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Cleaning and sanitizing agents for seafood processing plants

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Selecting proper cleaning and sanitizing agents is an important first step toward a good sanitation program for your processing plant. Your choice is complicated by the sheer number of products available and by myriad claims of superiority. To make a proper choice, you must be fully aware of your particular needs and the characteristics and capabilities of the cleaning and sanitizing agents available to you. This bulletin is intended to help you select cleaning and sanitizing agents for your needs by pointing out their strengths and weaknesses.

Brand names are purposely avoided in this bulletin, but for your information, Table 1 lists active ingredients of some common products.

As you read this publication, you will encounter terms printed in italics. Many of them are explained in the glossary. Other terms, avoided in the text for the sake of simplicity, are explained in the glossary also.

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Some Basic Considerations

Cleaning and sanitizing agents can do the job they are intended to do only if they are used properly. This means using the solution at proper strength, using it before it loses its strength from long storage, and preventing foreign material from interfering with the action and destroying the effectiveness of the product.

Remember the first rule of cleaning and sanitizing:

Always remove organic materials first, then apply sanitizers. The reason for this fundamental rule is that sanitizers rapidly lose strength when they come in contact with organic material.

Remember also that cleaning and sanitizing agents are preventive measures, not cure-alls. They are only a part of your broader plant sanitation program.

Detergent. Sanitizer. Cleaner. Disinfectant. Bactericide. Wetting agent. Germicide.

These and other terms common to the field of sanitation are used in many ways by many people. Their meanings vary with their use making it difficult to understand the topic of sanitation. To help you understand the uses of sanitation aids, this publication defines and uses terms in a manner we believe is generally acceptable. We recognize that some of these terms may be defined differently elsewhere.

Cleaning Agents

Soap is the first cleaning agent known to humans. It was made by combining lye (sodium hydroxide) with fat to form the sodium salt of fatty acids. Its cleaning power is derived from its ability to *emulsify* fats in water so that they may be lifted and rinsed away. *Emulsification* occurs because the long, organic soap molecules combine with fats and oils at one end and with water at the other, linking them together semi-permanently. The commercial use of soaps is now uncommon as synthetics have been designed that are more versatile and effective. The single remaining advantage of soaps is that they are made up of naturally occurring organic materials and are, therefore, biodegradable.

Modern cleaning agents are synthetic materials containing a number of chemicals added to achieve specific purposes. Commercial detergents are cleaning agents that contain synthetic wetting agents, *water conditioners, extenders* and *fillers*, and, sometimes, *chelating agents*. Other cleaning agents, frequently referred to as "*cleaners*," are highly acidic or *alkaline* and are used for specific cleaning purposes. They have varying degrees of detergent properties and can be used singly or in combination. As a rule, they are more harsh and corrosive than detergents and require special precautions in handling.

Detergents

Detergents contain varying components depending on their intended use. It is important to understand the characteristics of these components.

Wetting agents. In modern detergents, synthetic *wetting agents* serve the same function as soap: emulsifying fats and oils. These wetting agents may be classified as *cationic, anionic*, or *non-ionic*. The functional group (working part) of the wetting agent molecule determines which classification a particular wetting agent falls into. Detergents made with cationic wetting agents are strong *bactericides* but have poor wetting properties. They are used exclusively as *germicides* and *deodorizers* (see *quaternary ammonium compounds*, page 3). Detergents made with anionic wetting agents are most common and numerous. Their functional group is negatively charged with *sulfate* or *sulfonate*, which makes them compatible with alkaline cleaning agents.

Detergents made with non-ionic wetting agents do not rely on acid or alkaline conditions for effectiveness and work well in hard water. They have a tendency to foam and create problems in sewage treatment plants. Many commercial detergent formulations contain non-ionic wetting agents as foam boosters to give an impression of high strength.

Among the other components of detergents are water conditioners. They are added to prevent minerals that may be in the water from interfering with the action of the wetting agents. Chelating agents sometimes are added to remove certain other metal ions which may also interfere. Extenders and fillers sometimes are added to commercial cleaning agent formulations mainly to add bulk. Some of these materials, such as *phosphates, silicates*, and *carbonates* contribute to water conditioning and emulsification processes, which may increase the effectiveness of synthetic wetting agents.

The most commonly used fillers are the so-called condensed phosphates. These are inexpensive materials that increase the alkalinity of the cleaning agent. Unfortunately, these materials add nutrients to waste water and constitute a source of pollution. In some cases, more expensive non-phosphate additives are being substituted.

Most detergent formulations are designed to remove fatty substances. In many processing plants, however, deposits of protein build up and are not adequately removed by these detergents. For such cases, special cleaning agents have been formulated with protolytic *enzymes*. Theoretically, these enzymes are effective in dissolving the protein. In practice, however, presoaking is necessary to permit the enzyme sufficient time to act, thus limiting its value for general use in seafood processing plants.

