and water. The relative density is 1,226 and the boiling point is 110 °C. Peroxyacetic acid is very unstable and decomposes when exposed to heat, metal and water.

Peroxyacetic acid usually includes two forms as below:

— Peroxyacetic acid aqueous solution: The concentration of peroxyacetic acid is about 20 %, containing about 0,1 % stabilizer (8-hydroxyquinoline). When it is stored at room temperature of 15 °C to 20 °C, its monthly decomposition rate is 2,88 %. It can be diluted with water to meet the required concentration when applied for use.

— Mixed form peroxyacetic acid: The two ingredients A and B are normally stored separately and mixed well before use. A is the treated glacial acetic acid, and B is mainly the proportioned hydrogen peroxide solution. On the day before use, solutions A and B can be mixed at 10:8 or 12:10 (by volume) and stored at room temperature. The peroxyacetic acid content can reach about 20 % on the following day. If the temperature is lower than 10 °C, the reaction time can be appropriately extended. If the temperature is about 30 °C, the concentration can reach about 20 % within 6 h after mix.

— Solid peroxyacetic acid: A solid organic compound containing acetyl group that can be dissolved in water and a solid compound containing peroxy group (-OOH) that can be dissolved in water are in binary packaging. They are usually stored separately. When it is used, they are dissolved in water in proportion to react chemically, so as to produce peroxyacetic acid. For example, 30 % acetylsalicylic acid and 30 % sodium perborate monohydrate are used to prepare solid peroxyacetic acid, and a 40 % anti-corrosion buffering agent is added. When it is used, it can be dissolved in water to be diluted to a peroxyacetic acid solution with the required concentration by adding the anti-corrosion buffering agent. As another example, a binary package consisting of TAED and sodium percarbonate is used as a solid peroxyacetic acid. The disinfectant in the binary package is of white powder, which is dissolved in water to obtain colourless and transparent peroxyacetic acid, with a content of 163 g/l, and then diluted with deionized water to reach the required concentration of the aqueous solution when it is used.

B.2.1.2 Mechanism of killing microorganisms

With its strong oxidation effect, peroxyacetic acid firstly destroys the permeability barrier of spores, and then destroys and dissolves the core of spores, so that DNA, RNA, protein, DPA and other substances are destroyed and leaked out, causing the death of spores. Its strong bactericidal effect is due to the dual action of acid and oxygen, and the action of active oxygen can be more important. Electron microscopy revealed changes in the ultrastructure of spores of *Bacillus subtilis var. niger* after disinfection with peroxyacetic acid, with not only the disruption of structures and permeability barriers such as the spore coat and cortex, but also the disruption or dissolution of the core of the spores.

B.2.1.3 Application in the disinfection and sterilization of infectious diseases

a) Scope of application

When applied for disinfection of infectious diseases, peroxyacetic acid is mainly used for disinfection of environmental surfaces and articles, sanitary ware, tableware and indoor air.

b) Application methods

1) Immersion: All articles that can be soaked can be disinfected by immersion in peroxyacetic acid, such as teaware, tableware, toys, sanitary ware, glassware, clothes, towels, fruits, eggs, vegetables and meat. The concentration of peroxyacetic acid disinfectant used for immersion is generally 400 mg/l to 2 000 mg/l. The immersion time can be determined according to the type of microorganism killed, concentration, temperature and other parameters.

2) Wiping: The environment surface and the surface of large objects can be disinfected by wiping. The concentration of common disinfectant is 400 mg/l to 1 000 mg/l.

3) Spraying: The peroxyacetic acid disinfectant is sprayed into an aerosol with a sprayer, which not only kills microorganisms in the air but also has a good disinfecting effect on surfaces. The peroxyacetic acid aqueous solution with a concentration of 400 mg/l to 4 000 mg/l is usually adopted. During disinfection, the relative humidity of the environment can be kept at 60 % to 80 %, the dosage can be 0,75 g/m^3 to 1 g/m^3, and the action time can be 1 h to 2 h.

4) Fumigation: The peroxyacetic acid is diluted to 30 000 mg/l to 50 000 mg/l, put in an evaporating dish or enamel tray, and heated and evaporated. The dosage is calculated as 1 g/m^3. It is sealed for 1 h to 2 h, with relative humidity ≥60 %.

c) Disinfection methods for the different objects to be disinfected

1) Disinfection of fabrics such as clothes and bedding: The fabrics are immersed in peroxyacetic acid with a concentration of 200 mg/l for 1 h, and then rinsed with clean water. For hepatitis virus, the articles are immersed in peroxyacetic acid with a concentration of 400 mg/l for 2 h, and then rinsed. The peroxyacetic acid spray with a concentration of 1 000 mg/l can also be used for disinfection.

2) Disinfection of rooms: It can be fumigated with peroxyacetic acid or disinfected by spraying. Spraying uses a peroxyacetic acid solution containing a deodorant with a concentration of 400 mg/l (for general bacteria) or 1 000 mg/l (for hepatitis virus) to disinfect walls, doors, windows and floors, closing doors and windows after spraying for 1 h. Fumigation involves heating and evaporating the peroxyacetic acid with a concentration of 20 000 mg/l to 50 000 mg/l in the enamel tray, and sealing it for 1 h. The dosage of peroxyacetic acid is 1,0 g/m^3. The peroxyacetic acid with a concentration of 10 000 mg/l is sprayed in the ward for 15 min (5 ml/m^3).

3) Disinfection of tableware: The cleaned tableware can be immersed in the peroxyacetic acid solution with a concentration of 1 000 mg/l for 2 min, and then rinsed. The unwashed tableware can be immersed in the peroxyacetic acid with a concentration of 1 000 mg/l for more than 3 min and washed.

4) Disinfection of toilet: It can be wiped with peroxyacetic acid with a concentration of 400 mg/l and then rinsed with water, or immersed in the peroxyacetic acid with a concentration of 400 mg/l for 1 h. For hepatitis virus, it can be immersed in the peroxyacetic acid with a concentration of 1 000 mg/l for 1 h to 2 h.

B.2.2 Hydrogen peroxide disinfectant

B.2.2.1 Physical and chemical properties and forms

Hydrogen peroxide is a strong oxidant. Its aqueous solution is weakly acidic. The molecular formula is H_2O_2. Pure hydrogen peroxide is a colourless and transparent liquid with good stability. It explodes when heated to over 153 °C. Impurities in the liquid, some heavy metal ions and light can accelerate its decomposition, while sodium stannate and sodium pyrophosphate can stabilize it. Hydrogen peroxide

can be mixed with water in any proportion. The final decomposition product of hydrogen peroxide is oxygen and water, which has no pollution to the environment.

Hydrogen peroxide disinfectants include single-component hydrogen peroxide disinfectants and compound hydrogen peroxide disinfectants. The content of the hydrogen peroxide stock solution is 30 % to 50 %. The available content of single-component hydrogen peroxide disinfectants sold on the market ranges from 0,5 % to 20 %.

Compound hydrogen peroxide disinfectant is a liquid disinfectant compounded by hydrogen peroxide, synergist and stabilizer, with an available component content of 8 % to 10 %. The pH can be 2,0 to 3,5 so that its stability, sterilization ability and sterilization speed can be improved accordingly while the surface tension reduced. The product is a colourless and transparent liquid, without sediment and a pungent smell.

B.2.2.2 Mechanism of killing microorganisms

Hydrogen peroxide can directly oxidize the outer structure of cells and destroy the permeability barrier of cells. The permeability barrier of bacteria can maintain normal structure and physiological metabolism. As a result, the material balance inside and outside is destroyed, resulting in bacterial death. When candida albicans are treated with H_2O_2, it can be observed that the cell wall and cell membrane are damaged under the electron microscope.

Free radicals such as hydroxyl (OH) and active [O] are produced during the decomposition of hydrogen peroxide, which can directly react with microbial proteins and nucleic acids, destroy the material structure and lead to death. The decomposition product of hydrogen peroxide can inhibit the bacterial enzyme system and act with the amino acids in the enzyme protein. In addition, when the hydrogen peroxide enters the cell, it can act on the phosphodiester linkage in the DNA strand and break it, all of which can cause microbial death.

Silver ions in compound hydrogen peroxide disinfectant, together with H and O, act on bacteria, destroy the integrity of cells and protoplasm, and coagulate proteins in cells, so as to accelerate the death of bacteria. The silver ion can not only promote the decomposition of H and O to produce free radicals to accelerate the death of microorganisms, but also prolong the duration of sterilization.

B.2.2.3 Application in the disinfection and sterilization of infectious diseases

a) Scope of application

When applied for disinfection of infectious diseases, hydrogen peroxide can be used for preventive disinfection and disinfection of infectious focus, including object surface disinfection, tableware disinfection, fruit and vegetable disinfection, patient clothing and supplies disinfection, skin mucosa and instruments disinfection before the operation, bathtub and toilet supplies disinfection, and hand disinfection.

b) Application methods

1) Disinfection of environment and object surfaces: the environment and object surfaces are commonly disinfected by wiping or spraying. The clean surface is disinfected with hydrogen peroxide disinfectant with a concentration of 30 000 mg/l, and the dwell time is 30 min. The contaminated surface is disinfected with disinfectant with a concentration of 50 000 mg/l to 60 000 mg/l, and the dwell time is 30 min.

