
British Standard Code of practice for
**Cleaning and disinfecting of plant and equipment
used in the dairying industry**

Nettoyage et désinfection des installations et matériels utilisés dans l'industrie laitière —
Code de bonne pratique

Leitfaden für die Reinigung und Desinfektion von Anlagen und Geräten in der Milchwirtschaft

Confirmed January 2011

Foreword

This standard has been prepared under the direction of the Dairying Standards Committee. It supersedes BS 2756 : 1970 and BS 5305 : 1977 which are withdrawn.

In revising BS 2756 : 1970 and BS 5305 : 1977 it was decided that it was an appropriate time to combine the two texts, an intention which had been noted at earlier Technical Committee meetings during the mid 1970s. As well as making that major change the opportunity has been taken to introduce recommendations for the use of peracetic acid and biguanides and to bring up to date the procedures described in the standards as well as the reference to current regulations and official advice.

The recommendations of this standard are based on knowledge gained by industry and others in cleaning and disinfecting plant and equipment, and are based on practical considerations. It is the responsibility of users to ascertain whether their premises are controlled by the Milk and Dairies (General) Regulations 1959, as amended, and if so to ensure that for the purposes described in those regulations, cleansing is undertaken using approved chemical agents (see 2.1) at the approved strengths.

Attention is drawn to the need to read sections two and three before proceeding to the subsequent sections which deal with specific situations in detail.

Satisfactory standards of cleanliness and hygiene in milk plant necessitate careful application of detergents, disinfectants and procedures combined with adequate monitoring. The protection of treated surfaces against recontamination is also important.

The scope of the revised standard continues to include the treatment of specialized equipment such as milk evaporators and ice cream plant, as well as farm and dairy equipment. Attention is drawn to BS 5226 which gives more specific and detailed recommendations for cleaning milking machine installations.

In conforming with general usage the word 'disinfection' and its derivatives has been used throughout the text, in place of 'sterilization' and its derivatives; however the latter have been retained in connection with UHT plants to describe the process intended to destroy or remove living organisms.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

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Section one. General

1 Scope

This British Standard describes procedures for cleansing, i.e. cleaning and disinfecting, of plant and equipment used in the dairying industry. It covers the use of detergents, disinfectants and combined detergents/disinfectants.

Although reference is made to certain precautions, this standard does not contain specific or comprehensive advice on health and safety precautions and further advice should be sought as appropriate.

NOTE 1. Attention is drawn to BS 5226 which provides further details concerning cleaning and disinfecting of milking machine installations.

NOTE 2. The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this British Standard the following definitions apply.

2.1 approved chemical agents. Disinfecting agents or detergent/disinfectants approved jointly for use in England and Wales* by the Minister of Agriculture, Fisheries and Food and the Secretary of State for Social Services and the Secretary of State for Wales under regulation 27(6)(a) of the Milk and Dairies (General) Regulations 1959.

The list of approved chemical agents is revised periodically.

2.2 available chlorine. The quantity of chlorine equivalent to the oxygen released when the chlorine-containing disinfecting agent is completely decomposed to chloride and oxygen.

NOTE. The use of the term available chlorine is confined in practice to liquid hypochlorites and solid chlorine-releasing agents in which the disinfecting action follows a ready hydrolysis to hypochlorous acid and its subsequent decomposition to chloride and oxygen.

2.3 buffering. Stabilizing the pH value of a solution.

2.4 chilled water. Clean water at a temperature of less than 5 °C.

2.5 cleaning. The process of removing soil.

2.6 cleansing. As in various milk and dairies legislation, a combination of cleaning and disinfecting processes.

2.7 clean water. Water that, at the point of use, is of a quality sufficient to comply with the classification set out

in Section 4, 'Standards of Bacterial Quality', of 'Reports on Public Health and Medical Subjects No. 71'*.

NOTE. In the case of small rural supplies, if bacteriological examination of samples repeatedly shows inability to comply with the classification set out in the above-mentioned report, efficient chlorination or other equally effective treatment should be practiced at all times.

2.8 corrosion inhibitors. Substances capable in specific instances of minimizing the corrosion of certain metals.

2.9 detergents. Substances capable of assisting cleaning when added to water. They include soaps, organic surface-active agents, e.g. synthetic detergents, alkaline materials and, in certain circumstances, acids.

2.10 disinfection. A process that reduces the number of bacteria in dairy plant and utensils to a level consistent with acceptable quality control and hygienic standards.

2.11 disperse. To bring into and keep in suspension undissolved soiling matter.

2.12 emulsify. To bring into and keep in dispersed form oils and fats from the milk residue.

2.13 fogging. The application of a disinfecting agent in the form of a dense mist of minute droplets.

2.14 fumigation. The application of smoke or fumes from substances that when volatilized are capable of destroying insects, bacteria, yeasts and moulds.

2.15 milkstone. A deposit that contains calcium caseinate and calcium phosphate.

2.16 sequestering agents. Chemicals that combine with calcium and magnesium salts, such as those occurring in hard water, to form water-soluble compounds, generally enhancing the detergent operation.

2.17 soil. The milk residue, scale and other deposits of soiling matter that have to be removed from plant and containers during the cleaning process.

2.18 sterilization. A process intended to destroy or remove all living organisms (see BS 5283).

2.19 surface-active agents. Substances capable of modifying the physical forces existing at surfaces, such as between liquids and solids, permitting more intimate contact and facilitating their mixing.

2.20 swabbing. The application of a liquid to a surface by means of a cloth or other absorbent material.

*Scotland: By-laws made under Section 8, Milk and Dairies (Scotland) Act 1914. The Milk (Special Designations) (Scotland) Order 1980.

Northern Ireland: Statutory Rules and Orders of Northern Ireland 1981, No. 234 (for milk) as amended by the Milk (Amendment) Regulations (Northern Ireland) 1983, No. 337. Statutory Rules and Orders for Northern Ireland 1966, No. 204 (for marketing of milk products) as amended by the Milk Marketing of Milk Products (Amendment) Regulations (Northern Ireland) 1983, No. 336.

*'The Bacteriological Examination of Water Supplies' (1982), published by HMSO.

Section two. Detergency and detergents

3 Fundamentals of cleaning process

3.1 Basic steps

In all cleaning processes in the dairying industry every endeavour should be made to carry out each of the following steps. They are normally all necessary for successful cleaning and any subsequent or combined disinfecting process:

- (a) a preliminary rinse with water to remove gross soil;
- (b) a cleaning treatment with detergent solution so that the soiled surface is freed from soil;
- (c) one or more rinses of the cleaned surfaces with clean water (see 2.7) so that they are freed from released contaminants and detergent solution.

These are basic steps; full details of how they are applied to all the major cleaning tasks in the dairy industry are given in sections five to thirteen.

3.2 Processes occurring

During cleaning treatment with the detergent solution the following processes occur:

- (a) wetting of the soiled surface;
- (b) removal of the soil from the surface by solution, emulsification, chemical action and/or mechanical action;
- (c) dispersion and suspension of the undissolved soil within the bulk of the solution.

During the subsequent rinsing process it is essential that a detergent has good rinsability, i.e. that the detergent solution should be capable of holding the soil in suspension whilst the solution is being diluted during the rinsing operation, so that there is no redeposition. This also means that the detergent solution should leave no residual detergent film on the rinsed surface*.

