CLEANING COMPOUNDS FOR FOOD PROCESSING PLANTS

The use of properly formulated cleaning compounds is an important part of any food plant sanitation program. Cleaning compounds may contain one or more ingredients based on the type of soil to be removed, the surface to be cleaned, the hardness of the water, and the application method to be used. Cleaning compounds are formulated to achieve the following results:

1. Bring the cleaning solution into contact with the soil to be removed.

2. Displace the solid and liquid soils from the surface to be cleaned.

3. Disperse the soil in the solution.

4. Prevent the redeposition of the soil back onto the clean surface.

Cleaning compounds should also be formulated to soften the water; to dissolve or disperse quickly and completely; and to be nontoxic, noncorrosive, economical, stable upon storage, noncaking, and nonclustering. Because no single chemical can satisfy all these requirements, it is essential to have the proper blend of ingredients.

I. CHARACTERISTICS OF WATER

Water Hardness

Water is the primary constituent of all cleaning solutions. Pure water represents no problems, but no food processing facility, retail supermarket, restaurant, or hotel has an ideal water supply. Thus, the cleaning compound must be formulated to satisfy the requirements imposed by the plant's water supply.

Temporary hardness, which is due to the presence of soluble calcium and magnesium carbonates, causes most of the scale in food plants. This hardness is called temporary because these salts can be converted into insoluble compounds and precipitated by heat.

$$Ca(HCO_3)_2 + \text{Heat} \text{ ------> } CaCO_3 + CO_2 + H_2O$$

soluble — insoluble

Temporary hardness is also precipitated by the action of certain chemicals such as caustic soda:

$$Mg(HCO_3)_2 + 4\ NaOH \text{ ------> } Mg(OH)_2 + 2Na_2CO_3 + 2H_2O$$

soluble — insoluble

$$Ca(HCO_3)_2 + 2NaOH \text{ ------> } CaCO_3 + Na_2CO_3 + 2H_2O$$

soluble — insoluble

Permanent hardness is due to soluble calcium and magnesium salts that are not precipitated by heat. These are chiefly sulphates, nitrates, and chlorides; they can be precipitated by the action of certain alkalis and alkali salts such as sodium carbonate.

$$CaSO_4 + Na_2CO_3 \text{ ------> } CaCO_3 + Na_2SO_4$$

soluble soda ash insoluble soluble

Total hardness is the sum total of temporary and permanent hardness.

Water Impurities

Iron compounds, which are often precipitated by chlorinated detergents, can leave a reddish film or residue in lines or on equipment. Iron residues can be prevented by using other types of detergents, or can be removed with acid cleaners.

Sulfur can leave a black stain or residue on equipment, most noticeably on enamel or painted surfaces. This residue is formed when hydrogen sulfide reacts with other chemicals in the water to form insoluble deposits such as lead sulfide. The addition of chlorine will oxidize the hydrogen sulfide into a nonfilming form of sulfur such as sulfate.

Water Temperature

Water temperature is an important consideration. At 177°F, maximum precipitation of hard water salts occurs. Lower temperatures reduce scale formation, increase gasket life, and are safer for operators.

II. CLEANING COMPOUND TERMINOLOGY

Terms used to identify the functions of cleaning compound ingredients include:

Anionic.	Possessing a negative electric charge.
Cationic.	Possessing a positive electric charge.
Nonionic.	Possessing a net neutral electric charge.
Dispersion.	The breaking up of soil particles into smaller particles.
Dissolution.	The conversion of solids into water-soluble compounds.
Emulsification.	The suspension of tiny oil globules.
Peptization.	The dispersion of protein.
Rinsability.	The ability to be easily removed from surfaces.
Saponification.	The conversion of fats into water-soluble compounds.
Sequestration.	The process of holding minerals in suspension.
Wetting.	The lowering of the surface tension of water to permit penetration of cleaning compounds into soil.

III. CLEANING COMPOUND INGREDIENTS

Cleaning compounds are composed of a variety of chemical components, each serving a specific purpose.

Abrasives

Abrasive ingredients are added to cleaners when scouring is required. However, they should be used with caution, since harder or coarser types will scratch metals. Common abrasives include volcanic ash, biotite, pumice, and silica flour. Gentler abrasives, used in so-called "non-scratching" cleaners, include calcium carbonate and some of the softer feldspars and calcites.