2) Disinfection of tableware: tableware is commonly disinfected by immersion. For preventive disinfection, tableware can be immersed in hydrogen peroxide disinfectant with a concentration of 30 000 mg/l for 30 min; for disinfection of infectious focus, tableware can be immersed in disinfectant with a concentration of 50 000 mg/l to 60 000 mg/l for 30 min, and then rinsed with clean water before use.

3) Disinfection of skin and hands: Skin and hands are commonly wiped, sprayed and immersed with hydrogen peroxide disinfectant with a concentration of 15 000 mg /l to 30 000 mg /l for 1 min to 3 min.

4) Disinfection of bacterial spore-contaminated articles: Such articles can be disinfected with hydrogen peroxide disinfectant with a concentration of 60 000 mg/l for 60 min to 120 min.

B.2.3 Ozone disinfectant

B.2.3.1 Physical and chemical properties and forms

Ozone or triatomic oxygen, with the molecular formula of O_3, is a light blue gas with a special odour, and the relative density is 1,658.

Ozone is an allotrope of oxygen. It is unstable in water, and the half-life of ozone in distilled water is usually 20 min to 30 min at 20 °C. It is a strong oxidant.

The preparation methods of ozone include silent discharge, electrolysis and ultraviolet irradiation.

B.2.3.2 Mechanism of killing microorganisms

The killing mechanism of ozone to microorganisms is mainly through its strong oxidation. It has stronger oxidation in water and can carry out rapid oxidation reactions with biological components such as glutathione, cystine, tryptophan, methionine and histidine, and amino acids of protein components. It can also oxidize with the double bond of unsaturated fatty acid and guanine of the gene, which are the components of the cell membrane, at a faster reaction rate, so as to destroy or decompose the cell wall of bacteria, quickly diffuse and penetrate into the cell, oxidize and destroy the enzymes in the cell, and make the cell die. Its action mechanism can be summarized as follows:

— It acts on the cell membrane, resulting in the increase of the permeability of the cell membrane, the outflow of intracellular substances, and the loss of cell vitality.

— It inactivates enzymes necessary for cellular activity, which can be for basal metabolism or for the synthesis of essential cellular components.

— It destroys the genetic material in cells and makes them lose their function. Ozone kills viruses by directly destroying their DNA or RNA.

B.2.3.3 Application in the disinfection and sterilization of infectious diseases

a) Scope of application

When applied for disinfection of infectious diseases, ozone is mainly used for air disinfection, water disinfection (including hospital sewage, diagnosis and treatment water, swimming pool water, etc.), and object surface disinfection.

b) Application methods

1) Air disinfection: For ozone application, the ozone concentration can be ≥20 mg /m^3 and the action time can be ≥30 min.

2) Water disinfection:

i) Disinfection of water for diagnosis and treatment (not water for injection): generally, 0,5 mg/l to 1,5 mg/l of ozone is added and the remaining ozone concentration in the water is maintained at 0,1 mg/l to 0,5 mg/l for 5 min to 10 min; if the water quality is poor, the ozone content can be 3 mg/l to 6 mg/l.

ii) Water disinfection in public places: the input amount of ozone is 1 mg/l to 1,7 mg/l, and the action time is 1 min to 2 min; if it is used for the treatment of swimming pool circulating water, the input amount of ozone is 2 mg/l.

iii) Disinfection of drinking water: the ozone can be contacted with water for at least 12 min before leaving the factory, and the residual ozone in the disinfected water can be ≤0,3 mg/l.

3) Object surface disinfection:

i) Ozone gas disinfection: the concentration of ozone gas can be ≥ 60 mg/m^3, the relative humidity can be ≥ 70 %, and the action time can be 60 min to 120 min.

ii) Ozone water disinfection: ozone concentration in water can be >1 0 mg/l, and action time can be ≥ 60 min.

B.2.4 Chlorine dioxide disinfectant

B.2.4.1 Physical and chemical properties and forms

a) Physical and chemical properties and forms

Chlorine dioxide, with molecular formula of ClO_2, is a red-yellow gas at normal temperature, with a pungent smell similar to chlorine gas, melting point of -59 °C, boiling point of 11 °C, and density of 3,09 g/l.

The solubility of chlorine dioxide in water at 20 °C and 30 mmHg is 2,9 g/l. When the content of chlorine dioxide in the air is 14 mg/l, it can be perceived. When the content is 45 mg/l, it obviously irritates the respiratory tract. In water, chlorine dioxide is more volatile and escapes from the water with little aeration. Generally, it is prepared on site and used on site.

The chlorine dioxide molecule is composed of one chlorine atom and two oxygen atoms. The molecular formula is ClO_2 and the structural formula is O-Cl-O. Chlorine dioxide is more soluble in water than chlorine or ozone. The solubility of gas is that when the dissolution equilibrium is reached. the concentration of dissolved gas has different solubility at different temperatures. The higher the temperature, the higher the concentration of chlorine dioxide in water. The solubility of chlorine dioxide is not changed by the presence of other impurity gases. In a wide range of pH, chlorine dioxide does not undergo hydrolysis, but exist in the form of dissolved gases. When the concentration is 5 mg/l to 10 mg/l and pH value is 12, gaseous chlorine dioxide can be maintained in the solution for 20 min to 3 h. The stability of chlorine dioxide aqueous solution is related to its purity.

Chlorine dioxide is a strong oxidant, and its oxidation capacity is about 2,5 times that of chlorine. However, unlike chlorine, chlorine dioxide reacts with inorganics and organics with strong selectivity, and only oxidation occurs, whereas chlorine reacts with organics in both substitution and oxidation reactions, so when chlorine is used to treat water, organic halides that are carcinogenic to humans are formed.

b) Forms

1) Chlorine dioxide generator: Chlorine dioxide is a relatively unstable gas. When its volume concentration in the air reaches more than 10 %, it is explosive and cannot be compressed or liquefied. Therefore, chlorine dioxide must be prepared on site to dissolve it in water. The chlorine dioxide generator is a device used to prepare chlorine dioxide on site. The methods of preparing chlorine dioxide by generator mainly include electrolysis and the chemical method. The principle of the electrolysis is to use table salt as raw material, and platinum or titanium electrode reacts in diaphragm electrolytic bath to produce a mixed solution containing chlorine dioxide, chlorine, hydrogen peroxide, ozone and other gases. The output of chlorine dioxide is low, generally only about 10 % to 30 %. The principle of the chemical method is to add a reducing agent in the acidic medium to reduce chloric acid into chlorine dioxide. There are mainly two methods of generating chlorine dioxide with sodium chlorate and sodium chlorite as raw materials.

2) Stable chlorine dioxide solution: It is prepared by dissolving high-purity chlorine dioxide gas in stabilizers containing sodium carbonate, sodium percarbonate, sodium borate, sodium

perborate, etc. It can be used after being activated and diluted. Generally, 2 % to 8 % aqueous solution is made and sold as commodities.

3) Solid chlorine dioxide disinfectant: The stable chlorine dioxide liquid is adsorbed on the carrier to make solids of various shapes such as colloid, paste, powder and tablet. When used, it is mixed with the activator and the activation rate is controlled to obtain different chlorine dioxide release rates and meet the needs of different occasions; Or chlorine dioxide precursor, activator and stabilizer are mixed together to make a reactive solid preparation. Solid chlorine dioxide products include products in the forms of powder, tablet, binary packaging and ternary packaging.

B.2.4.2 Mechanism of killing microorganisms

The electronic structure of the chlorine dioxide molecule is unsaturated, and there are 19 electrons in the outer layer, with strong oxidation. Bacteria, viruses and fungi are low-level organisms with single cells. Their enzymes are distributed on the membrane surface and are easy to be inactivated by chlorine dioxide. The cell contents (proteins and nucleic acids) of bacteria treated with chlorine dioxide do not leak out, indicating that the disinfectant does not destroy the integrity of the cell wall, while the process of cellular protein synthesis is significantly inhibited, and that the degree of inhibition of intracellular protein synthesis is dose-effective in relation to the amount of chlorine dioxide used. The destruction of ATPase and lipid peroxidation of *Escherichia coli* by chlorine dioxide are important causes of its death. Chlorine dioxide inactivates the enzyme containing sulfhydryl groups in cells. The oxidative decomposition ability of chlorine dioxide can lead to the breaking of the amino acid chain and the loss of protein function, resulting in the death of microorganisms. Its function is neither protein denaturation nor chlorination, but strong oxidation.

B.2.4.3 Application in the disinfection and sterilization of infectious diseases

a) Scope of application

When applied for disinfection of infectious diseases, chlorine dioxide disinfectant is mainly used for disinfection of public environment and supplies, disinfection of drinking water, disinfection of water storage containers, sewage treatment, disinfection of corrosion-resistant diagnosis and treatment instruments and supplies, disinfection of tableware and teaware, disinfection of sanitary ware, disinfection of toys, disinfection of infectious focuses, disinfection and preservation of food, etc.

b) Application methods

1) Drinking water: Chlorine dioxide disinfection of drinking water can not only kill microorganisms in water, but also kill protozoa and algae, as well as improving water quality and deodorizing. Generally, for natural water, it is added by 2,0 mg/l for 3 min.

