Lecture -2

Classification of Disinfectants

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Unit -IV
Petrochemicals, Oils & Soaps

Dr. Anjali Sinha

Disinfectants are classified as follows

- Air disinfectants
- Chemical disinfectants -
  - Organic
  - Inorganic
- Non- chemical disinfectants
- Oxidising disinfectants
- Home disinfectants
- Others disinfectants

Air disinfectants

- They are typically chemical substances capable of disinfecting microorganisms suspended in the air.

- An air disinfectant must be dispersed either as an aerosol or vapour at a sufficient concentration in the air to reduce the number of viable infectious microorganisms to be significantly reduced.

- Various glycols, principally **propylene glycol** and **triethylene glycol,** are ideal air disinfectants because they have both high lethality to microorganisms and low mammalian toxicity to inactive of diverse bacteria, influenza virus, and *Penicillium chrysogenum* (previously *P. notatum*) mold fungus

Chemical disinfectants

- **Organic disinfectant –**
- **Alcohols :** are most effective when combined with distilled water (concentration of 60% to 70% v/v) to facilitate diffusion through the cell membrane & have fairly rapid bactericidal action against vegetative bacteria. Ethanol 60 to 70% v/v and isopropanol 50 to 60% v/v are used as skin disinfectants while methanol vapour has been used as fungicide. Additionally, high-concentration mixtures (such as 80% ethanol + 5% isopropanol) are required to effectively inactivate lipid-enveloped viruses (such as HIV, hepatitis B, and hepatitis C.The higher alcohols (propyl, butyl, amyl etc) are more germicidal than ethyl alcohol. Alcohols are used as preservatives in some vaccines.

- **Aldehyde** : Formaldehyde (HCHO) is the main aldehyde used for disinfection, have a wide microbiocidal activity and are sporicidal and fungicidal. Formaldehyde in solution is useful for sterilization of certain instruments. Sometimes, ortho-phthalaldehyde is aiso used.

Phenol and its derivatives : Phenol is the chief products obtained by the distillation of the coal tar. Phenol 1% has bactericidal action. Many derivatives of phenol are more effective and less costly. Phenolics are active ingredients in some household disinfectants. They are also found in some mouthwashes and in disinfectant soap and handwashes. Phenols are toxic to cats and newborn humans. *o*-Phenylphenol is often used instead of phenol, since it is somewhat less corrosive

- Hexachlorophene is a phenolic that was once used as a germicidal additive to some household products but was banned due to suspected harmful effects.

- Chloroxylenol is the principal ingredient in Dettol, a household disinfectant and antiseptic.

- Thymol, derived from the herb thyme, is the active ingredient in some "broad spectrum" disinfectants that often bear ecological claims. It is used as a stabilizer in pharmaceutic preparations. It has been used for its antiseptic, antibacterial, and antifungal actions, and was formerly used as a vermifuge.

- Amylmetacresol is found in Strepsils, a throat disinfectant.

- Although not a phenol, 2,4-dichlorobenzyl alcohol has similar effects as phenols, but it cannot inactivate viruses.

- **Quaternary ammonium compound :** ("quats"), such as benzalkonium chloride, are widely used for the control of microorganisms like non-enveloped viruses such as norovirus, rotavirus, or polio virus , bacteria and pathogenic fungi within (3–5 minutes) on floors, walls, nursing homes and other public places. They are also used as skin antiseptics and as sanitizing agents in dairy, egg and fishing industries. Quats are biocides that also kill algae and are used as an additive in large-scale industrial water systems to minimize undesired biological growth.

- **Terpenes :** such as Pine oil and Thyme ; **Pine oil** is a disinfectant that is mildly antiseptic, effective against , the fungi ,bacteria, influenza virus etc.. It will kill the causative agents of typhoid, gastroenteritis (some agents), rabies, cholera several forms of meningitis, whooping cough, gonorrhea and several types of dysentery. It is not effective against spore related illnesses, such as tetanus or anthrax, or against non-enveloped viruses such as poliovirus, rhinovirus, hepatitis B, or hepatitis C.

- **Thymol** can also be used as a medical disinfectant and general purpose disinfectant ; used in alcohol solutions and in dusting powders for the treatment of ringworm infections.

- **Lactic acid :** is a registered disinfectant. Due to its natural and environmental profile, it has gained importance in the market

Inorganic disinfectants –

- **Acids and bases :**

  Sodium hydroxidePotassium hydroxide,Calcium hydroxide, Magnesium hydroxide, Sulfurous acid, Sulfur dioxide
- **Metals**
- **Iodine :** Iodophors are prepared by mixing iodine with the solubilizing agent; Diluted iodophor is often used by brewers and winemakers to sanitize equipment and bottles; Its major advantage over other sanitizers is that when used in proper proportions, it does not require rinsing.
- **Chlorine :** This group comprises aqueous solution of chlorine, hypochlorite, or hypochlorous acid. Occasionally, chlorine-releasing compounds and their salts are included in this group. Frequently, a concentration of < 1 ppm of available chlorine is sufficient to kill bacteria and viruses, spores and mycobacteria requiring higher concentrations. Chlorine has been used for applications, such as the deactivation of pathogens in drinking water, swimming pool water and wastewater, for the disinfection of household areas and for textile bleaching.