Acids

Acids are used in cleaners to dissolve mineral deposits, as well as for their sequestering ability and rinsability. Acid cleaners are generally used at a pH of 2.5 or lower. Strong acids include hydrochloric, sulfuric, nitric, and phosphoric. Milder acids include hydroxyacetic, lactic, gluconic, citric, tartaric, levulinic, and saccharic.

Alkalis

Alkalis are the primary detergent ingredients of most cleaners. They emulsify oils, saponify fats, and peptize proteins to form soluble compounds which are easily removed by water. Since their properties differ, two or more are generally used in combination.

Caustic Soda (NaOH) is high in germicidal action and dissolves proteins readily, but it lacks deflocculating and emulsifying power. It is the most corrosive alkali on metals and it is difficult to rinse off equipment. Caustic soda can cause severe burns and should not be used for manual cleaning operations.

Soda Ash (sodium carbonate) is a common constituent of cleaners and is also the least expensive form of alkali. It is a poor water softener and has only fair deflocculating and emulsifying properties. It has the advantage of being a good buffer. When used in hard water, it causes precipitation of calcium carbonate deposits on equipment.

Trisodium Phosphate is a readily soluble ingredient with high deflocculating and emulsifying powers. It is a fair water softener. In comparison with metasilicate or soda ash, it is relatively corrosive on tin unless metasilicate is present as a protective agent.

Sodium Metasilicate has a high alkalinity and excellent deflocculating and emulsifying properties. Although it is the strongest alkali next to caustic soda, it is relatively non-corrosive and has the property of protecting metals against corrosion by other alkalis. It is also effective for suspending soil during the washing operation.

Amphoteric Compounds

Amphoteric compounds possess both positive and negative electrical charges, and function to loosen and soften protein and cellulose materials.

Examples include compounds with an amine salt or quaternary ammonium compound as the cation, and a carboxyl group, a sulfate ester, or sulfonic acid as the anion.

Antifoaming Agents

Certain nonionic wetting agents suppress foam formation, and are used in special applications such as bottle washing.

Chlorine

Chlorine reacts strongly with proteins and increases the effectiveness of alkaline cleaners; it also helps minimize mineral deposit formation. Examples include chlorinated trisodium phosphate, dichlorohydantoin, and di- and trichlorocyanuric acid.

Chlorinated alkalis do not function as bactericidal agents because of their high pH, which also minimizes the corrosive activity of the chlorine.

Complex Phosphates

The complex phosphates are excellent cleaning components with good water softening ability. They emulsify, disperse, and peptize soil, and prevent soil redeposition. The pyrophosphates are the least effective in this respect.

Pyrophosphates are the most widely used and lowest in price. The pyrophosphates lack calcium-sequestering power when compared to other phosphates, but are more stable under high temperatures and high alkalinity. Pyrophosphates dissolve slower than other common alkalis.

Tripolyphosphate and Tetraphosphate are superior to pyrophosphate in their ability to sequester calcium hardness. Both products are readily soluble in warm water, but are unstable in hot solutions.

Hexametaphosphate, also known as Calgon, is the most effective sequestering agent with respect to calcium hardness. It is also the highest priced. In comparison with other phosphates, it lacks sequestering power on calcium in the presence of magnesium hardness. It is also unstable under high temperatures and high alkalinity.

Corrosion Inhibitors

Corrosion inhibitors are added to strong acid and strong alkali cleaners to minimize corrosion of metal surfaces. Examples include sodium sulfite and sodium metasilicate in alkaline cleaners; methyl-, ethyl-, propyl-, and butylamines; arylthioureas; and heterocyclic nitrogen compounds in acid cleaners.

Enzymes

Enzymes assist in softening, breaking up, and suspending protein soils.

Foaming Agents

Foaming agents generate foam, which increases the time a cleaning solution is in contact with soils.

Sanitizers

Detergent sanitizers have both cleaning and sanitizing activity. They are usually expensive, and not all formulations are fully effective. Examples of detergent sanitizers include alkaline cleaners with quaternary ammonium compounds and nonionic wetting agents, and acid cleaners with iodophors, substituted amino acids, or betaine derivatives.

Sequestering Agents

Sequestering agents form soluble complexes with calcium, iron, manganese, magnesium, and other minerals. Examples include ethylenediaminetetraacetic acid (EDTA), tetrasodium pyrophosphate (TSPP), sodium tripolyphosphate (STPP), sodium acidpyrophosphate (SAPP), and sodium gluconate.