2) Public supplies: For glass, plastic and ceramic utensils and supplies, they can be disinfected with chlorine dioxide immersion at 500 mg/l for 25 min and 1 000 mg/l for HBsAg contaminants for 2 min. Chlorine dioxide is certain corrosive to carbon steel and slightly oxidative to aluminium and stainless steel. Therefore, chlorine dioxide cannot be used for long-term immersion disinfection of metal instruments and supplies.

3) Health care and disease prevention and infectious victim pollutants: For the disinfection of pollutants of hepatitis patients, general articles can be wiped and disinfected with chlorine dioxide with a concentration of 500 mg/l. The infectious diseases and household environmental articles and surfaces can be disinfected by wiping or spraying chlorine dioxide with a concentration of 200 mg/l to 500 mg/l. The sanitary ware can be disinfected by immersing in the chlorine dioxide with a concentration of 500 mg/l to 1 000 mg/l for 30 min.

4) Tableware, teaware, food containers, water storage containers and food processing equipment: Tableware, teaware and food containers can be disinfected by immersing in the chlorine dioxide disinfectant with a concentration of 200 mg/l for 1 min to 5 min. After disinfection, they can be rinsed with water and dried. The pipes, storage tanks and mixing tanks of food processing equipment can be washed first, then rinsed with clean water, and finally immersed

in the chlorine dioxide with a concentration of 80 mg/l for 30 min, and then rinsed with clean water.

5) Application in food preservation: For meat, aquatic products and poultry, immersing them in the activated chlorine dioxide disinfectant with a concentration of 40 mg/l to 60 mg/l for 5 min can effectively control the reproduction of microorganisms.

B.2.5 Acidic electrolyzed oxidizing water

B.2.5.1 Physical and chemical properties

Acidic electrolyzed oxidizing water is a colourless and transparent liquid with a slight chlorine smell. The main active component is hypochlorous acid (HClO), containing active oxygen and active hydroxyl groups, and the available chlorine content is 60 mg/l ± 10 mg/l. Its pH value is between 2,0 and 2,7, and its oxidation-reduction potential (ORP) is ≥1 100 mV.

Usually, softened municipal tap water and 0,05 % sodium chloride are electrolyzed to generate chlorine from chloride ions on the anode side, and chlorine reacts with water (HO) to generate hydrochloric acid, hypochlorous acid and other substances. In addition, water is also electrolyzed at the anode to become oxygen (O) and hydrogen ion (H+), so that the pH value of the liquid produced by the anode drops below 2,7, the oxidation-reduction potential rises above 1 100 mV, and the available chlorine concentration reaches 50 mg/l to 70 mg/l.

B.2.5.2 Mechanism of killing microorganisms

The living environment of microorganisms is generally between the pH values of 3 to 10 and the ORP values of −400 mV to + 900 mV. The pH value of acidic electrolyzed oxidizing water is ≤3,0 and ORP is ≥1 100 mV, exceeding the living environment of microorganisms. In addition, the synergistic effect of available chlorine, hydroxyl radical (·OH) and reactive oxygen (·O) species produced in the process of formation changes the cell membrane potential instantaneously, resulting in swelling and rupture of cell membrane, DNA Proteins and metabolic enzymes are rapidly decomposed and inactivated, so microorganisms can be quickly killed.

B.2.5.3 Application in disinfection of infectious diseases

a) Scope of application

Acidic electrolyzed oxidizing water (EOW) has a high ORP value with a low pH value and low concentration of available gas. It is characterized by broad-spectrum sterilization, strong bactericidal effect, safe use and no pollution to the environment. When applied for disinfection of infectious diseases, the electrolyzed oxidizing water is used for the preventive disinfection of environmental surfaces, articles, tableware, fruits and vegetables, and hands, and also the disinfection of pollutants of infectious focuses and human skin mucosa.

b) Application methods

1) Acidic electrolyzed oxidizing water can only be used as the stock solution for preventive disinfection of infectious diseases and disinfection of infectious focuses, and it can be prepared on site. It can be used by immersion, wiping, spraying or rinsing for disinfection.

2) Preventive disinfection: For the disinfection of general articles and environmental surfaces, they can be cleaned first, and then immersed or wiped with acidic electrolyzed oxidizing water. The oil dirt on the surface can be washed, flushed with tap water, and then immersed and disinfected with acidic electrolyzed oxidizing water for 10 min. For the disinfection of food processing appliances, they can be immersed with acidic electrolyzed oxidizing water for 3 min to 5 min, or repeatedly wiped for 5 min for disinfection. For the disinfection of tableware, they can be cleaned thoroughly on the surface stains with alkaline reduction potential water or detergent, and washed with tap water, then rinsed and immersed with acidic electrolyzed oxidizing water for disinfection. For the disinfection of hands, they can be rinsed with alkaline

reduction potential water for 20 s, then rinsed with running acidic oxidizing potential water for 1 min, and then rinsed with alkaline reduction potential water or tap water for 10 s. If there is a lot of dirt on hands, they can be cleaned first and then disinfected according to the above method. If the sanitary ware is not clean, it can be repeatedly wiped or immersed with acidic electrolyzed oxidizing water for 5 min after being cleaned. For the disinfection of the floor, after the floor is cleaned, the floor can be wiped once to twice with a mop that is disinfected by acidic electrolyzed oxidizing water.

3) Disinfection of infectious focuses: Acidic electrolyzed oxidizing water can be used for the disinfection of infectious focuses of various infectious diseases. For articles contaminated by the patient's excreta or vomit, they can be cleaned first, and then sprayed, immersed or rinsed and with acidic electrolyzed oxidizing water for 15 min for disinfection. The tea ware, tableware and kitchen supplies used by patients can be cleaned and then rinsed and immersed with acidic electrolyzed oxidizing water for 5 min for disinfection. For door handles, table and chair armrests, switches, worktables and furniture contacted by the patient, their surfaces can be cleaned and wiped with acidic electrolyzed oxidizing water for 5 min for disinfection. For baths, toilets and bedpans used by patients, their surfaces can be cleaned, and then wiped or rinsed with acidic electrolyzed oxidizing water for 5 min for disinfection; The air polluted by patients attacked by respiratory tract can be sterilized by spraying acidic electrolyzed oxidizing water with a concentration of 15 ml/m^3.

4) Diagnosis and treatment equipment used by patients: Ventilator, monitor, infusion pump, microinjection pump, stethoscope, sphygmomanometer and electrocardiograph, especially the frequently contacted surfaces, such as the button and operation panel of the instrument, can be wiped with acidic electrolyzed oxidizing water for disinfection. The corrugated tubing, tubes, Y-joint, breathing valve, water collecting cup of ventilator, tubes and bottle of anaesthesia machine, atomizer and oxygen humidification bottle can be thoroughly cleaned after use, soaked with running acidic electrolyzed oxidizing water for 3 min to 5 min for disinfection, and then dried naturally or dried.

B.2.6 Potassium monopersulfate disinfectant

B.2.6.1 Physical and chemical properties and forms

Potassium monopersulfate is an inorganic peroxide, also known as potassium peroxymonosulfate sulfate. It exists in the form of triple salt combined with potassium bisulfate and potassium sulfate. Therefore, it is called potassium hydrogen peroxymonosulfate (potassium monopersulfate compound). Its molecular formula is $2KHSO_5 \cdot KHSO_4 \cdot K_2SO_4$. It is a white powdery solid that can flow freely and is easily soluble in water. At 20 °C, the water solubility is greater than 250 g/l. The aqueous solution is acidic, and the stability in the water is poor, so it cannot be stored for long time. It is generally stable in the solid state. When the temperature of dry powder is higher than 65 °C, it is easy to decompose and release oxygen and sulfide. However, it decomposes in water to release oxygen and potassium sulfate without harmful substances. It has a strong oxidation ability and high oxidation potential energy, which exceeds chloride, potassium permanganate, hydrogen peroxide, etc. It can oxidize chloride ions in the aqueous solution into chlorine, and oxidize alcohols, aldehydes and other organics into organic acids. Therefore, it is known as "peroxide with perfect combination of oxidation and safety". Its pH value (at 25 °C) in the 1 % aqueous solution is 2,0 to 2,2, and 1,5 to 1,9 in the 3 % aqueous solution.

Potassium monopersulfate compound disinfectant is a common powder containing 50 % to 60 % potassium monopersulfate compound. At the same time, it is compounded with no more than 3 % sodium chloride, a small amount of organic acid and surfactant, which is converted into available chlorine of no less than 10 %. The single compound salt agent is rarely used as a disinfectant. It is generally directly used in swimming pool water treatment to remove ammonia and nitrogen organics such as urea. However, the disinfectant made of potassium monopersulfate compound is widely used due to its small corrosivity and good stability.