3.3 Water

The use of soft water is to be preferred in cleaning processes involving alkaline detergents, from the viewpoints of detergent economy, efficiency of detergent action and prevention of scale formation. Attention is, however, drawn to the possible corrosion risks involved in the use of soft water in non-alkaline conditions. The advice of the plant manufacturer should be sought on this point.

4 Raw materials for detergents

4.1 General

Detergent products are formulated from a wide range of detergent raw materials, each being selected to contribute some desired property to the final product. The most important of these raw materials fall within the groups described in 4.2 to 4.9.

4.2 Inorganic alkalis

The most widely used inorganic alkalis are:

- (a) sodium hydroxide (caustic soda);
- (b) tetrasodium orthosilicate;
- (c) disodium metasilicate (sodium metasilicate);
- (d) trisodium phosphate;
- (e) sodium carbonate (soda ash, soda crystals);
- (f) sodium hydrogen carbonate (sodium bicarbonate).

These raw materials contribute the desired degrees of alkalinity, buffering and rinsing power to the final formulation.

Thus, if high alkalinity is required, sodium hydroxide or sodium orthosilicate will form a large proportion of the mixture. These materials should be handled with care because they can cause severe burns on the skin. In use, caustic alkalis are generally converted to carbonates. In the absence of sufficient suspending or sequestering agent, this will eventually cause scale or bloom to appear on equipment and utensils.

Tetrasodium orthosilicate, disodium metasilicate and trisodium phosphate are very effective for removing heavy soil. They also possess good buffering and rinsing properties.

Because of their lower alkalinity, sodium carbonate and sodium hydrogen carbonate are used in detergent solutions which come into contact with the skin.

4.3 Acids

The most widely used acids are:

- (a) inorganic acids, e.g.:
 - (1) nitric acid;
 - (2) orthophosphoric acid (phosphoric acid);
 - (3) sulphamic acid (sulphamidic acid);
- (b) organic acids, e.g.:
 - (1) glycollic acid (hydroxyacetic acid);
 - (2) gluconic acid.

These raw materials are used in formulations designed for the removal of tenacious soil, such as milkstone, which is frequently met in the dairying industry.

These materials should be handled with care because they can cause severe burns on the skin. In addition they are corrosive and for this reason they may have to be used with corrosion inhibitors.

4.4 Sequestering agents

Typical examples of sequestering agents are:

- (a) sodium polyphosphates;
- (b) ethylenediaminetetra-acetic acid (EDTA) and its salts;
- (c) gluconic acid and its salts.

They are included in detergents to prevent hard water scales developing or to prevent or remove milkstone.

* Attention is drawn to the requirements of the appropriate milk and dairies legislation (see 2.1).

Their inclusion in a formulation may also improve rinsing properties and the overall detergency of solutions containing surface-active agents.

4.5 Surface-active agents

The wetting, emulsifying, dispersing, foaming and overall detergent properties of a cleaning solution are to a large extent dependent on the conditions existing at the interfaces between liquid and the surface to be cleaned, liquid and oil or other soil, and liquid and air.

Some of these agents may be designed essentially as wetting agents, others as emulsifying agents, dispersing agents and detergents. Some possess all these properties to some degree whilst others possess only one or two.

As opposed to soap, which may be regarded as the oldest surface-active agent, most of the modern surface-active agents are stable in acidic solutions; furthermore, their performance is not appreciably affected by the hardness salts in water.

Each year the number of surface-active agents available for use in dairy detergents increases. Some are intended to be used alone as general-purpose detergents, but many are used to improve the performance of dairy detergents and detergent/disinfectants formulated for specific duties.

Surface-active agents are generally classified as anionic, non-ionic or cationic, depending upon how they dissociate in aqueous solution (see note to table 1). A fourth class consists of amphoteric or ampholytic surface-active agents which contain anionic and cationic groupings. These agents possess anionic properties in the alkaline range and cationic

properties in the acidic range. Anionic and cationic surface-active agents are mutually incompatible. Examples of the more common surface-active agents within this class are set out in table 1.

4.6 Suspending agents

Suspending agents assist in keeping undissolved soil in suspension. Typical examples are starch and sodium carboxymethyl cellulose.

4.7 Inhibitors

Inhibitors are used to minimize the corrosive attack of acids and alkalis on metals. Since many inhibitors are specific in their applications and some are toxic, the manufacturer's instructions should always be followed.

4.8 Anti-foaming agents

Anti-foaming agents may also be incorporated for special applications.

4.9 Chemical disinfecting agents

Chemical disinfecting agents may be incorporated with detergents to provide balanced products which both clean and disinfect. Examples of the types which are used for this purpose are given in table 2.

Only those brands of disinfectants and chemical agents approved by the authorities concerned in accordance with the appropriate milk and dairy legislation are permitted as alternatives to steam or boiling water for the disinfection of milk equipment.

Table 1. Surface-active agents		
Ionic class	Chemical family	Formulae
Anionic	Sodium alkylbenzenesulphonate Sodium primary alkyl sulphate Sodium alkylpoly (oxyethylene) sulphate	$\text{RC}_6\text{H}_4\text{SO}_3\text{Na}$ ROSO_3Na $\text{R}(\text{OCH}_2\text{CH}_2)_n\text{OSO}_3\text{Na}$
Non-ionic	Ethoxylated alkanols	$\text{R}(\text{OCH}_2\text{CH}_2)_n\text{OH}$
Cationic	Quaternary ammonium compounds	$(\text{R}_1\text{R}_2\text{R}_3\text{R}_4)\text{N. Halogen}$
Amphoteric	Alkylaminoalkanoic acids	$\text{RNH}(\text{CH}_2)_n.\text{COOH}$
NOTE. R , R_1 , R_2 , R_3 and R_4 in the formulae in the table represent organic radicals. Anionic agents dissociate in aqueous solution giving rise to surface-active anions, e.g. ROSO_3^- . Non-ionic agents do not ionize in solution. Cationic agents dissociate in aqueous solution giving rise to surface-active cations.		

Table 2. Chemical disinfecting agents	
Chemical disinfecting agent	Active agent
Chlorinated trisodium <i>orthophosphate</i>	Chlorine
1,3-dichloro-5,5-dimethylhydantoin	Chlorine
Sodium dichloro- <i>isocyanurate</i>	Chlorine
Sodium hypochlorite	Chlorine
Peracetic acid	Oxygen
<i>n</i> -Hexadecyl trimethylammonium bromide	Quaternary ammonium compound
Benzalkonium chloride	Quaternary ammonium compound
Iodophors	Iodine

5 Formulation and selection of detergents

5.1 General factors which influence the formulation of dairy detergents

Whilst it might be desirable to have a single detergent capable of dealing with every cleaning task in the dairying industry, no such product exists and for technical and economic reasons is unlikely to be developed.

In practice it is found that the most acceptable detergents are those that have been specially formulated to deal with particular cleaning tasks.

The more important basic features taken into consideration when a detergent product is formulated are as follows.

- (a) *The nature of the soil to be removed.* The tenacity and composition of the soil decides what detergency characteristics are required in the final product.
- (b) *The materials of construction of the equipment, plant or utensils.* These can have a restricting influence on the selection of detergent raw materials because of the need to minimize corrosion.
- (c) *The method of cleaning: whether manual, circulation cleaning or by specialized cleaning equipment.* This has a bearing on a number of factors, amongst which are the degree of alkalinity and the foaming characteristics of the product.
- (d) *The hardness characteristics of the water.* The hardness salts in water may call for the use of sequestering agents.

