THE ROLE OF ACIDS IN DAIRY AND FOOD EQUIPMENT SANITATION[1]

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The attainment of soil-free milk and food production, transport, storage, processing and service equipment devoid of bacterial population is an undertaking which has been so simplified and standardized in technique that individuals of average I.Q. may be expected to perform it effectively. Nevertheless, it involves a rather complex, inter-related series of physical, chemical, and biological actions and reactions. The pH levels of wash and sanitizing solutions and of post-wash rinse waters determine the rates and magnitudes of the chemical reactions involved, encourage certain advantageous physical phenomena sought, and favor or inhibit bacterial biological activities. In the language of dairy farm, milk plant, and food establishment personnel, the acidity or alkalinity of wash solutions, of post-wash rinse waters, of sanitizing solutions, and of washed and sanitized equipment surfaces determine the effectiveness of soil removal and bacterial control.

The function of the alkalinity—or causticity—of a wash solution in the disintegration and emulsion of soils (fats), so as to facilitate their removal from equipment surfaces, is elementary to most sanitarians. In this discussion it shall be my objective to emphasize the various roles played by acids, as compared with alkalies, in both detergents and sanitizers. I shall attempt to enumerate the uses of acids in equipment sanitation in the chronological order in which the uses were developed.

Use of Acids in Scale Removal

The initial use of acid in sanitation was to remove scale from mechanical washers. The formation of scale in bottle washers, can-washers and dish-washers interferes with efficient operation by increasing the load on motors, reducing heat transfer to wash solution and rinse water, reducing the diameter of spray-nozzle orifices, and increasing carry-out of wash solution. Furthermore loosened flakes become lodged in and on washed articles. Hydrochloric acid, in one form or another, is the base of most scale removers.

A brief review of the causes of scale formation is in order because one of the causes accounts for the use of acids in several phases of equipment washing. The effect of heat in precipitating carbonates of calcium and magnesium (temporary hardness) from waters used to prepare wash solutions is now well understood by sanitarians. Since mechanical washers cannot effectively be operated without hot wash solution and rinse water, it must be recognized that one condition responsible for the formation of scale is continuously operative.

Another cause of the precipitation of dissolved minerals from waters—one of which sanitarians are not so generally conscious—is the change in pH in wash solution make-up waters effected by the addition of the chemicals required to produce alkaline wash solutions. Consequently, particularly in bottle-washing solutions, and to a lesser extent in can-washer and dish-washer solutions, both of the primary causes of the precipitation of minerals from water operate and scale is formed— unless the detergent compound includes in its composition sufficient water conditioning chemical to prevent the precipitation of water minerals.

Milk sanitarians whose experience extends back to the 1940's will recall that the Lathrop-Paulson can-washing technique dispensed with alkaline wash solution and employed a combination of levulinic acid and wetting agent. The objective was the progressive removing of the build-up of water minerals and milk solids in milk cans and preventing the formation of new coatings. Another objective advanced but not too widely conceded was the creation in washed cans of an acid environment unfavorable to the biological activity of the types of bacteria common to milk cans. This latter objective will be referred to later.

Manufacturers of conventional can-washers were in no position to meet the competition from the general acceptance of acid washing without major remodeling of washers necessary for complete conversion. But the manufacturers of can-washing detergents met the issue by developing acid-wetting agent detergents and by advocating the adoption of the "Alternate" or "5-2" method, in which an alkaline wash solution was employed for five consecutive days followed by acid washing for the remaining two consecutive days of the week. Thus, in using conventional washers, all milk cans could be subjected

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to milkstone removal treatment at weekly intervals without seriously disrupting can-washing schedules.

USE OF ACIDS IN WASHING PROCEDURES

My first knowledge or experience with milkstone remover was in the early 1930's. The compound, as I recall was an acidic powder applied to surfaces in the form of a paste, allowed to remain for some minutes, and then rinsed off. Its application combined the chemical effect of the acid and the abrasive effect of the pumice, of which I assume some of the powder consisted. The removal of "milkstone" or food film from equipment surfaces is "old shoe" to most sanitarians and no time will now be devoted to a discussion of it. Permit me to emphasize, however, that this application of acid is identical in principle to the removal of scale from mechanical washers—and from blanchers in canneries, except that acids less active than hydrochloric are employed. Less mineral matter is to be removed in most instances and the avoidance of corrosion of non-stainless metals and the comfort of users of the less active acids is taken into consideration.