B.2.6.2 Mechanism of killing microorganisms

The first is that sodium chloride, organic acid and potassium monopersulfate compound are compounded into finished disinfectant. In the aqueous solution, a chain reaction occurs in water with the special oxidation ability of potassium monopersulfate, and new nascent oxygen, hypochlorous acid and free hydroxyl are continuously generated, killing microorganisms through oxidation, chlorination and acidification. The chloride released after killing microorganisms is oxidized into hypochlorous acid and free hydroxyl by the active oxygen of potassium monopersulfate, which acts for a long time to kill microorganisms. The second is that the bactericidal effect of potassium monopersulfate itself. Potassium monopersulfate is inorganic. It contains an monopersulfate ion (SO_5H^-) that can directly kill microorganisms.

B.2.6.3 Application in disinfection of infectious diseases

a) Scope of application

Potassium monopersulfate is an oxidizing disinfectant, which can kill all kinds of microorganisms. Its advantages are broad-spectrum sterilization, strong bactericidal effect, reliable disinfection effect, easy storage, no secondary pollution after disinfection and safe use. The disadvantages are that the aqueous solution is irritating to the skin mucosa, corrosive to metals and bleaching to textiles. However, if the concentration is below 1 %, the skin mucosal irritation is small. When applied for disinfection of infectious diseases, potassium monopersulfate disinfectant can be used for disinfection of infected water, air, drinking water, tableware, environmental surface, articles, medical appliances, as well as the living environment and body surface of pets.

b) Application methods

1) Diagnosis and treatment equipment: Corrosion resistant articles and medical devices with certain corrosion resistance can be disinfected with potassium monopersulfate disinfectant, such as thermometer and tongue depressor, with a concentration of 2 000 mg/l for 30 min. Equipment with obvious contamination can be cleaned first, and potassium monopersulfate with a concentration of 5 000 mg/l can be used for disinfection together with trace surfactant for 20 min.

2) Environmental surface: The environmental surfaces of hospital wards, outpatient clinics, offices, kitchens, toilets, etc. and the surface of articles can be disinfected by spraying or wiping with potassium monopersulfate disinfectant, with a concentration of 2 000 mg/l for 20 min.

3) Tableware and teaware: They can be disinfected by cleaning and immersion with potassium monopersulfate disinfectant with a concentration of 200 mg/l to 1 000 mg/l for 5 min to 10 min. Potassium monopersulfate disinfectant can also be used with detergent and other cleaning agents to disinfect dishes. After disinfection, tableware and teaware can be rinsed with clean water.

4) Advanced treatment and disinfection of drinking water: Potassium monopersulfate disinfectant can be used for disinfection of tap water and advanced treatment of drinking water. Generally, the concentration adopted is 0,5 mg/l to 3 mg/l, and the action time is 5 min to 10 min.

5) Animal living environment and body surface: Animal breeding environment and animal body surface can be rinsed, sprayed and washed with potassium monopersulfate disinfectant solution with a concentration of 500 mg/l to 700 mg/l for disinfection. For aquatic animals, 0,3 g to 0,5 g potassium monopersulfate can be added per 1 000 l of water in the whole pool.

B.3 Halogen disinfectant

B.3.1 Sodium hypochlorite disinfectant

B.3.1.1 Physical and chemical properties and forms

The molecular formula of sodium hypochlorite is NaOCl. Pure sodium hypochlorite is a white powder, while commercially available products are usually grey-green crystals with a strong chlorine irritating odour, unstable and easily decomposed. Chlorine gas is introduced into sodium hydroxide solution to prepare a white or light-yellow sodium hypochlorite emulsion, which contains available chlorine of 10 % to 12 % and the pH value of 10 to 12. The nature of this emulsion is relatively stable, and the available chlorine is lost by 0,5 % to 1 % after storage for half a year. It can be miscible with water, and the pH value of the solution decreases with the increase of dilution. The diluent is unstable, the available chlorine decreases rapidly, and the decomposition is accelerated when exposed to light and heat.

The available chlorine content of sodium hypochlorite disinfectant is about 5 %. It consists of sodium hypochlorite and anion surfactant. Sodium hypochlorite disinfectant can also be prepared by electrolysis of brine, and the available chlorine content is generally 1 % to 5 %.

B.3.1.2 Mechanism of killing microorganisms

The disinfection mechanism of sodium hypochlorite is mainly oxidation. The disinfectant dissolved in water can produce undissociated hypochlorous acid (HOCl). The higher the concentration of hypochlorous acid, the stronger the disinfection effect. Hypochlorous acid not only destroys the cell walls of microorganisms, but also, because of its small molecular size and lack of charge, easily invades the body of microorganisms and oxidizes proteins or destroys their phosphate dehydrogenase, resulting in sugar metabolism disorder and death. Hypochlorous acid produced by sodium hypochlorite in aqueous solution can decompose nascent oxygen [O], which has strong oxidation, and can oxidize with bacterial components and viral nucleic acid substances to kill microorganisms. The second is chlorination. The active chlorine in sodium hypochlorite disinfectant can change the permeability of cell walls and cell membranes, causing rupture of the cell membranes and extravasation of cell contents, and leading to the death of microorganisms. Chlorine can combine with protein to form nitrogen-chloride compounds, changing the nature of the protein, interfering with cell metabolism, and leading to the death of microorganisms. Chlorine oxidizes some important enzymes of bacteria and interferes with bacterial metabolism.

B.3.1.3 Application in disinfection of infectious diseases

a) Scope of application

Sodium hypochlorite is a high-level disinfectant. When applied for disinfection of infectious diseases, sodium hypochlorite disinfectant is mainly used for the disinfection of corrosion-resistant contaminated environmental surfaces and articles, such as sanitary ware disinfection, tableware disinfection and corrosion-resistant environmental surface disinfection, secretion and excretion disinfection and hospital sewage treatment.

b) Application methods

According to the characteristics of items to be disinfected, immersion, wiping and spraying can be used for disinfection.

Disinfection of items contaminated by bacterial vegetative forms is carried out by soaking them in disinfectant containing 250 mg/l available chlorine for more than 10 min. Disinfection of items contaminated by hepatitis virus, tuberculosis bacilli and bacterial spores is carried out by soaking them in disinfectant containing 2 000 mg/l available chlorine for more than 30 min.

Wiping is used for large items or other items that cannot be disinfected by immersion. The concentration and action time of disinfectant used are the same as that of immersion. For the contaminated

environment and the surface of items, sodium hypochlorite disinfectant containing 1 000 mg/l available chlorine can be evenly sprayed on the contaminated surfaces until they are wet, and the action time is more than 30 min. The disinfection of the surfaces contaminated by hepatitis B virus (HBV) and tuberculosis bacilli is carried out by evenly spraying the disinfectant containing 2 000 mg/l available chlorine on the contaminated surfaces for more than 60 min. For the surfaces or items contaminated with blood and secretions of human immunodeficiency virus (HIV) or hepatitis B virus (HBV), they can be disinfected with disinfectants containing 2 000 mg/l available chlorine for 60 min.

B.3.2 Calcium hypochlorite disinfectant

B.3.2.1 Physical and chemical properties and forms

Calcium hypochlorite (molecular formula: $Ca(ClO)_2$) has a melting point of 100 °C (decomposition) and a relative density of 6,9 (water: 1). Calcium hypochlorite is a white powder, which is soluble in water, with impurities precipitated in the solution. Its active ingredient is hypochlorous acid. It is a high-level disinfectant. It is corrosive to the disinfected items and is unstable in aqueous solution.

The molecular formula of calcium hypochlorite is $Ca(ClO)_2$. The disinfectant also contains calcium hydroxide, calcium carbonate and calcium chloride, etc. It is a white powder with a pungent smell of chlorine, soluble in water, and the solution is easy to be turbid with many residues. Its aqueous solution is alkaline, and the pH increases with the increase of concentration. The aqueous solution has bleaching and corrosion effects on items; however, due to its poor stability, its decomposition speeds up under sunlight, heat, moisture and other conditions. The commonly used dosage forms include the bleaching powder containing 25 %to 32 % available chlorine, and the bleaching powder concentrate containing 56 % to 60 % available chlorine, which is more stable than the bleaching powder.

B.3.2.2 Mechanism of killing microorganisms

Calcium hypochlorite disinfectant dissolves in water to form hypochlorous acid, which produces bactericidal effect. The amount of hypochlorous acid formed is associated with the pH. The lower the pH, the more hypochlorous acid is formed. The hypochlorous acid is a neutral uncharged molecule, with low molecular weight, which is easy to diffuse to the negatively charged bacteria surface and penetrate into the bacteria through the cell wall, thus oxidizing the bacterial protein and causing bacterial death. In addition, the nascent oxygen produced by the decomposition of chlorine and hypochlorous acid can also oxidize the bacterial protein. Chlorine can also change the permeability of the cell membrane and exude the cell contents, thus causing bacterial death.

B.3.2.3 Application in disinfection of infectious diseases

a) Scope of application

Dry powder and solution of calcium hypochlorite can be used for disinfection. The supernatant solution can be generally used for disinfection of object surface, tableware, drinking water, walls, floors, sewage, excrement, etc. Dry powder can be used for disinfection of excrement of infectious disease patients.

b) Application methods

Spraying, immersion and wiping can be used for disinfection with solution. Stirring and spraying can be used for disinfection with dry powder. See B.3.1.3 b) for specific concentration and action time.