(e) *Whether a combined detergent/disinfectant is to be used.* It is important to ensure that the detergent and disinfecting components are compatible. In addition, for maximum economy, attention should also be given to their reserves of activity, since ideally the bactericidal and cleaning activities of the product should exhaust at the same rate.

The user of any detergent product expects it to comply with certain other requirements, including the following.

- (1) It should not be dangerous to use under normal operating conditions.
- (2) If it is to be used for manual washing operations, it should be mild and non-irritating to the skin.
- (3) It should have a stated shelf-life and should be stable during that period.
- (4) If it is in powder, granular or flake form, it should not cake or deteriorate when stored as directed and should be easily withdrawn from its container. It should not give off irritating dust.
- (5) If it is a liquid, it should not separate into layers and should have good flow properties at normal storage temperatures.
- (6) The cost of the detergent product should be balanced against its efficiency and its method of application, so that the entire process is economically sound.

5.2 Selection of proprietary detergent products

5.2.1 General. Established manufacturers of detergents for the dairying industry are familiar with its cleaning problems. They cater for cleaning needs by developing not only effective detergent products but also, where appropriate, equipment which will enable these detergents to be used at their maximum efficiency.

5.2.2 Range of products. Examples showing the range of products the industry calls for are as follows.

- (a) Detergents for manual washing processes.
- (b) Detergents for cleaning in-place pipelines and milk storage tanks.
- (c) Detergents to clean equipment which is used for milk heat treatments, e.g. pasteurizing and ultra-high temperature (UHT) plants and evaporators.
- (d) Powdered and granular detergents for bottle washing in hard and soft water.
- (e) Liquid detergents for bulk delivery and storage which may be used in conjunction with apparatus automatically controlling the detergent concentration.

5.2.3 Information on products. When considering the purchase of a proprietary brand of detergent, the user should inform the supplier of the exact purpose for which the detergent is to be used and supply any other relevant information which the supplier may call for, e.g. the hardness of water, the make and size of the equipment in which it will be used and the normal operating conditions.

Suppliers of branded dairy detergents can be expected to provide the customer with the following.

- (a) A clear statement indicating the cleaning operations for which the products are intended.
- (b) Full and easily understood instructions on their use, the means of testing solution concentrations and any special handling instructions.
- (c) When requested, a general guide to the nature of the product and, in the case of simple detergents, an approximate analysis.
- (d) Advice on storage of the product, particularly in the case of bulk-delivered liquid detergents.
- (e) Technical service.

NOTE. Regulations under the Health and Safety at Work, etc. Act 1974 require information to be provided on safe storage and usage of the products.

Section three. Disinfection and chemical agents

6 Fundamentals of disinfecting processes

6.1 General

As far as possible equipment should be designed to facilitate cleaning and disinfection and every care should be taken to maintain it in good condition.

6.2 Necessity for clean surfaces

In the dairying industry the soil remaining on equipment after use is usually contaminated with micro-organisms and is a medium in which they can readily multiply.

If inadequately cleaned equipment is subjected to a disinfection process, then:

- (a) micro-organisms present in soil residues will be protected from contact with chemical disinfectants and also, to some extent, from the effects of heat;
- (b) the strength of any chemical disinfecting solution and hence its effectiveness may be reduced by excessive quantities of soil;
- (c) heat disinfection will render the residual soil more resistant to subsequent cleaning processes;
- (d) micro-organisms surviving either heat or chemicals may multiply in moist soil residues and, if sufficient time elapses before use, the equipment may become seriously contaminated.

Build-up of soil as a result of continued inadequate cleaning will accentuate these effects.

Effective cleaning is essential for successful disinfection; general recommendations concerning cleaning processes and detergents for equipment and plant used in the dairying industry are given in section two.

6.3 Timing of disinfection

Whereas all dairying equipment should be cleaned with the minimum delay after use, disinfection of processing and manufacturing plant should immediately precede the next run. Farm dairy equipment, however, is normally cleaned and disinfected in one operation, using a combined detergent/disinfectant solution.

Any equipment not used within a few hours of disinfection should be re-disinfected immediately before use.

6.4 Construction and physical condition of equipment

Traces of soil and micro-organisms can penetrate joints, stopcock seatings, dead ends and beneath gaskets where they will accumulate if the components are not dismantled and cleaned. Similar accumulations may occur where any metal equipment has cracks, open seams or corroded surfaces and also where rubber and plastics have deteriorated in any way, e.g. have perished or become abraded. In all these circumstances effective cleaning is difficult if not impossible. Thus chemical disinfection is likely to fail and processes relying on heat will only succeed if the temperature and time employed allow conduction of sufficient heat to the sites of contamination.

6.5 Legislation affecting the use of disinfecting agents

Only those brands of chemical disinfecting agents and combined detergent/disinfectants approved by the authorities concerned in accordance with the appropriate milk and dairy legislation are permitted as alternatives to steam or boiling water for the disinfection of equipment used for milk and cream. See also 2.1 and 7.2.

Although returned milk bottles should be disinfected as well as washed before refilling with milk, the legislation accepts that any glass bottle which is effectively cleaned in a bottle-washing machine need not be disinfected with boiling water, steam or an approved chemical agent.

The legislation requires that equipment has to be in a state of thorough cleanliness, and all traces of chemical disinfecting agent have to be rinsed off with clean water before the equipment is used again for milk. However, in some circumstances it is permissible, and indeed necessary, to add approved sodium hypochlorite solution to the final rinse water (see 2.7).

Approved chemical agents are required to carry a label which states among other things the use(s) for which the product has been approved as an alternative to scalding by boiling water or steam, the concentration at which it should be used for these purposes, the period within which it should be used and the concentration of active agent(s). Agents are also required to carry information of safe usage and storage in accordance with Regulations under the Health and Safety at Work, etc. Act 1974.

7 Types of disinfecting and chemical agents

7.1 Heat

7.1.1 General. The efficiency of processes involving heat depends on the temperature reached, the time the temperature is maintained and the humidity. The required degree of microbial destruction will be achieved provided the method of application and the design of the equipment permit adequate penetration of heat to all parts of the plant or equipment. Temperatures should be measured by means of thermometers of known accuracy. Temperature-sensitive papers attached to the external surfaces of glass and metal equipment may be used as a guide.

7.1.2 Steam. When steam at atmospheric pressure is used, the recommended time of application depends on the method, e.g. for milk cans, steaming on a steaming stool for 1 min to 2 min depending on the capacity of the can is recommended as adequate; for milking equipment or milk bottles in a steam chest, steaming should be continued for at least 10 min after the temperature in the chest reaches 96 °C; for storage tanks and other large vessels, steam should be injected until the condensate from the tanks reaches 85 °C and should then continue for at least 10 min. Steam at atmospheric pressure will not destroy all bacterial spores but if applied as recommended is effective against vegetative bacteria, bacteriophages, yeasts and moulds (see clause 13).