Suspending Agents

Suspending agents assist in keeping undissolved soil in suspension. Examples include starch and carboxymethyl cellulose.

Wetting Agents

Wetting agents or surfactants emulsify and disperse fats, oils and pigments. They combine water-soluble and oil-soluble properties in a single molecule. The water-soluble portion can attach itself to a water molecule and the oil-soluble portion to lipid molecules; this provides a link between otherwise immiscible phases. Soluble in cold water, they are used in relatively low concentrations. At a concentration of 0.15%, for example, wetting agents reduce the surface tension of water to half its original value.

Anionic Wetting Agents can be used with acid or alkaline cleaners, and many are "high foamers" responsible for suds formation. Examples include sulfated alcohols or hydrocarbons, alkylarylpolyether sulfates, sulfonated amides, and alkylarylsulfonates.

Nonionic Wetting Agents have better emulsifying and dispersing abilities than anionic wetting agents, and vary considerably in foaming ability. They may be used with either acid or alkaline cleaners. Examples include ethoxylated alcohol, polyethenoxyethers, ethylene oxide - fatty acid condensates, and amine-fatty acid condensates.

Cationic Wetting Agents function poorly as emulsifiers, but have good antibacterial activity. Examples are the quaternary ammonium compounds.

IV. SELECTING A CLEANING COMPOUND

The selection of a cleaning compound should be based on the composition of the equipment to be cleaned and on the type of soils involved. Only USDA-approved cleaners may be used in food processing plants. Approved cleaners are

listed in "List of proprietary substances and nonfood compounds authorized for use under USDA inspection and grading programs" (USDA, 1985). Should questions on the best cleaning compound to use, request technical advice from a reputable cleaning compound manufacturer.

Characteristics of Cleaning Compounds

Strongly alkaline cleaners are highly corrosive to metal and painted surfaces, irritating to the skin, and difficult to rinse from equipment surfaces. They are used in mechanical bottle washing operations, clean-in-place applications, and in heavy-duty nonmanual cleaning operations.

Moderately alkaline cleaners are less effective for removing fat and protein soils than strongly alkaline cleaners, but they are safer to use and less corrosive to equipment. They are used in pressure cleaning equipment, tank immersion cleaning, interior tank washing, and general manual food plant cleaning operations.

Neutral cleaners are noncorrosive, and contain nonionic wetting agents and/or amphoteric compounds. Neutral cleaners are effective for removing oils and fats, but alkaline cleaners are more effective for removing both fat and protein soils.

Mildly acid cleaners are somewhat corrosive to most metals, and are irritating to the skin. They are used to dissolve mineral deposits and to clean stainless steel. They flush easily and leave a clean, film-free surface.

Strongly acid cleaners are corrosive to most metals, particularly galvanized metal and stainless steel. They are used to remove heavy mineral deposits.

Types of Soil to be Removed

The types of soils found in food processing plants vary with the types of food being processed. Select a cleaning compound that is effective in removing the types of soils found in the food processing plant.

Type of Soil	Recommended Cleaner
Heavy fat and oil deposits	Strongly alkaline cleaners
Burned or dried-on deposits	Strongly alkaline cleaners
Most food waste deposits	Moderately alkaline cleaners
Protein waste deposits	Chlorinated mildly alkaline cleaners
Mineral/hardwater deposits	Mildly acid cleaners
Heavy mineral deposits	Strongly acid cleaners

Types of Surfaces to be Cleaned

Food processing plant surfaces vary in their resistance to corrosion or damage from cleaning compounds. Select a cleaning compound that will not cause surface damage or corrosion.

Type of Surface	Recommended Cleaner
Stainless steel	Resistant to corrosion from most cleaners, except hydrochloric acid.
Tin, aluminum, copper, galvanized metal	Use moderately alkaline cleaners with corrosion inhibitors. Avoid strong acids and alkalis.
Wood and fabric	These surfaces are softened by alkaline cleaners. Use polyphosphate and a wetting agent.
Rubber	Use alkalis; and avoid strong acids and organic solvents.
Glass, oil-based paint	Moderately alkaline cleaners are best. Strong acids and alkalis will etch these surfaces.
Concrete floors	Use alkaline cleaner with corrosion inhibitor. Acids will etch concrete surfaces.

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Prepared by: Robert J. Price (A/EA-1)
Seafood Technology Specialist
Food Science & Technology Extension
University of California, Davis

Pub. # UCSGEP86-11

June, 1986