B.3.3 Chlorinated trisodium phosphate disinfectant

B.3.3.1 Physical and chemical properties and forms

The molecular formula of chlorinated trisodium phosphate is: $Na_3PO_4 \cdot 1/4NaOCl \cdot 12H_2O$. It has a weak smell of chlorine. The content of available chlorine is 3 % to 5 %. It is a white needle-like or rod-like crystal; its pure products are colourless transparent crystals; and its industrial products are generally white needle-like crystals or powders like soft white sugar, which are easy to absorb moisture and

agglomerate. Its solubility in water at 20 °C is 200 g/kg. The pH value of its 10 g/l solution is 11,7. In aqueous solution, it can directly form insoluble phosphate crystals with calcium, magnesium and heavy metal ions to soften the water, and at the same time settle the insoluble impurities in the solution.

B.3.3.2 Mechanism of killing microorganisms

a) Oxidation

Hypochlorous acid is a very small neutral molecule, which can diffuse to the surface of the negatively charged bacteria and penetrate into the bacteria through the cell wall for oxidation, thus destroying the phosphate dehydrogenase of bacteria, causing the imbalance of sugar metabolism and resulting in microbial death. The decomposition of hypochlorous acid can form nascent oxygen and can also oxidize the bacterial protein.

b) Chlorination

Chlorine can bind with the cell membrane protein to form nitrogen-chlorine compounds or oxidize some important enzymes, which interfere with the metabolism of microorganisms and finally cause microbial death.

B.3.3.3 Application in disinfection of infectious diseases

a) Scope of application

Chlorinated trisodium phosphate is a high-level disinfectant that kills various microorganisms. It has corrosive and bleaching effect on the disinfected items and is unstable in aqueous solution. In the disinfection of infectious diseases, it is mainly used for the disinfection of surfaces and items in contaminated environment such as hotels, restaurants, entertainment venues, public transportation service units and vehicles, the cleaning and disinfection of tableware, the purification and disinfection of infectious water, bath pool water, swimming pool water and drinking water.

b) Application methods

1) Immersion: The items to be disinfected are put into a container containing the disinfectant solution and the container is covered. Disinfection of items contaminated by bacterial vegetative forms is carried out by soaking them in disinfectant containing 500 mg/l available chlorine for more than 10 min. Disinfection of items contaminated by blood-borne pathogens and mycobacterium is carried out by soaking them in disinfectant containing 2 000 mg/l available chlorine for 30 min to 45 min. Disinfection of items contaminated by bacterial spores is carried out by soaking them in disinfectant containing 2 000 mg/l to5 000 mg/l available chlorine for 30 min to 60 min.

2) Wiping: Wiping is used for large items or other items that cannot be disinfected by immersion. For the concentration and action time of disinfectant used for disinfection, see immersion.

3) Spraying: Disinfection of general contaminated surfaces is carried out by evenly spraying the disinfectant containing 1 000 mg/l available chlorine on the surfaces until they are wet, and the action time is more than 30 min. Disinfection of surfaces contaminated by blood-borne pathogens and mycobacterium is carried out by evenly spraying the disinfectant containing 2 000 mg/l available chlorine on the surfaces (the amount is the same as above), and the action time is more than 60 min.

4) Dry powder disinfection: Disinfection of excrement is carried out by adding the powder into the excrement to reach 10 000 mg/l available chlorine, and stirring it evenly, with the action time of 2 h to 6 h. Disinfection of hospital sewage is carried out by adding the dry powder into the sewage to reach 50 mg/l available chlorine and stirring it evenly. After 2 h of action, the sewage can be discharged.

B.3.4 Sodium dichloroisocyanurate disinfectant

B.3.4.1 Physical and chemical properties and forms

The molecular formula of sodium dichloroisocyanurate or NaDCC is $C_3O_3N_3Cl_2Na$. It is white powder or crystal, which belongs to chlorinated isocyanuric acid compounds and organic chlorine-containing disinfectants, mainly including dichloroisocyanuric acid and its salts. It has strong oxidizing effect.

Product form and properties: The content of available chlorine in pure sodium dichloroisocyanurate is about 60 %. The melting point is 240 °C to 250 °C, and it decomposes above the melting point. It is easily soluble in water. The solubility at 25 °C is 25 %, and the pH of 1 % aqueous solution is 4,8 to 7,0. Sodium dichloroisocyanurate disinfectant has three forms: powder (white crystal powder), granule and tablet. The available chlorine content of different products is slightly different. Tablet, powder and granule of sodium dichloroisocyanurate disinfectant are all easily soluble in water.

B.3.4.2 Mechanism of killing microorganisms

The disinfection mechanism of sodium dichloroisocyanurate includes the oxidation and chlorination of hypochlorous acid and the action of nascent oxygen.

a) Oxidation

Sodium dichloroisocyanurate dissolved in water can produce hypochlorous acid (HOCl), which can kill microorganisms by its oxidation.

The higher the concentration of hypochlorous acid in disinfectant, the stronger the disinfection. The dissociation of hypochlorous acid is associated with the pH of disinfectant. Under acidic conditions, the bactericidal capacity increases due to the increase of undissociated HOCl; however, when the solution is alkaline, the bactericidal effect reduces due to the decrease of hypochlorous acid released. Hypochlorous acid can act with the cell walls of microorganisms and destroy them. Due to its small molecule and no charge, it can easily intrude into the microbial cells to oxidize the protein or destroy its phosphate dehydrogenase, causing disorder of sugar metabolism and death.

Hypochlorous acid can decompose to produce nascent oxygen [O], which is highly oxidizing, and can oxidize bacteria components (even nucleic acid substances of virus) to kill microorganisms.

b) Chlorination

The available chlorine in sodium dichloroisocyanurate can chlorinate bacterial protein. Free chlorine can change the permeability of cell wall and cell membrane, and even cause mechanical rupture of cell membrane, thus exuding the cell contents and causing bacterial death. Chlorine can bind with proteins to form nitrogen-chlorine compounds, which can alter the properties of proteins and interfere with cell metabolism, causing microbial death. Chlorine can oxidize some important enzymes of bacteria and interfere with metabolism of bacteria.

B.3.4.3 Application in disinfection of infectious diseases

a) Scope of application

Sodium dichloroisocyanurate (DCCNA) is a high-level disinfectant that can kill various microorganisms. It is unstable in aqueous solution and has corrosive effect on the disinfected items. In the disinfection of infectious diseases, sodium dichloroisocyanurate disinfectant is mainly used for preventive disinfection of environmental surfaces, supplies and appliances, toys, tableware, teaware and sanitary wares, and disinfection of infectious focus contaminated by pathogenic microorganisms. Dry powder of sodium dichloroisocyanurate can be used for disinfection of secretions and excrement of patients.

b) Use

Its aqueous solution is often used to soak, spray or wipe the contaminated surfaces for disinfection. Disinfection of general surfaces and objects can be carried out by soaking or spraying with sodium

dichloroisocyanate disinfectant containing 500 mg/l available chloride, and the action time is 30 min. Disinfection of items contaminated by mycobacteria and hydrophilic viruses can be carried out by using disinfectants containing 1 000 mg/l available chlorine, and the action time is 30 min. Disinfection of items contaminated by bacterial spores can be carried out by using disinfectants containing 2 000 mg/l available chlorine, and the action time is 2 h. Disinfection of secretions and excretions from patients infected with Sporothrix schenckii can be carried out by using disinfectants containing 10 000 mg/l available chlorine, and the action time is 2 h.

B.3.5 Iodophor disinfectant

B.3.5.1 Physical and chemical properties and forms

The surfactant in iodophor plays the role of carrier and hydrotropic agent and reduces the steam pressure of iodine. Its physical and chemical properties are stable, making it easy for preservation. Iodophor is not a simple mixture of several components, nor a compound connected by several components with chemical bonds. It is a complex formed by attracting and aggregating parts of molecules with certain affinity or electrostatic attraction. Iodine is loaded in the centre of the colloidal particle beam formed by surfactant, which can gradually disaggregate in water to release free iodine with bactericidal effect. The chemical composition of iodophor varies with the carrier and formula. It has no certain molecular weight and molecular formula, and its physical properties are not identical. Therefore, there is not one kind but a large family of iodophors. There are dozens of different iodophor products in China that have been approved for market entry. Iodophor overcomes the disadvantages of iodine, such as odour, poor water solubility (0,034 % at 25 °C), easy sublimation, easy yellow staining, high irritation, and allergic reaction. Different types of iodophors have different killing effects on the same bacterial vegetative form. The bactericidal effect of iodophors with different formulations and preparation processes also varies greatly.