7.1.3 Hot or boiling water. Where the temporary (alkaline) hardness of the water supply exceeds 50 mg/L, water scale will be deposited on surfaces of equipment unless the water is suitably softened. The temperature of the circulating water at its coolest point determines the time of treatment. Common time and temperature combinations for plant used for milk, milk products and ice cream are 85 °C for 15 min and 80 °C for 20 min. A higher temperature should be used if the time is to be reduced. Circulation of water at such temperatures is a convenient and effective method for treatment of plant following cleaning in-place (CIP)* and where destruction of bacterial spores is not required. The volume of water used and its flow rate will influence the time taken by the components to reach the required temperature.

On dairy farms, pipeline milking machines may be treated by drawing acidified boiling water into the machine (see 17.1.3). Provided that a temperature of not less than 76 °C when measured on the external surfaces of all glass and metal components is maintained for at least 2 min, satisfactory bacteriological results can be obtained (see BS 5226). Immersion in water which is then raised to boiling point may be used to disinfect small components, filter cloths, cheese cloths, etc.

Pouring so-called 'boiling' water into milking buckets and similar utensils is not a reliable method of disinfection because of the difficulty of ensuring that the utensils have been adequately heated.

7.2 Chemicals

7.2.1 General. In the dairying industry 'chemicals' may be disinfecting agents alone or combined detergent/disinfectants. It is essential that both types are approved if used for disinfecting milk-handling and cream-handling equipment (see 6.5). This restriction does not apply to equipment used for milk products and ice cream although approved chemicals are normally used. Sodium hydroxide and formaldehyde or formalin may be used for special purposes (see 7.2.9 and 7.2.10).

The efficacy of all approved disinfecting agents is influenced by concentration, contact time, temperature, organic matter (soil), pH, water hardness, combination with detergents and types of micro-organisms. All chemical disinfecting agents lack penetrative power, and micro-organisms in milkstone and in crevices may survive treatment. The presence of less resistant films of soil, e.g. air-dried milk residues, may also hinder immediate contact of the chemical with micro-organisms. However, combination of the disinfecting agent with compatible detergents to facilitate soil removal enables cleaning and disinfection to be affected in one operation (see also clause 10).

As normally used, chemical disinfecting agents are not effective against bacterial spores and should not be relied on to kill mould spores.

A cumulative list of brands of approved disinfecting agents and detergent/disinfectants classified according to type of active agent and giving the approved use concentration is published periodically by HMSO for the Ministry of Agriculture, Fisheries and Food. This list is also applicable

to Northern Ireland. Information on products approved for use in Scotland is available from the Department of Agriculture and Fisheries for Scotland, Chesser House, Edinburgh EH11 3AW.

7.2.2 Chlorine. Sodium hypochlorite solutions and brands of chlorinated trisodium phosphate may be used as disinfecting agents alone; hypochlorite may also be added to solutions of suitable detergents to provide dual-purpose solutions. Organic chemicals releasing chlorine, e.g. dichlorodimethyl hydantoin and sodium dichloroisocyanurate, are most commonly formulated with detergents and marketed in powder form (see 9.2).

An approved hypochlorite solution within its recommended shelf life should contain not less than 8 % (m/m) of available chlorine and not more than 12 % (m/m) of available chlorine. For practical purposes this may be taken as 10 % (m/m) of available chlorine so that the dilution of one part of an approved hypochlorite in 1000 parts of water gives a solution containing approximately 100 mg/L of available chlorine.

The available chlorine from hypochlorite and other chlorine-releasing chemicals reacts rapidly with, and is inactivated by, organic matter such as milk residues but, as normally used, the volume of solution and its concentration are such that the quantity of soil present on equipment does not seriously impair the disinfecting efficiency of the solution. Storage of used solutions may however result in a marked decline in strength and, except with products specially recommended for repeat use, only freshly prepared solutions should be used.

Chlorine-releasing chemicals are corrosive to most metals including stainless steel (see table 3). At low concentration in alkaline conditions, at low temperature and with short contact time, these corrosion hazards are minimized and the disinfecting action remains effective.

The pH values of hypochlorite solutions diluted to contain 50 mg/L to 250 mg/L of available chlorine fall within the range 8.0 to 10.5 depending on the chemical composition of the water supply and the caustic alkalinity of the hypochlorite. Thus hypochlorite solutions may be used safely and effectively on product contact surfaces provided suitable precautions are taken. Where previously cleaned equipment is to be disinfected with hypochlorite solutions, the following precautions are necessary.

- (a) The equipment should be rinsed free of detergent residues.
- (b) If acid has been circulated to remove milkstone, all traces of acid should be removed, and for this purpose circulation of an alkaline solution is advisable.
- (c) It is preferable to disinfect the equipment just prior to use to obviate the risk of corrosion resulting from traces of hypochlorite remaining for some hours in the equipment. Disinfecting solutions containing chlorine should not be left in contact with metal equipment overnight.
- (d) Because of their construction, stainless steel plate-type heat exchangers are particularly prone to corrosion by chlorine-releasing chemicals and the precautions

* Throughout this standard the expression 'cleaning in-place' is used but in the industry it is commonly referred to as 'CIP'.

listed under (a), (b) and (c) are essential to prevent damage to such equipment.

(e) It is unnecessary and may be harmful to the equipment to use solutions containing more than 200 mg/L of available chlorine at a temperature greater than 40 °C for a period of longer than 10 min. For most purposes disinfection using cold solutions containing 100 mg/L of available chlorine for a period of 15 min is adequate.

(f) Where possible, the available chlorine content of disinfecting solutions should be checked at the time of use.

All chlorine-based disinfecting agents should be used in accordance with the manufacturer's instructions.

Recommendations for the use of chlorine-based detergent/disinfectant solutions are given in 8.1 and 8.2.

7.2.3 Quaternary ammonium compounds (QACs).

Alkyldimethylbenzyl-ammonium chloride (benzalkonium chloride) is an example of a QAC cationic surface-active bactericide. A number of QACs are approved as disinfecting agents alone and, as used in the dairying industry, their properties are basically similar.

Unlike sodium hypochlorite, QAC disinfecting agents should not be added by the user to detergent solutions for combined cleaning and disinfection because the QAC may be seriously inactivated by certain detergent ingredients, e.g. anionic wetting agents, and to a lesser or unpredictable extent by others.

Formulation with compatible detergents may enhance the bactericidal activity of QACs, e.g. by increasing the alkalinity, and approved combined detergent/QACs are available.

The more important properties of QACs influencing their performance as disinfecting agents and their use in the dairying industry are as follows.

(a) In concentrated form they are highly stable and have a long shelf life.

(b) Compared with undiluted hypochlorite they are much safer to handle although they may cause skin irritation.

(c) Being relatively non-corrosive to metals, they can be used, if necessary, on equipment at higher temperatures and for longer times than is acceptable with hypochlorite.

(d) Their high surface activity and consequent foaming properties makes them unsuitable for circulation or other mechanical application in most pipeline systems, where foam production may hinder effective circulation and make rinsing difficult. Copious foam may also be drawn into the vacuum pump in some systems.

(e) At low concentration, e.g. less than 50 mg/L of QAC, and low temperatures (less than 10 °C) QACs are selective in their bactericidal activity, being less effective against Gram-negative bacteria, e.g. coliforms and psychrotrophs, than they are against Gram-positive bacteria, e.g. staphylococci and streptococci. Hard water reduces bactericidal activity of most QACs. Combination of such adverse conditions may encourage the development of a QAC-resistant flora on imperfectly cleaned equipment treated with QAC solutions. Selective bactericidal action is unusual at normal use concentrations (150 mg/L to 250 mg/L of QAC), at temperatures greater than 40 °C and with a contact time of not less than 2 min.