Non-chemical disinfectants

- Ultraviolet germicidal irradiation is the use of high-intensity shortwave ultraviolet light for disinfecting smooth surfaces such as dental tools, but not porous materials that are opaque to the light such as wood or foam.

- Ultraviolet light is also used for municipal water treatment. Ultraviolet light fixtures are often present in microbiology labs, and are activated only when there are no occupants in a room(e.g., at night).

- The phrase "sunlight is the best disinfectant" was popularized in 1913 by United States. As sunlight's ultraviolet rays can act as a disinfectant, the Earth's ozone layerblocks the rays' most effective wavelengths. Therefore, ultraviolet light-emitting machines, such as those used to disinfect some hospital rooms, make for better disinfectants than sunlight.

- Heat treatment can be used for disinfection and sterilization.

Oxidising disinfectants

Oxidizing agents act by oxidizing the cell membrane of microorganisms, which results in a loss of structure and leads to cell lysisand death. Chlorine and oxygenare strong oxidizers, so their large number of disinfectants operate in this way are as follows:

- Electrolyzed water or **"Anolyte"** is an oxidizing, acidic hypochlorite solution made by electrolysisof sodium chloride into sodium hypochlorite ; hypochlorous acid is the predominant oxychlorine species.

- Hydrogen peroxide is used in hospitals to disinfect surfaces and it is used in solution alone or in combination with other chemicals as a high level disinfectant. Hydrogen peroxide is sometimes mixed with colloidal silver. It is often preferred because it causes far fewer allergicreactions than alternative disinfectants. Also used in the food packaging industry to disinfect foil containers. A 3% solution is also used as an antiseptic.

- **Hydrogen peroxide vapour** is used as a medical sterilant and as room disinfectant. Hydrogen peroxide has the advantage that it decomposes to form oxygen and water thus leaving no long term residues. **Occupational Safety and Health Administration** OSHA permissible exposurelimit is 1 ppm.

- **Accelerated Hydrogen Peroxide** , 2% solution (antimicrobial action of hydrogen peroxide can be enhanced by surfactants and organic acids), stabilized for extended use, achieves high-level disinfection in 5 minutes, and is suitable for disinfecting medical equipment made from hard plastic, such as in endoscopes. The evidence available suggests that products based on Accelerated Hydrogen Peroxide, apart from being good germicides, are safer for humans and benign to the environment.
- **Ozone** is a gas used for disinfecting water, laundry, foods, air, and surfaces. It is chemically aggressive and destroys many organic compounds, resulting in rapid decolorization and deodorization in addition to disinfection. Regardless, ozone has a very wide range of applications from municipal to industrial water treatment due to its powerful reactivity.

- **Potassium permanganate ($KMnO_4$)** is a purplish-black crystalline powder that colours everything it touches, through a strong oxidising action. It is used to disinfect aquariums and is used in some community swimming pools as a foot disinfectant before entering the pool.

Home disinfectants

- The most cost-effective home disinfectant is chlorine bleach (typically a >10% solution of sodiumhypochlorite which is effective against most common pathogens, including disinfectant-resistant organisms such as tuberculosis (mycobacterium tuberculosis), hepatitis B and C, fungi, and antibiotic-resistant strains of staphylococcus and enterococcus. It has disinfectant action against some parasitic organisms.

- The benefits of chlorine bleach include its inexpensive and fast acting nature. However it is harmful to mucous membranes and skin upon contact, has a strong odour ; and combination with other cleaning products such as ammonia and vinegarcan generate noxious gases like chlorine.

Others

- **Biguanide polymer : Polyaminopropyl biguanide** is specifically bactericidal at very low concentrations (10 mg/l). It has a unique method of action: The polymer strands are incorporated into the bacterial cell wall, which disrupts the membrane and reduces its permeability, which has a lethal effect to bacteria. It is also known to bind to bacterial DNA, alter its transcription, and cause lethal DNA damage. It has very low toxicity to higher organisms such as human cells, which have more complex and protective membranes.

- **Detergents and Soaps:** They are widely used as surface active agents, wetting agents and emulsifiers. They are classified into four main groups such as anionic, cationic, non-ionic and amphoteric. The most important antibacterial agents are the cationic surface active agents. Eg: cetrimide, benzalkonium chloride etc. ⎜Soaps and sodium lauryl sulfate are anionic compounds. Soaps prepared from saturated fatty acids are more effective against gram negative bacilli while those prepared from unsaturated acids have greater action against gram positive. Nonionic detergents are not ionized. However these substances do not posses significient anti-microbial activity. ⎜Amphoteric compounds have the detergent properties of anionic surfactants combined with disinfectant properties of cationic surfactants. Eg: Tego compounds.

- **Sodium bicarbonate:** ($NaHCO_3$) has antifungal properties, and some antiviral and antibacterial properties, though those are too weak to be effective at a home environment.

- **Dyes :** A number of dyes have been used to inhibit the bacterial growth. Basic dyes are more effective bactericides than acidic dyes. Acridine and triphenylmethane dyes are commonly used as antimicrobial agents.