Iodophor disinfectants mainly include povidone iodine (PVP-I), polyethylene glycol iodine (PEG-I), nonylphenol polyoxyethylene ether iodine (POP-I), alkyl sulfonate iodine (AES-I), polyvinyl alcohol iodine (APA-I), nonylphenol polyoxyethylene dodecyl ether iodine (NP-I), polypropoxy ether iodine (PPE-I), poly vinylimidazole iodine (PV1-1), Cycloglucoside iodine (CD-1), povidone, p-cyclodextrin iodine (WD-D), cross-linked starch iodine (CS-1) and alkyl polyether alcohol iodine (GS-I). PVP-I (povidone iodine) is most commonly used in disinfection and anticorrosion. PVP-I has been included in the national pharmacopeia of China, the United States, the United Kingdom, Japan and other countries, and is allowed to be used for human disinfection. It has been listed as the national basic disinfectant.

The forms of iodophor include liquid (the available iodine content is usually 0,1 % to 1,0 %), solid (the available iodine content is usually 10 % to 20 %), gel (the available iodine content is 0,1 % to 0,2 %), emulsion (the available iodine content is 0,5 % to 2 %), paste (the available iodine content is 0,85 % to 1,15 %) and suppository (the available iodine content is 0,017 g/pcs to 0,023 g/pcs). The colour of iodophor is reddish brown and it gradually turns yellow as its available iodine content decreases. The concentration of liquid iodophor is 0,1 % to 1,0 %, mostly 0,5 %.

B.3.5.2 Mechanism of killing microorganisms

Iodine in aqueous solution mainly exists in 7 forms: I_2, HOI, OI^-, H_2O^+I, I^-, I_3^-, IO_3^-. I_2 and HOI are considered to play the important role of bactericidal effect. I_2 can quickly penetrate into the cell wall, and HOI is highly oxidizing. When iodophor contacts with pathogens, direct halogenating reaction can occur between it, bacterial protein and bacterial enzyme protein, thus destroying the biological activity of proteins and causing microbial death; at the same time, due to the surfactivity and emulsification of the iodophor, which, on the one hand, enhance the penetrability of iodophor, and on the other hand, destroy the cell walls. Large volume of iodophors enter into the cell in to destroy the permeable barrier of the bacterial membrane, causing the leakage of cell contents and microbial death.

B.3.5.3 Application in disinfection of infectious diseases

a) Scope of application

Iodophor is an amorphous complex formed by iodine and surfactant, also called complex iodine. Iodophor is an intermediate-level disinfectant. It is a kind of disinfectant with storage stability and low toxicity that has no irritation to skin mucosa and can clean and decontaminate. In the disinfection of infectious diseases, iodophor is mainly used for the disinfection of hand and skin mucosa and can also be used for the disinfection of contaminated public environments and various object surfaces.

b) Application methods

1) Hand: Generally, hands are soaked or washed with 250 mg/l to 500 mg/l iodophor aqueous solution for 3 min. The gauze or sponge box is made wet with 1 000 mg/l iodophor aqueous solution. Fingers are dipped into the disinfectant before and after counting cash for 1 min to 3 min.

2) Skin: The skin contacting easily contaminated items can be wiped and disinfected with 100 mg/l to 250 mg/l iodophor aqueous solution.

3) Environment and object surface: Generally, 100 mg/l to 250 mg/l iodophor can be used for disinfection by wiping for 2 min to 3 min or soaking for 10 min. PVP-I disinfection is preferred for all items exposed to babies and infants. During the disinfection operation, special care can be taken to avoid blind spots and dead corners. The appliances that can be disassembled must be disassembled for disinfection.

B.3.6 Iodine tincture disinfectant

B.3.6.1 Physical and chemical properties and forms

Iodine tincture is the ethanol solution of iodine; it is reddish brown liquid, with characteristics of both iodine and ethanol. 2 % iodine tincture is commonly used, containing 2 % iodine, 1,5 % potassium iodide (or sodium iodide, which contributes to iodine dissolution) and 50 % ethanol. According to Chinese Pharmacopoeia, iodine content (I) of iodine tincture can be 1,80 % to 2,20 % (g/ml), and potassium iodide content (KI) can be 1,35 % to 1,65 % (g/ml).

B.3.6.2 Mechanism of killing microorganisms

Iodine tincture has strong penetrability and bactericidal ability. Iodine element itself plays the main role of bactericidal effect. It can directly iodinate some active groups on the amino acid chain of microbial protein, causing microbial death. It can also oxidize the active groups in plasmosin of pathogen and bind with proteins to denature and precipitate them. It has strong killing effect of bacteria, viruses and amoeba. At the same time, the iodine tincture solution contains about 50 % ethanol, which plays a great synergistic role on coagulation of microbial protein and has an enhanced bactericidal effect.

B.3.6.3 Application in disinfection of infectious diseases

a) Scope of application

Iodine tincture is an intermediate-level disinfectant. In the disinfection of infectious diseases, iodine tincture is mainly used for skin disinfection at the operation and injection sites, preventive disinfection of hairdressing and beauty tools, disinfection of pedicure appliance, hand hygiene disinfection, skin disinfection and wound disinfection of new-born umbilical cord.

b) Application methods

1) Skin and wound: The wound and its surroundings or contaminated skin are wiped and disinfected with gauze ball of 2 % iodine tincture for 1 min to 3 min. After drying, iodine tincture is removed by wiping twice with gauze balls of 70 % alcohol.

2) Hygiene disinfection of hands: The contaminated fingers are wiped with gauze ball of 2 % iodine tincture for 1 min to 3 min and the iodine tincture is wiped off with cotton balls of 70 % alcohol. It is especially suitable for the disinfection of hands for cash counting personnel and other personnel exposed to contaminated currency, bills and items.

3) Beauty, hair and pedicure appliances: The appliances are soaked in iodine tincture disinfectant for 30 min, then taken out and rinsed with sterile water before use.

4) Drinking water: 3 drops of 2 % iodine tincture are added in 500 ml water, which can kill microorganisms such as bacteria and amoeba in the water within 15 min without objectionable odour in the water.

B.3.7 1,3-dibromo-5,5-dimethylhydantoin disinfectant

B.3.7.1 Physical and chemical properties and forms

The chemical name of 1,3-dibromo-5,5-dimethylhydantoin is dibromodimethylhydryanide (DBDMH), which is a white and off-white crystal powder. Its molecular formula is $C_5H_6Br_2N_2O_2$. Its melting point is 194 °C to 197 °C, and its density is 1,36 g/cm. Dibromohydantoin is slightly soluble in water and soluble in organic solvents such as chloroform, ethanol, and acetone, and can be easily decomposed in a strong acid or strong alkali.

Since the solubility of pure DBDMH in water is only 0,25 %, personnel can prepare a DBDMH disinfectant form that can dissolve in water for disinfection. At present, DBDMH disinfectants in the market include DBDMH disinfectant tablets and powders with cosolvents, synergists and corrosion inhibitors, and their available bromine content is 50 %. It is easily soluble in water. When used, it is prepared into disinfectant solution of the required concentration with clean water.

B.3.7.2 Mechanism of killing microorganisms

The DBDMH cause microbial death by destroying the cell walls, cell membranes, proteins, and nucleic acids of microorganisms. Protein and nucleic acid leak out as the cell walls are destroyed. Under the action of DBDMH, the protein leakage of *Bacillus subtilis var. niger* spore increases with the increase of dosage and the extension of action time. It indicates that DBDMH has destructive effect on the spore coat of *Bacillus subtilis var. niger*. After DBDMHs containing 1 000 mg/l, 2 000 mg/l and 4 000 mg/l available bromine are used on *Bacillus subtilis var. niger* spore for different action time, DNA leakage of the spore is found; after DBDMHs containing 1 000 mg/l, 2 000 mg/l and 4 000 mg/l available bromine are used on *Bacillus subtilis var. niger* for 30 min, its DNA double-strand breaks (DSBs). The higher the concentration, the more severe the DNA damage.

B.3.7.3 Application in disinfection of infectious diseases

a) Scope of application

DBDMH is a new high-level disinfectant, which is characterized by broad bactericidal spectrum, strong bactericidal effect, moderate performance, small damage to disinfected items, good safety, actual nontoxicity, environmental friendliness, decomposition into carbon dioxide, nitrogen and water after releasing available bromine in the disinfection process, and low price. The disadvantage is that its dissolution rate in water is slightly slow.

DBDMH disinfectants can be used for preventive disinfection of infectious diseases and disinfection of infectious focuses. It is mainly used for environmental surface disinfection and disinfection of items; disinfection of diagnosis and treatment equipment, items and environment of health service units; disinfection of sanitary ware; disinfection of fruits, vegetables and tableware; disinfection of water storage containers and swimming pool water.

b) Application methods

1) Preparation of disinfectant solution: The available bromine content of DBDMH disinfectants (disinfectant tablet and powder) is both 50 %. They are soluble in water. When used, they are prepared into disinfectant solution of the required concentration with clean water. Immersion, wiping or spraying can be used for disinfection.

2) Disinfection by immersion: The items to be disinfected can be soaked in the disinfectant solution, then covered and taken out after a predetermined action time. For preventive disinfection, disinfectant of 250 mg/l available bromine can be used on clean environmental surfaces and items for 10 min to 20 min. For disinfection of infectious focuses, the items contaminated by general microorganisms can be soaked in DBDMH containing 500 mg/l available bromine for 30 min. Items contaminated by tuberculosis bacilli, hepatitis virus, avian influenza virus, SARS virus and fungi can be soaked in DBDMH containing 1 000 mg/l available bromine for 30 min. Pathogenic spores can be soaked in DBDMH containing 2 000 mg/l available bromine for 60 min.