(f) The bactericidal effectiveness of QACs will be impaired by the presence of organic matter such as milk; chemical tests may not, however, reveal any depletion of QAC and the results should not be taken to mean that the disinfecting solution is suitable for reuse.

All QACs should be used in accordance with manufacturer's instructions.

7.2.4 Iodine. Iodine can be rendered water-soluble by complexing it with suitable non-ionic surface-active agents, e.g. nonylphenol ethylene oxide condensates. Such complexes are known as iodophors. Acidic conditions enhance their bactericidal activity and those approved for use in the dairying industry are invariably acidified, usually with phosphoric acid. The presence of surface-active agents and acid confers detergent properties on these iodophors and all are classed as detergent/disinfectants.

Approved iodophors used at the recommended concentration usually provide 50 mg/L to 70 mg/L of free iodine and yield pH values of 3 or less in water of moderate alkaline hardness. Excessive dilution of iodophors with water having a high alkaline hardness may seriously impair their efficiency because their acidity is neutralized.

In concentrated form correctly formulated iodophors have a long shelf life but solutions may lose iodine by vaporization and the loss can be rapid at temperatures greater than 45 °C.

Some plastics materials absorb iodine and are stained brown. The rubber gaskets of heat exchangers may also absorb iodine and if hot milk comes in contact with the affected rubber, the milk may acquire an antiseptic taint.

Iodine stains milk residues and milkstone thus indicating clearly where equipment has been inadequately cleaned. Iodophor solutions are acidic and, if used regularly, they will help to prevent accumulation of milkstone but as normally used they should not be expected to remove existing milkstone.

Most iodophors foam when circulated in pipeline systems but low-foam types are available. Both types have been found suitable for spray cleaning and disinfection of storage tanks and tankers and, when used cold, for refrigerated farm bulk tanks; however, manual cleaning at intervals determined by inspection is necessary.

The amber colour of iodophor solutions provides visible evidence of the presence of the disinfecting agent, but the depth of colour is not a reliable guide to the concentration of iodine.

Organic matter such as milk inactivates the iodine in iodophor solutions and the amber colour fades. Unless excessive milk residues are present on equipment, the loss of iodine from solutions is slight but may increase if used solutions are stored. If they are to be reused, iodophors solutions should be checked and made up to the correct strength.

NOTE. In the interests of safety it is essential that iodophors are used only in accordance with the manufacturer's instructions.

7.2.5 Amphoteric (ampholytic) surface-active agents.

Amphoteric surface-active agents have detergent properties and some have bactericidal properties. The high foaming characteristics of products of this type make them unsuitable for cleaning in-place. They are non-corrosive and non-irritant to skin and are suitable for manual cleaning and disinfecting; for milking machines, their high surface activity may reduce adhesion between rubber and metal surfaces and may cause rubber tubes to slip off metal connections.

7.2.6 Acidic disinfecting agents. Acidic disinfecting agents are formulations containing anionic surface-active agents and inorganic acids, usually phosphoric acid (see 4.3 and table 1). They may be used either as detergent/disinfectants or as disinfecting agents. At normal use concentrations they yield pH values of about 2. Being highly acidic they will remove and prevent milkstone but are corrosive to metals other than stainless steel. They foam when recirculated in pipeline systems.

7.2.7 Peracetic acid. Peracetic acid can be provided in a number of relatively stable equilibrium mixtures of peracetic acid, hydrogen peroxide, acetic acid and water. Such systems are effective bactericides, fungicides, virucides and sporicides.

Dilutions, containing typically 0.05 g/L to 0.75 g/L active peracetic acid, are acidic (pH 3 to 5) and may be used alone, for disinfection, or be added to up to 20 g/L phosphoric acid BP to provide combined descaling and disinfection.

Dilutions are non-corrosive to stainless steel provided that the water used for dilution contains not more than 150 mg/L chloride ion and ideally not more than 50 mg/L chloride ion. This will be influenced by the precise nature of the equipment and the conditions of treatment, and the suppliers of both equipment and chemical should be consulted. Peracetic acid should not be used on copper or its alloys.

At ambient temperatures, stability is similar to that of sodium hypochlorite. Decomposition of peracetic acid is accelerated by elevated temperatures or by the presence of oxidizable impurities. Concentrates should not be kept other than in their original containers.

Concentrates are oxidizing, corrosive, cause burns, have a pungent odour and should not be handled manually. Dosing should be automatic, directly from the original container and only as directed by the manufacturer. Dilutions should not be kept or reused.

7.2.8 Biguanides. Biguanides are derivatives of guanidine, a naturally occurring substance found in vegetables and cereals. The group includes a small number of materials that have been identified as having bactericidal properties. These are either bisbiguanides or polymeric biguanides. Only the polymeric biguanides have significant usage in dairy disinfection.

These materials are not surface active and are essentially non-foaming, non-corrosive and non-irritating. They may be used alone, for manual, circulation or spray disinfection. The lack of corrosivity to most materials allows the use of long contact times. When combined with appropriate non-ionic detergents they can be used for cleaning in-place.

The biguanides are deactivated by anionic materials and should not be blended with detergents by the user. Biguanides are precipitated by sodium hydroxide (caustic soda), and other alkalis such as silicates, and carbonates as well as by hypochlorite and therefore should not be allowed to mix with these chemicals.

The biguanides have excellent stability when stored in their original containers. Dilutions, typically 100 mg/L to 200 mg/L active biguanide, are effective over a wide pH range but they may be precipitated above a pH of 10 and may be reversibly deactivated below a pH of 3.

All biguanides should be used in accordance with the manufacturer's instructions.

7.2.9 Sodium hydroxide (caustic soda). Sodium hydroxide, because of its high alkalinity, has good bactericidal properties; a solution containing 15 g/L to 20 g/L used at a temperature of 45 °C is normally effective in a period of 2 min against non-sporing bacteria.

Sodium hydroxide is included in bottle-washing detergents and at the caustic alkalinities and temperatures normally recommended these detergent solutions are highly bactericidal and may kill a proportion of bacterial spores.

7.2.10 Formaldehyde

7.2.10.1 General. Sometimes it is necessary to disinfect or fumigate (see 2.14) rooms, particularly those used for the storage of, for example, packaging materials and products such as cheese and yogurt. It is usually possible to empty the room and clean any soiled surfaces, but the application of a disinfecting agent to all the surfaces presents practical problems. In such circumstances the disinfecting agent may be applied as a generated fog or a gas, and formaldehyde is particularly suitable because it is cheap, is not injurious to fabrics, paint and most metals and is effective against bacteria, moulds and yeasts.

Formaldehyde gas can be generated by atomizing or boiling off a solution of the gas in water (formalin) or by mixing a cold aqueous solution with solid potassium permanganate thereby producing a violent exothermic chemical reaction. As an alternative, solid paraformaldehyde can be vaporized to produce formaldehyde.

The quantity of formalin required depends upon the size of the room, the duration of exposure allowed, the relative humidity, the temperature and, to a lesser extent, the nature of the surfaces involved.