Cleaners

Acid and alkaline cleaners are simple *organic* and *inorganic* chemicals that are mainly used for special cleaning needs. While they are usually harsh, corrosive, and difficult to handle, they flush readily from surfaces and frequently are used where possible contamination of food handling areas by the cleaning agent is undesirable.

Alkaline cleaners popularly used in food processing plants include *caustic soda* and *silicates*. Caustic soda *(sodium hydroxide)* is used in mechanical bottle washing operations. It has the properties of a strong detergent, but it is effective only at a high alkalinity, thus making it highly corrosive.

Among the silicates, *metasilicate*, when used in low concentrations, is said to be non-corrosive to tin and aluminum although it is irritating to human skin. *Orthosilicate* and *sesquisilicate* may be used for removing accumulations of fat although these cleaners are so corrosive to metal that they are only safe to use on concrete floors.

Alkaline cleaners form mineral and protein deposits (*stone*). When accumulated, these deposits will trap bacteria and make sanitizing difficult. Occasional flushing with acid cleaners will prevent stone formation.

Acid cleaners contain such mild acids as citric, tartaric, sulfanic, phosphoric, gluconic, and levulonic. In addition to their use in removing deposits, acid cleaners may be formulated with corrosion inhibitors and synthetic wetting agents and used in place of more common alkaline cleaners. They are commonly used for stainless steel care as they flush easily and leave a clean, degreased surface.

Sanitizers (Disinfectants)

The proper use of cleaning agents will ensure a physically clean surface—the first step. The next step in your plant sanitation program calls for proper use of sanitizers (disinfectants) to make the surface microbiologically clean. Sanitizers destroy living microbes.

The most common sanitizers used in food plants belong to one of three basic groups. They are chlorine or chlorine-releasing-compounds, *iodine* compounds, and quaternary ammonium compounds.

Chlorine sanitizers rely on the germicidal property of chlorine and may be divided into two types: inorganic chlorine and organic chlorine-releasing compounds. The most common inorganic compounds are gaseous chlorine, *sodium hypochlorite*, and *calcium hypochlorite*. When used with water, gaseous chlorine must be used in acid conditions to permit formation of *hypochlorous acid*, the bacteria-killing agent. This limits its use in the presence of organic materials. Gaseous chlorine lends itself well to in-line chlorination of water systems, although it is highly unstable and can be dangerous if handled improperly.

Sodium and calcium hypochlorites are easier to handle than gaseous chlorine. Sodium hypochlorite is unstable in powder form and is usually purchased as an aqueous mixture. Calcium hypochlorite is stable in powder form, easy to handle, and inexpensive, but will form precipitates and scale in the presence of some organic materials.

The major drawbacks of inorganic chlorine compounds are their extreme corrosiveness to metal and their harshness to human skin and mucous membranes (eyes, nose, etc.).

Organic chlorine-releasing compounds, as the name implies, are chemical complexes of chlorine and organic molecules. The chlorine in these compounds is "trapped" or "tamed" to be slowly released, resulting in less chemical activity and corrosiveness. The organic chlorine-releasing compounds are relatively more expensive, and they may leave residues from their organic molecules that are undesirable on food processing surfaces. Otherwise, they have most of the same characteristics of inorganic chlorine compounds.

Iodophors are the second of the three basic groups of sanitizers. In iodophors, iodine is complexed with a wetting agent. The wetting agent helps the iodine to contact the microbes directly by removing their protective surroundings. Iodophors, which are about twice as expensive as chlorine compounds, are about equal to chlorine in germicidal properties, are also effective against wide varieties of bacteria, but are somewhat more stable and less corrosive. The intensity of the amber color of an iodophor provides a quick visual approximation of its relative strength.

The third basic group of sanitizers, *quaternary ammonium* compounds, are actually cationic wetting agents, but they are more effective as bactericides. The major advantages of quaternaries (QACs) are their stability in room temperature solutions, effectiveness in neutral to alkaline solution, and effectiveness in the presence of organic matter. QACs are not corrosive to metals, do not irritate human skin, and they have deodorizing properties.

The major disadvantage of QAC is the residual film it leaves. This may be desirable for non-food processing areas, but the residue must be removed from food processing surfaces not only because of Food and Drug Administration regulations but also because of the bitter flavor it imparts to foods. Other limitations of QACs are their incompatibility with common soaps, anionic wetting agents, and phosphates, and their expense relative to other sanitizers.

QACs are effective against *Staphylococcus*, a bacterium which produces food poisoning and boils on human skin and is frequently found in foods that have undergone improper human handling. QACs, however, are totally ineffective against *Pseudomonas*, a group of bacteria associated with fish and active in seafood spoilage.

