

Laboratory Disinfectants (November 2009)

Chlorine (Sodium Hypochlorite)

Chlorine, a fast-acting oxidant, is a widely available and broad-spectrum chemical disinfectant. It is normally sold as household bleach, an aqueous solution of sodium hypochlorite (NaOCl), which can be diluted with water to provide various concentrations of available chlorine. Chlorine is highly alkaline and can be corrosive to metal. The disinfectant activity of chlorine is considerably reduced by organic matter (protein). Storage of stock or working solutions of bleach in open containers, particularly at high temperatures, release chlorine gas thus weakening their disinfectant potential. **Undiluted household bleach stored at room temperature in the original container has a shelf-life of approximately six months.** Working solutions of bleach should be prepared on a daily basis. Household bleach (5.25% NaOCl) should be diluted 1:10 to obtain final concentration of 0.5% NaOCl. Industrial solutions of bleach have a higher sodium hypochlorite concentration and must be diluted accordingly to obtain the correct concentration. To increase the efficacy of sodium hypochlorite solutions against spores, vinegar may be added to the solution. Combine 5 ounces of household bleach with one gallon of water and add 8 ounces of 5% distilled white cooking vinegar to the diluted bleach solution.

Chlorine gas is highly toxic. Bleach must therefore be stored and used in well-ventilated areas only. Undiluted bleach must not be mixed with acids or other incompatible chemicals, such as ammonia containing compounds, to prevent the rapid release of chlorine gas. Many by-products of chlorine can be harmful to humans and the environment and must be handled and disposed of properly.

Phenolic compounds

Phenolic compounds, are now banned from use as disinfectants.

Quaternary ammonium compounds

Many types of quaternary ammonium compounds are used as mixtures and often in combination with other germicides, such as alcohols. They have good activity against some vegetative bacteria and lipid-containing viruses. The germicidal activity of certain types of quaternary ammonium compounds is considerably reduced by organic matter, water hardness, and anionic detergents. Care is therefore needed in selecting agents for pre-cleaning when quaternary ammonium compounds are to be used for disinfection. Potentially harmful bacteria can grow in quaternary ammonium compound solutions. Quaternary ammonium compounds, properly diluted, have low odour and are not irritating.

Alcohols

Ethanol (ethyl alcohol, C₂H₅OH) and 2-propanol (isopropyl alcohol, (CH₃)₂CHOH) have similar disinfectant properties. They are active against vegetative bacteria, fungi, and lipid-containing viruses but not against spores. Their action on non-lipid-containing viruses is variable. For highest effectiveness they should be used at

concentrations of approximately 70% (v/v) in water: higher or lower concentrations may not be as germicidal. A major advantage of aqueous solutions of alcohols is that they do not leave any residue on treated items. Mixtures with other agents are more effective than alcohol alone, for example 70% (v/v) alcohol with 100 g/L formaldehyde and alcohol containing 2 g/L available chlorine. A 70% (v/v) aqueous solution of ethanol can be used to soak small pieces of surgical instruments. A contact time of ten minutes or more is necessary. Ethanol should never be used to disinfect hands since ethanol can dry the skin. Alcohol-based hand-rubs, alcohol mixed with emollients, are recommended for the decontamination of lightly soiled hands in situations where proper hand-washing is inconvenient or not possible. However, it must be remembered that ethanol is ineffective against spores, HBV, Mycobacterium tuberculosis (TB) and may not kill all types of non-lipid-containing viruses. Alcohols are volatile and flammable and must not be used near open flames. Do not use 70% ethanol to clean a Class II, type A recirculating biosafety cabinet. The vapors from ethanol are flammable and the lower explosive limit (LEL) for ethanol is easily attained. Working solutions should be stored in proper containers to avoid the evaporation of alcohols. Alcohols may harden rubber and dissolve certain types of glue. Proper inventory and storage of ethanol in the laboratory is very important to avoid its use for purposes other than disinfection. Bottles with alcohol-containing solutions must be clearly labeled to avoid autoclaving.

Iodine and Iodophors

The action of these disinfectants is similar to that of chlorine, although they may be slightly less inhibited by organic matter. Iodine can stain fabrics and environmental surfaces and is generally unsuitable for use as a disinfectant. On the other hand, iodophors and tinctures of iodine are good antiseptics. Polyvidone-iodine is a reliable and safe surgical scrub and preoperative skin antiseptic. Antiseptics based on iodine are generally unsuitable for use on medical/dental devices. Iodine should not be used on aluminium or copper. Iodine can be toxic. Organic iodine-based products must be stored at 4–10°C to avoid the growth of potentially harmful bacteria in them.

Properties of common disinfectants

Disinfectant type	Vegetative bacteria	Bacterial spores	Fungi	Enveloped viruses	Non-enveloped viruses	Myco-bacteria	TSE & Prion agents
Hypochlorite	√	√	1	√	√	1	√
Alcohols	√	x	x	√	√	√	x
Aldehydes	√	√	√	√	√	√	x
Surface active agents	√	x	1	2	2	x	x
Peroxygen compounds	√	√	√	√	√	√	x
Phenolics	CAN NO LONGER BE USED						
	√ = Generally Effective			1 = Limited activity			
	x = Generally ineffective			2 = Depends on the virus			
NB. The specific activity of a particular disinfectant must be assessed on a case by case basis							

Characteristics of common disinfectants

<u>Disinfectant type</u>	<u>Hazard Class</u>	<u>Inactivated by:</u>			<u>Corrosive to metals</u>	<u>Flammable</u>
		<u>Organic matter</u>	<u>Hard water</u>	<u>Detergent</u>		
Hypochlorite	Toxic	√	x	1	√	x
Alcohols	Toxic	x	x	x	x	√
Aldehydes	Toxic Irritant	x	x	x	x	x
Surface active agents	n/a	√	√	2	x	x
Peroxygen compounds	Irritant (dust)	x	x	x	3	x
1 = Inactivated by cationic detergents						
2 = Inactivated by anionic detergents						
3 = Can corrode lower quality steel on prolonged contact						

Additional information on concentrations and contact times of some common disinfectants. [Phenolics are no longer permitted to be used as laboratory disinfectants and the entry below for Phenolics should be disregarded.]

Common Liquid Disinfectants		Usage Requirements		Active Against (positive effect +, no effect -, variable effect *)						
Category	Example	Dilution	Contact Time (mins)	Vegetative Bacteria	Bacterial Spores	Lipoviruses	Non-lipid viruses	HIV	HBV	Tb
Quaternary Ammonium Compounds	Vindicator+	0.1-2%	10-30	+	+	+	-	+	-	-
	Lysol I.C.	1:256	10	+	+	+	-	+	-	+
Phenolics	Hil-Phene	1-5%	10-30	+	-	+	*	+	*	+
Chlorine	Clorox	5-10%	10-30	+	+	+	+	+	+	+
Iodophors	Wescodyne	0.5-10%	10-30	+	-	+	+	+	*	+
Ethyl Alcohol		70-85%	10-30	+	-	*	*	+	*	-
Isopropyl Alcohol		70-85%	10-30	+	-	*	*	+	*	-
Formaldehyde	Sterac	0.2-8%	10-30	+	+	+	+	+	+	+
Glutaraldehyde	Cidex	2%	10-30	+	+	+	+	+	+	+