The aim should be to achieve, at the end of the exposure period, a gas concentration of 1 mg/L and to maintain a relative humidity of about 70 % r.h. for an exposure period of about 3 h at a temperature of 15 °C to 20 °C; this may be achieved by using the procedure described in 7.2.10.2 or 7.2.10.3. The room should be sealed completely for the duration of the exposure period and if the room is to be fumigated regularly it is an advantage to install a fan to circulate the gas within the room. No free moisture should be present within the room since the gas is extremely soluble and comparatively ineffective in solution. If the room has to be heated, time should be allowed so that all surfaces reach the required temperature.

CAUTION. It is necessary for caution in the use of formalin. The general advice given in the cautionary note to 7.2.10.3 regarding formalin should be followed.

7.2.10.2 Boiling or atomizing method. A solution containing 400 g/L of formaldehyde in water is available commercially as formalin. For every 3 m³ of room space use at least 50 mL of formalin. It may be dispersed within the room using a fog generator or boiled off, for example from an electrically-heated vessel. Unless it is possible to switch the vessel on and off from outside the room, a suitable cut-off device to protect it if it runs dry should be fitted. In order to ensure that the correct humidity is reached, add additional water to the formalin before vaporization at the rate of 50 mL to 100 mL of water for every 50 mL of formalin used.

7.2.10.3 Permanganate method. If the permanganate method is used more formalin is required because a proportion of the formaldehyde is consumed in the chemical reaction. For every 3 m³ of room space use 100 mL of formalin and 30 mL of water and react with potassium permanganate in the ratio of three parts of formalin to two parts of permanganate by mass.

CAUTION. Attention is drawn to the necessity for caution in the use of mixtures of formalin and potassium permanganate. These compounds react with violence when mixed together in large amounts and this may result in personal injury or fire. It is essential to observe the following precautions.

- (a) Use a sufficient number of containers throughout the space being treated to avoid the necessity of using more than 1 L of formalin in each. The containers should have deep sides to prevent the reactants boiling over and should be made of metal on account of the high temperatures that can occur. The sides should extend to a height of twice the depth of the reactants.
- (b) Remove any flammable materials for a distance of at least 30 cm from the containers. If the floor is wooden the containers should be placed on brick bases.
- (c) *Add the formalin after the permanganate and not before.*
- (d) It is essential that fumigations with formaldehyde are only carried out by staff who have received proper instruction in the properties of formaldehyde and in the safety precautions necessary for handling and applying it, and who are otherwise competent to use it. All operators should be trained in the use of the type of respiratory protective equipment used and in first-aid. As a general rule, the operator should always be accompanied by a second person who will keep him constantly under observation until the process of mixing the reactants has been completed.
- (e) In fumigation work the aim should be to avoid entering any atmosphere containing the fumigant. However, if exposure to formaldehyde vapour concentrations above the exposure limit (2 p.p.m.) occurs, then for the circumstances described in (d) a full face-piece canister gas respirator complying with section four of BS 2091 : 1969, and fitted with a type O, CC or H canister should be used.
- (f) The operator should be experienced and competent in the use of suitable formaldehyde detecting equipment and in the interpretation of the results. Gas detector tube systems, capable of measuring the concentration in the region of the exposure limit, are suitable for this purpose. Such systems consist of a graduated, transparent tube containing a chemically impregnated solid through which a sample of the contaminated air is drawn by means of an associated hand pump. A stained zone is produced on the indicating portion of the tube, the length of which is a measure of the concentration of formaldehyde present in the air. Only tubes complying with BS 5343 should be used and they should be used strictly in accordance with the manufacturer's instructions. A fresh tube is required for each determination.
- (g) In order to limit the period for which the operator has to remain in the room, the required amounts of potassium permanganate should first be placed in the containers which

should then be distributed along the length of the room. The required amounts of formalin and water should then be measured out and placed beside the reaction containers in separate vessels. Starting with the container furthest from the door of the room, the formalin should be added to the permanganate and the process repeated with each container as the operator retreats to the door which he should seal from the outside.

7.2.10.4 Paraformaldehyde method. For every 1 m³ of space 10 g of solid paraformaldehyde, of a purity not less than 90 % (m/m), should be vaporized on a hotplate heated electrically to a temperature of about 230 °C. The temperature should not be allowed to reach 300 °C otherwise ignition will occur. Suitable thermostatically controlled gas generators are available commercially. Sufficient water should be vaporized in the room beforehand to achieve a relative humidity of about 70 % r.h.

7.2.10.5 Neutralization. At the end of the 3 h exposure period the concentration of gas present in the room will be such as to prevent it being used and ventilation will be required. In order to reduce the ventilation time the gas may be neutralized at the end of the exposure period by introducing concentrated ammonia solution (35 % (m/m)) into the room, using about 20 mL for every 1 m³ of space. If there is a strong smell of ammonia after neutralization, the quantity of ammonia solution used should be reduced on subsequent occasions.

8 Formulation of detergent/disinfectants

8.1 General

Chemical disinfecting agents may be formulated with detergents to provide balanced products (detergent/disinfectants) which both clean and disinfect; these are available in powder or liquid form, have the advantages of convenience and reduced possibility of misuse, and may be preferred for applications where it is possible to achieve effective cleaning at moderate temperatures, e.g. below 70 °C.

At temperatures of 80 °C and above, detergent solutions alone kill most spoilage and pathogenic bacteria and the inclusion of a chemical disinfecting agent may thus be unnecessary at this stage.

The suitability of detergent/disinfectants is, therefore, largely confined to manual washing, to cleaning and disinfection of cold milk lines, storage tanks and tankers, and to circulation of recorder and pipeline milking installations on dairy farms where the maintenance of adequate disinfecting temperatures cannot be ensured.

A detergent/disinfectant solution may be prepared by the addition of approved sodium hypochlorite to a suitable detergent solution. Most proprietary dairy detergents intended for use on dairy farms for manual cleaning or as stated in the instructions for use are suitable. The hypochlorite is normally added at the rate of 0.25 % (V/V), providing approximately 250 mg/L of available chlorine.

NOTE. Attention is drawn to the potential hazards arising from the mixing of incompatible materials (see clause 11).

8.2 Factors influencing the formulation of detergent/disinfectants

8.2.1 General. Chemical disinfecting agents cannot be effective on surfaces from which soil has not been removed and the efficiency of a detergent/disinfectant is therefore partly dependent on its capacity to clean.

8.2.2 Detergent properties. Detergent/disinfectants should be suitable in respect of detergent properties to comply with the requirements of different methods of application and the various types of equipment and installations used in the dairying industry.

In formulating detergent/disinfectants, the detergency factors to be considered are similar to those applying to detergents as described in 5.1. In summary the factors are:

- (a) the nature of the soil to be removed;
- (b) the materials of construction of the equipment, plant or utensils;
- (c) the method of application;
- (d) the hardness characteristics of the water.

8.2.3 Compatibility of ingredients of detergent/disinfecting agents. The following important considerations apply specifically to detergent/disinfectants.