The best use of QACs is in personal skin care, restroom sanitation, and other non-food surfaces. They should be kept away from food processing areas.

Other Sanitizers

In addition to the three common basic groups of sanitizers, *phenolic compounds* and combination sanitizer-detergents have limited application in seafood processing plants.

Phenolic compounds are insoluble in water and impart strong undesirable odors. One phenolic compound, copper 8-hydroxquinoline (copper 8 quinolinate, copper 8), is commonly used as a mold inhibitor in some exterior paints and may have limited use on wood surfaces in plants and boats where contact with the product is not a consideration. This compound is not soluble in water and does not impart undesirable odors as do other phenols.

Sanitizer-detergent combinations are intended to provide a chemical mixture that performs the cleaning and sanitizing operations in a one-step process. Given the varieties of cleaning and sanitizing agents available, it is easy to understand the attractiveness of such ready-made products to seafood processors. A word of caution is in order, however. As is the case with most ready-made products, the combination is a compromise and will be the least flexible to meet your special needs. The result may be that it is neither a good cleaning agent nor a good sanitizer.

Glossary

Simplified definitions of frequently encountered technical terms are provided. Whenever possible, common terms were used in place of technical ones.

Acidity—Degree of acid strength or sourness. Acids are compounds which are sour, sharp, or biting to the taste, i.e., citric acid in citrus fruits and acetic acid in vinegar. Compounds that donate positive-charged ions.

Aerobes—Air-loving bacteria; organisms that grow and live in the presence of oxygen.

Alkalinity—Degree of alkaline strength or acrid taste. Alkali or bases are compounds that neutralize acids or accept positive-charged ions.

Anaerobes—Bacteria that grow and function in the absence of air or oxygen (vacuum packaged foods).

Anionic—Compounds that possess negatively-charged functional groups that attract positively-charged groups or material. See *Detergent* or *Ion*.

Bactericide (Germicide)—Agent or substances that kill bacteria. Germicide often refers to agents that kill microorganisms capable of producing disease or infection. The ending "cide" is added when a killing action is implied.

Bacteriostatic—Agents that do not kill but prevent the growth or multiplication of bacteria. The ending "static" is added when organisms are inhibited in growth or prevented from multiplying.

Bacteria (Microbes)—Singular is bacterium. Typically one-cell microorganisms that multiply by cell division and can only be seen with a microscope. There are three common forms: spherical (cocci), rod-shaped (bacilli), or spirillar (spirilli). Often, the agents responsible for the spoilage of food. Certain kinds may be useful (fermentation, nitrogen fixation) or pathogenic (cause diseases or produce harmful toxins). Some need air (oxygen), and some grow when oxygen is removed such as in vacuum packed foods. The former are called *aerobes*, and the latter, *anaerobes*. The term *microbe* usually includes other microscopic living forms, such as yeasts and molds.

Break-point—See *Chlorination.*

Cationic—Compounds that possess positively-charged functional groups, which attract or go toward negatively-charged groups or materials. See *Detergent* and *Ion.*

Chelation—The process of binding metallic ions (hardness factors) in solution. Ability of a cleaner to "tie up" minerals.

Chlorination—The addition of chlorine to water. Some of the terms used in chlorination are: *chlorine dosage*—Quantity of chlorine added to water.

Chlorine Residual—Amount of chlorine remaining in water after specific contact period.

Chlorine Demand—Chlorine dosage minus chlorine residual. This is the chlorine "used" by the water itself and must be known prior to general application.

Available Chlorine—The term used for pricing or comparing compounds. The value is determined by the quantity of chlorine equivalent to the released iodine in a specific chemical reaction. The term does not necessarily reflect the capacity to disinfect and should not be confused with chlorine residual.

Break-point and Break-point Chlorination (In-plant Chlorination)—Ammonia and organic matters in water take up or bind chlorine (chlorine demand), and the chlorine residual does not increase in proportion to the chlorine added, to a certain point. After this point, the residual increases in proportion to the chlorine added. This specific point of departure is called *break-point.* Since all in-plant chlorination systems require chlorine dosage beyond the break-point, the system is called *break-point chlorination* or simply *in-plant chlorination.*

Chloramines—Products of ammonia-like compounds reacting with chlorine. Chloramines are weaker bactericides but are more stable in water than the "active" chlorine. When the water has to travel a great distance from the point of chlorination, such as in a municipal chlorination plant, the chloramines in water compensate for the rapid loss of chlorine activity.

Compatibility—Capacity of one compound to maintain its effectiveness in the presence of another compound. If the effectiveness of one or both are boosted by the other agent, the relationship is called synergistic (1 + 1 = more than 2). If a germicide loses its effectiveness in the presence of a particular detergent or a cleaner, they are incompatible (1 + 1 = less than 2).