3) Wiping: Wiping can be used for the floor, wall surface and large items that cannot be disinfected with immersion. For the concentration and action time of disinfectant, see immersion.

4) Spraying: The surface of general items can be evenly sprayed with disinfectant containing 500 mg/l available bromine until they are wet, and the action time is 30 min The items contaminated by mycobacteria, hydrophilic virus and fungi can be sprayed with disinfectant containing 1 000 mg/l available bromine, and the action time is 30 min. Pathogenic spores can be sprayed with disinfectant containing 2 000 mg/l available bromine, and the action time is 60 min.

5) Disinfection for water: After the disinfectant is dissolved in water, the solution is poured into water. Depending on the pollution degree of water quality, the dosage ranges between 2 mg/l to 5 mg/l. When used for disinfection of swimming pool water and sewage, the dosage and action time can be determined according to the water quality.

6) Ultrasonic atomization or spraying: The methods can be used for disinfection of the indoor air and object surfaces. The concentration of disinfectant is 1 000 mg/l, and the dosage is calculated by 30 ml/m. After atomization or spraying, the action time is 30 min. After disinfection, the window is opened for ventilation. Nobody is expected to be indoors during disinfection.

B.3.8 3-bromo-l-chloro-5,5-dimethylhydantoin disinfectant

B.3.8.1 Physical and chemical properties and forms

The full name of bromo-chlorodimethylhydantoin (BCDMH) is bromochlordimethyantoin, which is a halogenated derivative of methyl hydantoin. The main products include 3-bromo-1-chloro-5, 5-dimethylhydantoin and 1-bromo-3-chloro-5, 5-dimethylhydantoin. The chemical name is 3-bromo-1-chloro-5,5-dimethylhydantoin or 1-bromo-3-chloro-5,5-dimethylhydantoin, the molecular formula is $C_5H_6BrClN_2O_2$. It is a white or slightly yellow crystal or crystal powder, soluble in benzene, dichloromethane and chloroform, slightly soluble in water. The solubility in water at 20 °C is 0,2 % to 0,25 %. The pH of 0,1 % aqueous solution is 2,88. It is stable in dry condition and has a smell of chlorine.

The forms mainly include powder, tablet and granule, and there are also several kinds of products that are compounded and compacted into blocks with different halogenated hydantoin. The content of BCDMH is 92 % to 95 %, and the content of available halogen (as chlorine) is 54,0 % to 56,0 %.

B.3.8.2 Mechanism of killing microorganisms

BCDMH can hydrolyze in water to release the active bromine ions and chloride ions and form HOBr and HOCl. The hypohalous acid is the key component of bactericidal activity, which can intrude into microbial cells and oxidize the proteins, causing microbial death.

Nascent oxygen is produced when HOBr and HOCl are decomposed, which can bind with cell protoplasm of microorganism and cause microbial death.

The hypohalous acid can bind with the protoplasm in microorganisms in water, and then form a stable nitrogen-halogen bond with the nitrogen in protein, which interferes with the metabolism of microorganism cells and causes microbial death.

B.3.8.3 Application in disinfection of infectious diseases

a) Scope of application

BCDMH is a high-level disinfectant that is safe and environmentally friendly. The disadvantage is that its dissolution rate in water is slow.

In the disinfection of infectious diseases, BCDMH is mainly used for the disinfection of various contaminated environmental surfaces and object surfaces, as well as the disinfection of tableware, sewage, domestic drinking water, fabrics, fruits and vegetables.

b) Application methods

1) Disinfection of object surface: The object surface can be disinfected by wiping, immersion, spraying and other methods. General object surfaces can be treated with disinfectant containing 500 mg/l available halogen, and the action time is kept between 30 to 60 min. Object surfaces contaminated by spores can be treated with disinfectant containing 1 000 mg /l to 2 000 mg/l available halogen, and the action time is kept for 2 h. Object surfaces contaminated by mycobacteria and hydrophilic viruses can be treated with disinfectant containing 1 000 mg/l available halogen, and the action time is for 1 h.

2) Disinfection of floor and wall: The floor and walls can be disinfected by spraying. The floor and walls can be made thoroughly wet during spraying. The dosage and action time of disinfectant are listed above.

3) Disinfection of tableware: The tableware can be disinfected by immersion. Generally, the tableware can be soaked by disinfectant containing 500 mg/l available halogen for 30 min. For contaminated tableware, the dosage and action time of disinfectant are the same as above.

4) Disinfection of sewage in epidemic spots and epidemic areas: Generally, it can be treated with disinfectant containing 500 mg/l to 1 000 mg/l available halogen, and the action time is for 1 h to 2 h.

5) Disinfection of domestic water: It can be treated with disinfectant containing 3 mg/l to 5 mg/l available halogen, and the action time is for 0,5 h.

6) Fabric disinfection: The disinfection of fabrics can adopt immersion. With 500 mg/l available halogen, and the action time is for 0,5 to 2 h.

B.4 Alcohol disinfectant

B.4.1 Ethanol disinfectant

B.4.1.1 Physical and chemical properties and forms

The molecular formula of ethanol is C_2H_5OH. Ethanol is a colourless transparent liquid, which is flammable, volatile, with a relative density of 0,812 9 and a boiling point of 78 °C. It can be freely mixed with water, glycerine, chloroform and ether in any proportion. The content of commercially available medical ethanol is generally not less than 94,58 % (by volume). The concentration used for disinfection is generally 70 % to 80 %. Ethanol combined with bacteriostatic components (e.g. diphenylphenol) can still have bacteriostatic effect after rapid killing of bacteria in hands and skin; ethanol combined with other alcohols (e.g. n-propanol and isopropyl alcohol) can shorten the sterilization time and widen the spectrum of disinfectant under the condition that the total alcohol content remains unchanged; ethanol combined with functional additives (e.g. "surface tension lowering substances") can make the object surfaces fully wet and disinfect them more quickly and thoroughly.

B.4.1.2 Mechanism of killing microorganisms

Ethanol has coagulation and denaturing effect on protein, interference effect on microbial metabolism and dissolution effect on cells.

Ethanol has dehydration effect, and its molecules can act on the peptide chain of proteins, thus denaturing and precipitating the bacterial protein. This denaturation is performed in the presence of water, so the bactericidal effect of ethanol is the strongest at the concentration of about 70 %.

Ethanol can inhibit the rapid reproduction of bacteria by inhibiting bacteria enzymes. Ethanol of appropriate concentration can penetrate into the cells of microorganisms, thus destroying and dissolving the bacterial cells.

B.4.1.3 Application in disinfection of infectious diseases

a) Scope of application

Ethanol is a commonly used intermediate-level disinfectant. In the disinfection of infectious diseases, ethanol is mainly used for rapid disinfection of hands, skin and object surfaces.

b) Application methods

1) Hand and skin: They are wiped with about 2 ml to 3 ml of hand-washing-free disinfection gel combined with ethanol. After 30 s of action, bacteria, fungi and viruses on hands can be killed, and it also has the effect of bacteriostasis and skin care. Disinfection wet tissues combined with ethanol can also be used for disinfection by wiping.

2) Object surface: The object surface disinfectant combined with ethanol is often used for rapid disinfection of various surfaces above the ground (including table surface, chair surface, bedside table, telephone set, cart surface, equipment surface, door handle, corner, pipe, etc.), tools, stationery, toys, etc. Some ethanol surface disinfectants have dual-purpose sprinklers, which can spray liquid on the cloth for wiping or directly spray it to disinfect corners, pipes and other parts difficult to wipe, with the action time of 30 s to 60 s.

B.4.2 Isopropyl alcohol disinfectant

B.4.2.1 Physical and chemical properties and forms

Isopropyl alcohol is a colourless, transparent and volatile flammable liquid with a slightly bitter taste. Isopropyl alcohol has a relative density of 0,785 1, a boiling point of 82,5 °C and a flash point of 11,7 °C (molecular formula: C_3H_8O, structural formula: CH_3-CHOH-CH_3). Isopropyl alcohol can be mixed with water and most organic solvents such as ethanol, ether, chloroform. Its vapour can form explosive mixtures with the air, whose natural explosion limit is 2 % to 12 % (by volume). Therefore, it is classified as a medium explosive hazard.

Isopropyl alcohol is often used in combination with cationic surfactant, which can improve its disinfection effect. Isopropyl alcohol can also be combined with other alcohols or with other disinfectants as a solvent to increase the solubility and disinfection effect, such as combination with iodine-containing disinfectants.

B.4.2.2 Mechanism of killing microorganisms

Isopropyl alcohol kills microorganisms by three effects:

— destroying the peptide chain of protein, denaturing and coagulating the protein, causing microbial death;

— intruding into bacterial cells, interfering with and destroying the enzyme of microorganisms, disentangling the water membrane on the surface of protein, exuding the compounds containing

chlorine and phosphorus in the cells, and inactivating them, affecting the metabolism of microorganisms;

— dissolving and destroying the structure and function of the cell membrane by bacteriolysis, and causing bacteriostatic and bactericidal effects.