- (a) If they are to be approved (see 2.1 and 6.5), detergent/disinfectants are required to satisfy the appropriate tests, at the recommended concentrations.
- (b) Selection of detergent ingredients is limited because of the need for compatibility with the disinfecting agent. This is not always predictable; hence the need for approval tests (see 2.1 and 6.5).
- (c) The efficiency of disinfecting agents can be enhanced or depressed by formulation with detergents; the content of the same active agent in approved use concentrations may therefore vary from one formulation to another.
- (d) The risks of corrosion from chlorine-releasing chemicals can be reduced by the incorporation of suitable alkaline materials.
- (e) Care is needed to ensure that the combination of detergent and disinfecting agent does not increase the risk of corrosion of the plant or equipment or of skin irritation.
- (f) There should be an adequate reserve of disinfecting agent so that the bactericidal activity of the product is maintained during use under the conditions for which it is recommended.
- (g) Hygroscopic ingredients should be avoided as their presence may reduce the stability of powders containing organic chemicals which release chlorine.

8.2.4 User requirements. A detergent/disinfectant should comply with the following.

- (a) It should be safe to use under normal operating conditions and should be easily and safely dispensed.
- (b) If it is to be used for manual washing operations, it should be non-irritating to the skin, at the recommended dilution.
- (c) Its shelf-life and the conditions of storage should be clearly indicated.
- (d) If in powder or granular form, it should not cake or give off irritating dust.
- (e) If it is in liquid form, its constituents should not separate out or solidify, when stored at normal temperatures.

9 Selection of disinfecting agents and detergent/disinfectants

9.1 General

Steam at atmospheric pressure, water circulated at temperatures of 80 °C and above or chemicals are used for disinfecting equipment and utensils in the dairying industry. The choice of a suitable disinfecting agent is influenced by:

- (a) the type and the materials of construction of the equipment to be disinfected;
- (b) the method of application of the disinfecting agent (manual, spray, circulation);
- (c) the process or product for which the equipment is used;
- (d) the effectiveness, cost and convenience of the disinfecting agent.

Where the disinfection of any type of equipment requires a specific disinfecting agent or the choice is limited, this is indicated in sections five to thirteen as appropriate.

Reference should be made to table 3 for limitations imposed by materials of construction. Recommendations for the selection of proprietary chemical disinfecting agents and detergent/disinfectants are given in 9.2.

The following examples of equipment, plant or utensils for which certain disinfecting agents should or should not be used illustrate some of the principles of selection.

- (1) Ice bank refrigerated farm bulk tanks should not be treated with steam or hot water, because of the difficulty of raising the temperature of surfaces in contact with chilled water and the destruction of the ice bank. There

would be a risk of buckling or distorting the metal walls and damaging thermostats and thermometers if steam were used (see clause 18).

(2) UHT milk processing plant is required to be free of all micro-organisms including the most heat-resistant bacterial spores. To achieve the high temperature required for sterilization, pressurized water at a temperature of 140 °C to 150 °C is used (see 29.4).

(3) Silo tanks are not disinfected by steam because of the length of time which would be required for the tank surfaces to reach a sterilizing temperature. These tanks are equipped with spray or dish-type distributing devices: cleaning and disinfection are accomplished by spraying or distributing solutions of detergents and chemical disinfecting agents (see 33.3).

(4) Where smaller storage tanks or transport tankers are similarly equipped, chemical disinfection is also appropriate but where tanks are cleaned manually, steam disinfection (see 7.1.2) is preferred because of the difficulty of ensuring adequate coverage of surfaces when chemical disinfecting solutions are applied manually (see 33.3).

(5) Plant cleaned in-place is best disinfected in-place either by circulating water at a suitable temperature (see 7.1.3) or by circulating a chemical disinfecting solution. Steam disinfection would require the injection of steam at various points in the circuit and provision for drainage of condensate to ensure adequate penetration of steam. There is also a greater risk of damage to the equipment and injury to personnel from steam hoses.

(6) Portable milking equipment is rarely steam disinfected because of the high costs of fuel, steam-raising equipment and steam chests.

9.2 Selection of proprietary chemical disinfecting agents and detergent/disinfectants

9.2.1 General. Reputable manufacturers of disinfecting agents and detergent/disinfectants for the dairying industry are familiar with the cleaning and bacteriological problems involved. They supply not only effective products but also, where appropriate, equipment which will enable these products to be used at their maximum efficiency.

9.2.2 Range of products. Examples showing the range of products required by the dairying industry are as follows:

(a) detergent/disinfectants for manual and automatic cleaning of refrigerated farm bulk tanks;

(b) detergent/disinfectants for manual washing operations both on the farm and in the processing dairy;

(c) detergent/disinfectants and disinfecting agents for pipelines, storage tanks and tankers cleaned in-place.

9.2.3 Information on products. Because of the varied requirements and the wide range of disinfecting agents and detergent/disinfectants available, suppliers should provide the following information for their products.

(a) A clear statement indicating the operations for which the products are intended.

(b) Full and easily understood instructions for their use and any special handling instructions (see clause 11).

(c) When requested, a general guide to the nature of the products, the concentration of active agent in the recommended use solutions and the means of testing solutions for the content of active agent.

(d) Advice on storage of the products, particularly in the case of bulk-delivered liquid products.

(e) Technical service.

NOTE. Regulations under the Health and Safety at Work, etc. Act 1974 require information to be provided on safe storage and usage of the products.

When considering the purchase of a proprietary chemical disinfecting agent or detergent/disinfectant, the user should inform the supplier of the exact purpose for which it is required and provide any other information which the supplier may call for, e.g. the hardness of the water and the materials of construction, make and size of the equipment to be treated and the normal operating conditions.

9.2.4 Equipment for application of disinfecting agents and detergent/disinfectants. Examples of application equipment include:

(a) chlorinators and metering pumps for continuous dosage of water with disinfecting agents;

(b) automatic spray cleaning and disinfecting equipment for farm bulk milk tanks;

(c) spray devices, fittings and pumps for applying detergent/disinfectant solutions to storage tanks and tankers;

(d) dispensers controlled by conductivity cells for maintaining the strength of detergent solutions in bottle washing machines;

(e) fully automatic systems for cleaning in-place and disinfecting of processing plant, fillers, tanks, etc.

Section four. Management of cleaning and disinfecting products

10 General

Because high standards of physical and bacteriological cleanliness in the dairying industry are essential, and cleaning and disinfecting operations are an integral part of the production line, successful management implies both close attention to the training of operatives in the safe use of detergents, detergent/disinfectants and disinfecting agents, and continual supervision to ensure that there is no deterioration in standards of hygiene safety.

When solutions are being prepared, the quantities of water and detergents or chemical agents should be measured carefully. Thermometers of known accuracy should be used for checking the temperatures of solutions and, in particular, the temperatures at strategic points during heat disinfecting procedures. Carelessness can result in waste of detergents and chemical agents, ineffective cleaning and disinfection or damage to plant and personnel.

Solid detergents and detergent/disinfectants should be stored in covered containers in a dry cool place; liquids should be stored in the original containers which should be kept closed. Solutions of chlorine-releasing chemicals should be stored in a cool place protected from light; it is not advisable to carry large stocks in warm weather. Strict stock control of all products should be exercised to avoid deterioration and waste.

Where chemical methods of disinfection are used, it is essential to ensure that the solution of disinfecting agent is in contact with all internal surfaces for the required period of time.

In various clauses of this standard, reference is made to the manual reassembly of equipment after disinfection.

The risks of recontamination during such a procedure are self evident and every care should be taken to reduce such risks to a minimum. The use of pre-sterilized disposable plastics gloves or the wearing of disinfected rubber gloves during such operations is strongly recommended. Such disinfection can be effected and maintained by frequent dipping of the gloved hands into a solution of sodium hypochlorite maintained at 50 mg/L to 100 mg/L of available chlorine. Parts should be reassembled by taking them straight from the disinfecting vessel to their location in the equipment. They should never be placed on any possibly unhygienic surface prior to reassembly.