Detergent—Any chemical agent made from materials other than fats and lye (soaps) that helps the cleaning action of water. Popularly, detergent implies some chemical formulation which contains a *wetting agent*, chemicals that permit the water-insoluble fats to be "lifted" by water. The fats are insoluble in water because the molecules in fats are attracted to each other more strongly than to water molecules. Overcoming this attractive force is called *surface activation.* The subsequent dispersal of fat and other particulate matters in water is called *deflocculation.* When the fat particles are finely dispersed in water, it then is called *emulsification.* Synthetic wetting agents have two ends in the molecule. One end is attracted to water (*hydrophylic* end) and the other to fat (*hydrophobic* end). Thus the molecules form tiny "bridges" between water and fat.

Cationic detergents are more effective in acidic conditions and *anionic* detergents prefer alkaline conditions. *Non-ionic* detergents are not affected by the pH (acidity or alkalinity) of the solution or by the hardness of water.

Disinfect—A process of killing microbes. See *Bacteria.*

Emulsify—Suspension of very fine non-soluble particles in another liquid or system. In sanitation the holding of fats, oils, and greases in a stable state.

Enzyme—Organic catalysts. One of a class of substances formed in living cells that speed up specific chemical reactions. The proteolytic enzymes used in the detergent industry break down protein stains such as blood and meat particles.

Hydrophylic—Water attracted. See *Detergent.*

Hydrophobic—Water repelled. See *Detergent.*

Ion—Electrically charged atoms or groups of atoms. Some molecules in water become separated into positive or negative ions. Ions are attracted to materials of the opposite charge.

Inorganic Matter—Material of non-living origin, such as minerals.

Organic Matter—Material or products of biological origin.

Pathogen—Disease-causing microbe. See *Bacteria*.

pH—As a measure of acidity (sourness) and alkalinity (bitterness), pH 7 is neutral. Starting with pH 7, the acidity increases 10-fold with each decrease in pH value of one. pH 5, for example, is 10 times more acidic than pH 6. Alkalinity is expressed from pH 7 to 14 with each increase in number representing a 10-fold increase in alkalinity. pH 9 is, therefore, 10 times more alkaline than pH 8.

The alkalinity equal in strength to the acidity of pH 6 is pH 8. For acid of pH 1, the equivalent alkalinity is pH 13. Acid is neutralized by the equal strength of alkali and vice versa.

Phenol Coefficient—A measure of the relative effectiveness of a germicide by comparison with the lethal action of phenol. The test is a measure of effectiveness of the germicide against Salmonella typhosa (typhoid bacillus) and Staphylococcus aureus (bacteria causing skin boil and food poisoning) under specific conditions.

The phenol coefficient, therefore, does not show the effectiveness of the agent against other kinds of bacteria.

Rinsability—The ability of a cleaning solution to drain easily and smoothly from equipment, leaving a minimum residue.

Sanitizer—A chemical agent that renders food contact surfaces free of pathogenic growth and reduces the bacterial counts to safe levels as specified by public health codes. Sanitation implies cleanliness in addition to the above.

Specificity—A measure of the range of effectiveness of a given germicide to a variety of microbes. High specificity indicates that the effectiveness of the germicide is limited to few selected microbes. An example of the highly specific bactericide is the QAC. Non-specific germicides affect a wide variety of microbes. The non-specific germicides are the chlorine and iodine compounds.

Wetting Agent—Chemicals which lower the water's surface tension so that the solution will penetrate between the soil and surface to be cleaned. See *Detergent*.

Further Reading

Food Plant Sanitation, Parker, M. E., and J. H. Litchfield. 1962. Reinhold, New York.

Sanitation for the Food Preservation Industries, Association of Food Industry Sanitarians, Inc. 1952. McGraw-Hill, New York

Synthetic Detergents, Davidsohn, A., and B. M. Milwidsky. 7th ed, 1987. Burnt Mill, Harlow, Essex, England.

Table 1.—*Active ingredients of some common sanitizers*

Trade name	Active ingredient
Purex, Cloros, Master 8, Penn Swim, Oxyclor, Duko	Hypochorites (Sodium or calcium)
Krome, Multichlor	Organic chlorine releasing compounds
Tamed Iodine, T.I.C Microklene DF	Iodophors
LO-BAC-10, T-20X, SGC, Airkem	QAC

Brand names listed are obtained from a random sampling of Oregon seafood processing plants; this list does no constitute an endorsement of these products.

Know the Difference?

A good sanitation program involves the use of two classes of chemicals. You should know the difference.

Cleaning agents are designed to remove soils. They do not kill bacteria.

Sanitizing agents are made to kill bacteria. They do not remove soils. You should know the difference.

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