B.4.2.3 Application in disinfection of infectious diseases

a) Scope of application

Isopropyl alcohol (IPA) is an intermediate-level disinfectant with similar characteristics and effects as ethanol. It has a higher bactericidal effect and higher toxicity than ethanol. In the disinfection of infectious diseases, all places that can be disinfected with ethanol can also be disinfected with isopropyl alcohol. It is mainly used for disinfection of contaminated hands, skin, object surface and diagnosis and treatment equipment.

b) Application methods

1) Immersion: The items to be disinfected are put into a container filled with 60 % to 70 % isopropyl alcohol aqueous solution and covered. Disinfection of articles contaminated by bacterial vegetative forms is generally carried out by immersing them in 70 % isopropanol solution for more than 5 min to 60 min. It can also be compounded with 2 % alkaline glutaraldehyde for immersion disinfection of medical apparatus (2 % glutaraldehyde, 0,3 % sodium bicarbonate, 70 % isopropanol).

2) Wiping: For disinfection of hands and skin, they are wiped with 70 % isopropanol for 1 min to 3 min. Isopropanol dries faster on the skin than ethanol, and its fat-dissolving ability is stronger than that of ethanol. Therefore, the frequent use of isopropanol to immerse or wash hands can easily make the skin dry or chapping, but its concentration does not cause damage to the skin. Isopropanol is often used as a hand-brushing disinfectant. The disinfectant with 70 % isopropanol and chlorhexidine (5 000 mg/l, or 1 000 mg/l) as main components is added to stabilizer, synergist and skin conditioner to prepare disinfectant or disinfectant wet wipes for sanitary disinfection of skin and hands. Quick-acting hand disinfectant prepared with chlorhexidine gluconate and isopropanol, or hand disinfectant prepared with surfactant N-aldehyde-N, N-dimethyl hexadecylamine and isopropanol has a good disinfection effect. The wiping disinfection is also used for disinfection of the surface of articles, with an action time of 5 min to 60 min.

B.5 Phenolic disinfectant

B.5.1 Phenol disinfectant

B.5.1.1 Physical and chemical properties and forms

Phenol (molecular formula: C_6H_6O) is colourless needle crystal with a special smell. Phenol has a melting point of 40,6 °C and is slightly soluble in water at room temperature. When the temperature is higher than 65 °C, it is miscible with water in any proportion and easily soluble in organic solvents such as ethanol, ether and chloroform. Its aqueous solution is weakly acidic.

Phenol, commonly known as carbolic acid, is oxidized in the air and turns pink. It has a special taste and strong corrosivity. Phenol can react with aldehydes and ketones to produce phenolic resin and bisphenol A respectively, and can also react with acetic anhydride and salicylic acid to produce phenyl acetate and salicylate respectively.

B.5.1.2 Mechanism of killing microorganisms

Phenol can act on the cell wall and cell membrane of the microorganism to destroy their permeability, it can penetrate into the cell to destroy the basic structure of the cell, and it can also make the contents of

bacteria escape. It can also act on cytoplasmic protein to make it coagulate and precipitate, and act on the enzyme of the microorganism to make it lose biological activity.

B.5.1.3 Application in disinfection of infectious diseases

a) Scope of application

Disinfectants with phenol as the main bactericidal component are suitable for disinfection of article surfaces and fabrics, but they cannot be used for disinfection of articles contaminated by bacterial spores, high-level and medium-level disinfection of medical apparatus, and are not suitable for disinfection of skin and mucosa.

b) Application methods

2 % to 5 % aqueous solution is used to treat dirt, disinfection equipment and surgical instruments, and can be used for environmental disinfection. 1 % aqueous solution is used for relieving itching of skin. Application concentration and time: The content of effective components in the disinfectant application solution with phenol as the main bactericidal component is ≤5,0 %, and the pH value is 6,0 to 10,0. The article surfaces and fabrics are wiped for disinfection for a period of ≤15 min, and the immersion disinfection time does not exceed 30 min.

B.5.2 P-chloro-m-xylenol disinfectant

B.5.2.1 Physical and chemical properties and forms

The molecular formula of p-chloro-m-xylenol is C_8H_9ClO. P-chloro-m-xylenol is white or almost white needle crystal, with weak carbolic taint, and the melting point is 114 °C to 116 °C. It is soluble in alcohol, ether, terpenes, non-volatile oil and sodium hydroxide solution. It is slightly soluble in water. P-chloro-m-xylenol can be absorbed by the skin and rapidly metabolized into uricoglycinate that is quickly excreted.

P-chloro-m-xylenol disinfectant is a compound disinfectant prepared with PCMX as the main bactericidal component and other components. The form is aqueous solution. The content of PCMX in different products is different, and that in the stock solution is generally about 5 %. When used, it is diluted to the required concentration.

B.5.2.2 Mechanism of killing microorganisms

PCMX can act on the cell wall and cell membrane of the microorganism to destroy their permeability, it can penetrate into the cell to destroy its basic structure, and it can also make the contents of bacteria escape, resulting in the death of microorganisms. It can also act on cytoplasmic protein to make it coagulate and precipitate, and act on the enzyme of the microorganism to make it lose biological activity. For example, the activity of oxidase and deaminase can be inactivated to kill microorganisms.

B.5.2.3 Application in disinfection of infectious diseases

a) Scope of application

P-chloro-m-xylenol is a kind of phenolic disinfectant and belongs to halogenated phenol. In the disinfection of infectious diseases, p-chloro-m-xylenol disinfectant is mainly used for disinfection of hands, skin and mucosa, disinfection of wounds and wound surfaces, sanitation disinfection of environmental surfaces and disinfection of clothes.

b) Application methods

1) Disinfection of skin: The diluted compound p-chloro-m-xylenol disinfectant with an effective concentration of 0,22 % is used to wash or wipe the parts to be disinfected for 3 min to 5 min.

2) Disinfection of slightly scratched wounds and wound surfaces: 12 ml of p-chloro-m-xylenol disinfectant with an effective concentration of 0,22 % is taken to clean the wound for 3 min to 5 min, and then the wound is dressed with dry gauze or bandage.

3) Disinfection of mucosa: 12 ml of p-chloro-m-xylenol disinfectant with an effective concentration of 0,11 % is taken to immerse or wipe it for 3 min to 5 min.

4) Disinfection of clothes: 48 ml of compound p-chloro-m-xylenol disinfectant with 5 % stock solution is added to 2,5 l of water to prepare the solution with an effective concentration of 0,09 % for immersing underwear, coat and socks for 3 min to 5 min and immersing swimming suits, children's diapers, rags, napkins and towels for about 5 min.

5) Disinfection of floors and furniture surfaces: 60 ml of compound p-chloro-m-xylenol disinfectant with 5 % stock solution is added to 1,25 l of water to prepare the solution with an effective concentration of 0,22 % for cleaning the article surfaces. It can also be used for disinfection of toilets, basins, ditches, waste bins, etc., and its stock solution or diluent can be used for disinfection.

B.6 Guanidine disinfectant

B.6.1 Chlorhexidine disinfectant

B.6.1.1 Physical and chemical properties and forms

The chemical name of chlorhexidine is 1,6-bis (n-p-chlorobenzbiguanide) hexane. The molecular formula is $C_{22}H_{30}Cl_2N_{10}$.

At present, chlorhexidine acetate and chlorhexidine gluconate are used as disinfectants, and the former is more commonly used. Chlorhexidine acetate is white powder. It is slightly soluble in water and easily soluble in alcohol. Its aqueous solution and alcohol solution can be used. The aqueous solution is prepared by dissolving with a small amount of organic solvent and then adding water. The alcohol solution is colourless and transparent liquid without peculiar smell. It contains 0,1 % to 0,65 % chlorhexidine acetate and 70 % to 75 % ethanol.

B.6.1.2 Mechanism of killing microorganisms

Chlorhexidine can be quickly adsorbed on the surface of bacteria to destroy cell membranes, causing leakage of cytoplasmic components. It can also inhibit the activity of bacterial dehydrogenase. At high concentration, cytoplasmic components can be condensed, and cytoplasm can be concentrated and denatured, resulting in the death of microorganisms.

B.6.1.3 Application in disinfection of infectious diseases

a) Scope of application

Chlorhexidine is a low-level disinfectant. In the disinfection of infectious diseases, it is mainly used for disinfection of hands, skin and mucosa. It can also be used for disinfection of environmental surfaces and articles contaminated by bacterial vegetative forms and lipophilic viruses.

b) Application methods

1) Injection and skin before operation of cosmetology, hairdressing, pedicure and medical and health service units: 3 000 mg/l to 5 000 mg/l of chlorhexidine alcohol solution is used for wiping or spraying for 1 min to 3 min. The skin is sprayed with 6 000 mg/l chlorhexidine acetate skin disinfectant for 3 min.

2) Hands: The hands are immersed, sprayed or wiped with 3 000 mg/l to 6 000 mg/l chlorhexidine aqueous solution or alcohol solution for 3 min.