11 Hazards in transport and use of chemicals used in cleaning and disinfecting processes

Detergents, particularly those used in the more difficult operations such as cleaning after heat treatment, or in bottle washing, contain potentially hazardous materials, as do some types of chemical disinfecting agents.

Primary hazards arise during transport or use of the material, and concern the effect of spillage of the material on or near the person of the operator. Suppliers should provide adequate warning of such hazards, either incorporated in the general label on the container or as a separate warning label.

NOTE. Some detergents/disinfectants may contain flammable solvent in an amount which is sufficient to give a flash point. Attention is drawn to the following principal regulations affecting the transport, storage and use of highly flammable solvents or formulations.

Packaging and Labelling of Dangerous Substances Regulations 1978. Statutory Instrument 1978 No. 209, as amended by Statutory Instruments 1981 No. 792 and 1983 No. 17.

The Dangerous Substances (Conveyance by Road in Road Tankers and Tank Containers) Regulations 1981. Statutory Instrument 1981 No. 1059.

Notification of Accidents and Dangerous Occurrences Regulations 1980. Statutory Instrument 1980 No. 804, as amended by Statutory Instrument 1981 No. 1059.

The Petroleum (Consolidation) Act 1928.

The Petroleum (Mixtures) Order 1929.

The Petroleum (Inflammable Liquids) Order 1971. Statutory Instrument 1971 No. 1040.

The Highly Flammable Liquids and Liquefied Petroleum Gases Regulations 1972. Statutory Instrument 1972 No. 917.

The Petroleum (Consolidation) Act Northern Ireland 1929.

The Petroleum (Mixtures) Order Northern Ireland 1930 Statutory Rules and Orders No. 21.

The Petroleum (Inflammable Liquids) Order Northern Ireland 1973 Statutory Rules and Orders No. 468.

The Highly Flammable Liquids and Liquefied Petroleum Gases Regulations Northern Ireland 1975 Statutory Rules and Orders No. 256.

Secondary hazards can arise from admixture of incompatible materials or incorrect use of the chemicals. While warnings of such hazards may be included on the container label, it is wise to keep such warnings clear, simple and relating to the main hazard only. Suppliers therefore have the alternatives of providing warning of these secondary hazards on container labels, in technical literature or by other means. Examples of such warnings on labels are as follows.

- (a) '*Caustic liquid*. Do not dispense using aluminium or white-metal taps. Explosive gas produced.'
- (b) '*Acid-corrosive*. Do not mix with any chlorine-based material. Poisonous gas produced.'
- (c) '*Caustic powder*. Causes burns. In case of contact with skin wash immediately with running water.'

Attention is drawn to 'The Dairy Industry Code of Practice for the Safe Storage, Handling and Use of Chemical Substances', published by the National Dairywomen's Association*.

* Code in course of preparation. Available, when published, from National Dairywomen's Association, 19 Cornwall Road, London NW10 6P.

Section five. General introduction to cleansing operations

12 Types of soil

In the milk industry the soil that has to be removed from plant and utensils may be in one or more of the following forms:

- (a) liquid milk;
- (b) air-dried films of milk;
- (c) heat precipitated milk constituents (heat hardened protein or milkstone);
- (d) fat;
- (e) hard water deposits;
- (f) miscellaneous foreign matter.

Thus soil may range from easily removable liquid milk films to hardened deposits of coagulated protein and mineral matter which are difficult to remove.

13 Micro-organisms on surfaces and the effects of disinfecting agents

13.1 General

In the dairy industry, a wide variety of micro-organisms may be present on plant and equipment. If these are not properly cleaned after use, the micro-organisms may multiply in the residues and contaminate subsequent batches of milk or milk product.

Groups of micro-organisms of importance to the dairy industry are listed in 13.2 to 13.5.

13.2 Thermotolerant micro-organisms

Thermotolerant micro-organisms survive pasteurization and can contribute to the colony count of products made from pasteurized milk. Certain thermotolerant organisms are also psychrotrophic and may affect the shelf life of products.

13.3 Psychrotrophic micro-organisms

Psychrotrophic micro-organisms grow at refrigeration temperatures and are the most important factor in the keeping quality of refrigerated products. Most are non-thermotolerant Gram-negative rods introduced as post-pasteurization contaminants. However, thermotolerant psychrotrophs may originate from the raw material and affect the keeping quality.

13.4 Sporeformers

Bacterial spores are highly heat resistant and can withstand most time/temperature combinations used in the dairy industry. In exceptional circumstances some spores can even withstand UHT treatment.

Psychrotrophic members of this group can play an important role in product keeping quality (see 13.3).

13.5 Bacteriophage

Bacteriophage may show considerable heat resistance.

13.6 Effects of disinfecting agents

Disinfection procedures employing hot or boiling water, steam or approved chemical disinfecting agents are effective against most non-sporeforming bacteria. However, the more heat-resistant of the non-sporeforming bacteria sometimes present in milking equipment may survive the boiling water treatment recommended for this type of equipment (see section six).

Neither prolonged steaming at 100 °C nor special treatment with chemical disinfecting agents, such as prolonged soaking using non-corrosive types, can be relied on to be effective against bacterial spores; some types, however, may be reduced in number.

If contamination with bacterial spores becomes a problem, treatment to remove milkstone or dismantling and thorough cleaning may assist by physical removal of the spores.

14 Plant and equipment to be cleansed

The materials of construction of dairy plant include a variety of metals and non-metals, and detergents and disinfecting agents should be chosen to suit the material in question. The materials in common use and precautions which have to be taken when choosing detergents and disinfecting agents for each are listed in table 3. A summary of methods for disinfecting is given in table 4.

All surfaces in contact with milk or milk products should be smooth. Damaged and irregular surfaces are more difficult to cleanse since deposits adhere more tenaciously and bacteria are more easily harboured.

15 Examples of equipment requiring special treatment

Examples of equipment requiring special treatment are as follows.

(a) For UHT plant (see 29.4) where complete destruction of all micro-organisms is necessary, pressurized hot water at a temperature of 140 °C to 150 °C should be used for sterilizing.

(b) To ensure that equipment for starter preparation is completely free from harmful phages, steaming at a temperature of 100 °C is normally recommended, although sodium hypochlorite at a suitable concentration is also effective and may be used for disinfecting cheese vats (see clause 55).

(c) For some purposes it is essential that the equipment, e.g. that used for yogurt manufacture, should be free

from contamination with yeasts and moulds. Chemical disinfecting agents are generally effective but thorough cleaning is essential. Cleaning assists by physically removing some of the contaminants; furthermore, moist product residues support the growth of micro-organisms and the subsequent disinfection procedure may therefore be less effective.

(d) If build-up of a particular flora, e.g. coliform, psychrotrophic or thermophilic bacteria, should occur in equipment treated with a chemical disinfecting agent, merely changing to a different type is unlikely to be completely effective. Dismantling, inspection, thorough cleaning, removal of milkstone and replacement of defective components are frequently necessary preliminaries to successful disinfection with chemicals. Heat disinfection, if practicable, may be used periodically to prevent the build-up of a chemical-resistant bacterial flora.