Those responsible for the maintenance of equipment in which edibles are produced, transported, stored, processed, or served are in agreement that the formation of mineral film or deposit, or even water spots, is to be avoided if possible. A number of chemical compounds capable of sequestering or of chelating water minerals, so that precipitation of water minerals does not occur, are available. And there are numbers of detergent compounds available which include sufficient proportions of such components in their compositions to handle the composition of most waters.

Why are mineral film and deposits so prevalent? That question does not imply that I think detergent users do not buy products suited to the situation. I am certain that detergent compounds available are capable of minimizing the films and coatings so evident to trained observers. And I am also certain that ample supplies of "milkstone remover" are available.

MINERAL DEPOSITS FROM RINSE WATERS

The conclusion must be that mineral film is being deposited on equipment more rapidly than it is being removed even by conscientious clean-up personnel. And the cause of this situation should have been obvious to all of us sanitarians, manufacturers of detergent supplies, and equipment users and operators who have ignored this cause so long. The precipitation of dissolved minerals from the waters with which *wash* solutions are prepared has long been recognized and detergent compounds have been fortified with water conditioners to meet that situation. But we have continued to use the same mineral-loaded waters to *rinse* the residual alkaline wash solution from equipment without first treating it!

A brief analysis of what takes place makes it rather apparent that untreated post-wash rinse waters are heavier contributors to mineral deposits on equipment than are treated wash solutions prepared with waters from the same sources. Wash solution is generally rinsed from equipment before the deposition of precipitated minerals occurs and the minerals are flushed out with the wash solution. On the contrary, post-wash rinse waters adhering to equipment usually are allowed to evaporate and leave behind their entire load of mineral salts. Equipment operators are urged to facilitate the drying of surfaces wherever practical to encourage the development of corrosion-inhibiting oxide film. Also the existence of a film of moisture under a coating of mineral tends to result in the formation of a Galvanic cell with a small area of stainless steel surface, the end result of which is pitting, that is, corrosion.

EFFECTIVE STABILIZATION OF RINSE WATERS

A program of treatment of post-wash rinse waters so as to reduce to a minimum the deposition of mineral salts is obviously necessary. What should this treatment consist of? Acids again take an up-stage position. By adding acid to post-wash rinse water the alkalinity of wash solution clinging to equipment surfaces can be neutralized and precipitation of stabilized mineral salts in the rinse water does not occur. The creation of a pH level of 5.5 or less in post-wash rinse water effects such neutralization of residual alkaline wash solution, and also results in the solution of any water-insoluble chemical solids suspended in it, thus facilitating their complete removal from equipment by the rinsing operation.

ACIDIFIED SURFACES INHIBIT BACTERIA GROWTH

Acids introduced into post-wash rinse waters have a third function, in addition to those of neutralizing the alkalinity of residual wash solution. The acids become components of the post-wash rinse waters and while such rinse water as adheres to equipment remains in the fluid state, and even after it evaporates, these surfaces are slightly acidified. Neutralization of the alkalinity of unremoved wash solution is more nearly complete. Any degree of reduction in the alkalinity of an environment also decreases the influence of a factor favorable to the biological activity of bacteria.

There may be some question as to the manner in which post-wash rinse water may be acidified. In the first place, only food-grade acids are usable. The addition of an ounce of stock acid for each 5 gallons of water drawn into the rinse compartment of a wash vat, or in the rinse water tank of a wash solution circulation system, requires no mechanical wizardry. However, the introduction of precisely the desired proportion of acid into a flowing stream, spray, or fog, applied from a hose nozzle, does necessitate the availability of a mechanical device.

The several applications of the acidification of post-wash rinse waters which have been discussed may be regarded as "straws-in-the-wind" which indicate a definite trend. We are in an era which will be characterized by and noted for the efforts devoted to the prevention of water-spotting, filming, and coating of equipment surfaces by water minerals by treating post-wash rinse waters. The removal of a coating of water minerals impregnated with milk proteins from a fleet of farm pick-up or transport tanks, a battery of storage tanks, or a ring 30 feet above the floor of a silo-type storage tank, or from any milk or food processing equipment is not a manual task to be undertaken blithely. Prevention of the development of conditions necessitating a removal operation—which often assumes an emergency status—is a far more practical managerial and operational policy.

USE OF ACIDS IN SANITIZERS

I have enumerated the applications of acids to milk and food equipment washing operations. The remainder of this discussion will be devoted to their applications to sanitization.

We are aware that the germicidal effectiveness of hypochlorite sanitizing solutions at any specific concentration of available chlorine can markedly be increased by adding a small proportion of hydrochloric acid to the solution, that is, by lowering the pH of the solution. This is a potentiality which has not developed into a popular and prevalent practice, however, because the inherent corrosiveness of solutions consisting primarily of hypochlorites is thereby also sharply increased.

The element iodine, like chlorine, is also one of the halogens but is somewhat less active than chlorine. Iodine sanitizers are compounded in a manner differing widely from that in which hypochlorite sanitizers are made. Iodine is combined with a nonionic compound, generally a wetting agent, and this combination is acidified with these three objectives:

1. To increase the germicidal effectiveness of the available iodine. These sanitizers are as germicidally effective at 12 1/2 ppm. of available iodine as are hypochlorite solutions, unacidified, at 50 ppm. of available chlorine).

2. To provide for the removal of already-formed mineral film or coating, and

3. To create an acid environment on treated surfaces, disadvantageous to the biological activity of any surviving or subsequently-deposited bacteria.

Why is it practical or feasible to incorporate acid into iodine sanitizers or detergent sanitizers, whereas it is somewhat hazardous to equipment and to personnel to acidify hypochlorite sanitizers? Mild acids are employed in the composition of iodine sanitizers and the acids formed with iodine are not nearly as corrosive as the hydrochloric and hypochlorous acids formed in hypochlorite solutions.

Many surfactant (wetting agent) compounds possess germicidal properties. The germicidal properties of quaternary ammonium compound sanitizers are derived from cationic surfactant complexes. Some anionic surfactants are also germicidal as well as acid. But in these cases again, the pH level of the sanitizing solution determines the degree of germicidal effectiveness. The pH level essential for practical germicidal effectiveness of sanitizing solutions of anionic surfactants is relatively low—3.9. Such a low pH level of sanitizing solutions is attained by incorporating into the compound another acid (usually one of the phosphoric acids). The surfactant property of sanitizing solutions may also be enhanced by including in the compound another surfactant.

In this manner a type of sanitizer compound has been developed which is adequately germicidal to comply with Chambers Test criteria of a 99.999+ percent kill of specified micro-organisms, acid enough to dissolve films and coating of water minerals, and with sufficient surface tension reducing capacity to penetrate deposits of milk and food solids, and to have some detergent properties. The acidic nature of sanitizing solutions of this type leaves treated surfaces with an environment unfavorable to bacterial biology as previously mentioned. These sanitizers, at double the normal use solution concentration, are effective against bacteriophages. The compounds are liquid, which is advantageous in some applications.

Acid-type sanitizers are competitive with other types except for the fact that use dilutions are relatively heavy—1 oz. per gallon of water—making their routine use somewhat more costly. There are numerous situations, however, in which certain advantages accruing from their use far outweigh the cost factor.

A NEW ERA

Milk and food sanitation consists of an agglomeration of practices and procedures which experience has proven to be effective. New techniques are constantly being added to the arsenal, resulting in the eventual abandonment of traditional, or even conventional, procedures.

The increased use of acids in equipment sanitation in acidifying post-wash rinse waters and in activating germicidal agents in sanitizing solutions are examples of new techniques in sanitation which bid fair to mark the beginning of an era.

PUBLICATIONS OF INTEREST

Editorial Note: Listed below are books, pamphlets and reprints on a variety of subjects considered to be of interest. Requests for material should be addressed to the source indicated. Note cost of books and certain items.

Chemicals Used in Food Processing. 1966. Pub. No. 1274. Nat. Acad. of Sciences—Nat. Res. Council. Wash., D. C. $6.50.

Milkers Manual. Bull. No. A-37. College of Agric., Univ. of Arizona, Tuscon.

Questions and Answers about Leucocytes in Milk. NW Ext. Pub. No. 70. College of Agric., Oregon State Univ., Corvallis.

Mastitis Questions and Answers leaflet. College of Agric., Univ. of Wisconsin, Madison.

Mastitis is a Costly Disease. Bull. No. EC60-635. College of Agric., Univ. of Nebraska, Lincoln.

Mastitis Control in the Milking Herd. Ext. Bull. No. 344. College of Agric., Michigan State Univ., East Lansing.

Milking Management and its Relation to Milk Quality. Pub. No. AXT-94. College of Agric., Univ. of California, Davis.

Has the United States Enough Water? Estimates and projections to year 2000 of water supplies and demands for the 19 major drainage basins. Supt. of Doc., Govt. Printing office, Wash., D. C. 20402.

Guide to the Analysis of Pesticide Residues. Two volume compilation of methods for recommended analysis of pesticide residues. Prepared for Public Health Service, 1966. Supt. of Doc., Govt. Printing Office, Wash., D. C. 20402. $12.75.

Air Conservation. A report of the AAAS Air Conservation Comm., 1965. AAAS Publications, 1515 Mass. Ave. N.W., Wash., D. C. 20005. $8.00.

Food Quality: Effects of Production Practices and Processing. Editors, George W. Irving, Jr. and Sam R. Hoover, 1965. AAAS Publications, 1515 Mass Ave. N.W., Wash., D. C. 20005. $8.50.

What You Should Know About Oysters, Clams and Mussels. PHS Pub. No. 1393. Public Inquiries Branch, PHS U. S. Dept. of HEW, Wash., D. C. 20201.

Environmental Sanitation Handbook. For training supervisors and hospital cleaning personnel. Published by University Hospital, Office of Environmental Health, Univ. of Michigan Medical Center, Ann Arbor 48104. $20.00.

Publications of U. S. Dept. of Commerce for Scientific and Technical Information. (Order by stock number from Clearing House, U. S. Dept. of Commerce, Springfield, Va. 22151):

- Stock No. AD-633 390. A Study of the Microbiology of Selected Dehydrated Food Products. $3.00.
- Stock No. TID-22515. Application of Radiation—Pasteurization Processes to Pacific Crab and Flounder. $4.00.
- Stock No. NYO-3426-1. Study of Economics of Controlling Salmonellae in Foods by the Use of Ionizing Radiation. $3.00.
- Stock No. UCD-34P80-3. Radiation Technology in Conjunction With Postharvest Procedures as a Means of Extending Shelf Life of Fruits and Vegetables. $5.00.
- Stock No. PB-169 371. Symposium on Streamflow Regulation for Quality Control. Twenty one papers. $7.30.
- Stock No. CONF-651024. Radiation-Pasteurization of Foods, Summaries of Accomplishment. $6.00.

Selected U. S. Government Publications. (Order by Catalogue No. from Supt. of Documents, U. S. Govt. Printing Offices, Wash., D. C. 20402).

- Cat. No. FS 2.95; 947-65. Hill-Burton Program Progress Report. July 1, 1947-June 30, 1965. 40c.
- Cat. No. FS 1.20/a:Ai 71/3. The Clean Air Amendments and Solid Waste Disposal Act of 1965. 15c.
- Cat. No. Y 4. At 7/2:F73/4. Radiation Processing of Foods. Hearings held before subcommittee of joint congressional Committees on Atomic Energy. 1965. $2.50.
- Cat. No. C 41.2:C76/965. Sources of Information on Containers and Packaging. 20c.
- Cat. No. FS 1.20/s:W291/2. Water Quality Act of 1965. Contains history of the Act and gives information on grants and water quality standards. 15c.
- Cat. No. FS 16.2:W29. The New Federal Water Pollution Control Program. Describes the six major activities. 5c.
- Cat. No. I 49.4:226. The Effects of Pesticides on Fish and Wildlife. 45c.
- Cat. No. FS 2.2:L46/4. Symposium on Environmental Lead Contamination. Papers presented 1965. $1.25.
- Cat. No. PrEx 8.2:W 29. A Ten-Year Program of Federal Water Resources Research. Prepared by Comm. on Water Resources Research of Federal Council for Science and Technology. 40c.
- Cat. No. Fs 2.74/3: D9/2. Design Features Affecting Asepsis in the Hospital. Rev. 1966. 15c.
- Cat. No. FS 2.302:A-1/2. Emergency Health Preparedness Publications Catalog, 1966 Edition. Lists currently available publications specifically related to Division of Health Mobilization program areas. 20c.
- Cat. No. FS 2.2:Ai 7/30/966. Air Pollution Films. Listing of films available for free showing on national air pollution problems. 5c.
- Cat. No. HH 1.2:P 94/8/966. Programs of the Department of Housing and Urban Development. 20c.
- Cat. No. HH 2.2:E1 2/996. Some Facts about FHA Housing for the Elderly, Projects and People. Information on characteristics of the new FHA-insured housing projects for the elderly. 15c.