SANITARY DESIGN OF FOOD PROCESSING EQUIPMENT

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To design and construct food processing equipment that can be cleaned with a minimum of effort, and which, during its operation, will not contribute microbial, chemical, or extraneous contamination to the products, is a goal worthy of the best efforts. Such a goal is easy to define, but much more difficult to attain, particularly with today's production pressures.

CONCERN OF MANAGEMENT

Sanitation is of vital concern to company and plant managers in food processing. It is a necessary and integral part of food processing and can add materially to a firm's success or failure.

It has far more significance today than ever before, because the public is becoming increasingly sensitive about food. Consumer confidence in, and acceptance of, processed packaged foods is of utmost concern. The sanitary design of food-handling equipment is an important factor in preventing consumer dissatisfaction.

To design and construct equipment for the best advantage of the food processor becomes doubly important when it is realized that present day production and profit trends leave little room for mistakes. Today, there is even less room for the old fashioned trial and error methods. The pressure is on management and technical personnel at all levels. High maintenance costs, including cleanup for all useful years, because of poor equipment design assumes greater relative importance. The economic factors involved place a great responsibility on those who would recommend the best design and construction for a unit of equipment.

INDUSTRY TECHNOLOGY NEEDED

Technical knowledge and experience in the specific food processes and attendant sciences and the availability of research assistance are prerequisite to any attempt to specify for industry what shall constitute sanitary design and construction.

The canning industry alone packs approximately 1200 separate food items and combinations in 49 of the 50 states. The preparation and packing procedures for even the same products may vary from one plant to the next, and from one area to another. Because of the fiercely competitive nature of the industry, newer and more efficient methods are developed rapidly. Every industry needs room for innovations, for creativity, for the exercise of its ingenuity. Who can deny that competition and innovation are not to the advantage of the consumer? Let us be cautious that in the interest of simplicity of inspection and regulation we do not "standardize" initiative out of existence.

THE CANNING INDUSTRY EQUIPMENT COMMITTEE

The canning industry's approach to sanitary design and construction of equipment has been through the National Canners Association by the formation of a Special NCA Committee on Sanitation of Canning Equipment, which is composed of staff members, representatives of canning companies, and liaison members representing the Canning Machinery and Supplies Association.

One of the purposes of the Committee is to prepare and publish "recommendations" concerning sanitary design and construction of canning equipment with special consideration given to the efficiency and effectiveness of cleaning the equipment. The Committee does not attempt to establish iron-clad requirements which would be detrimental to the future progress of the industry. Also, because of the diversity of procedures and equipment and the desire to avoid unwarranted standardization, basic recommendations or suggestions are written in broad terms.

With such information accumulated and evaluated by the canners' own technologists and engineers, management has the means of exercising direct control over equipment constructed in the plant, and can also exert profound influence on the design of equipment available for purchase by specification of sanitary features.

The following list includes items generally applicable to most canning equipment. This was taken, with slight editing, from canning equipment construction and design recommendations approved by the National Canners Association Special Committee on Sanitation of Canning Equipment. The list will be expanded and modified as new recommendations are approved.

1. Canning equipment should be designed for easy cleaning, safety, and easy repair of mechanical failures.
2. All surfaces and areas should be readily accessible.

Foods processing equipment

This means accessible with no tools, or at most, with very simple tools, and so that all surfaces and areas can be seen or felt and easily cleaned.

3. In general, no wooden parts should be used.
4. Other absorbent materials, such as fabric, belting with exposed fabric core, and absorbent sponge type rubber should not be used.
5. All metal surfaces in direct contact with the food product should be of stainless steel with a finish of at least 2-B, or metal of equal resistance and finish.
6. All structural parts not in direct contact with the food product should be of smooth, non-corroding metal, or of metal that can be covered with a non-toxic coating to render it resistant to corrosion and easily cleanable.
7. Where possible, all external parts should be of round or tubular material to avoid accumulation of debris and to permit easy cleaning. They should be sealed to prevent corrosion.
8. All non-functional pockets should be filled to facilitate self-cleaning and self-drainage.
9. There should be no interior ledges, recesses, pits, unfinished welds, etc.
10. All joints should be continuously welded and ground smooth, or of equal sanitary construction.
11. Legs should be readily adjustable for height and rounded at the floor level. Exposed threads should be kept to a minimum.
12. Horizontal side rails, braces, etc., should be at least six inches above the floor to facilitate cleaning.
13. No motor or other drive mechanism should be mounted over the product unless adequately equipped with well-drained pan under all bearings. Any lubricated moving mechanism should be located or protected, so that contamination of the product cannot occur.
14. Sanitary type self-draining greaseless inboard bearings should be used. If other type bearings are used, they should be sealed with corrosion-resistant, non-absorbent materials and be drained to the outside. Outboard bearings should be sealed from the interior with corrosion-resistant non-absorbent material. All seals should be accessible, and provided with conventional means of adjustment to prevent leakage.
15. All belts should be of sanitary grade, moisture-resistant, non-absorbent material.
16. Conveyor guides, splash guards, etc., should be easily removable, or of open construction to permit cleaning.
17. All pulleys should be of sealed drum metal construction (without recesses or open joints). Some device should be provided to prevent product being ground between return belt and pulley.
18. Provision should be made at all transfer points to prevent accumulation of leaves, stems and other debris.
19. Steam and water valves should be designed and installed to prevent any leakage.
20. Product and ingredient line valves should have no pockets or recesses.
21. All product washing sections should be self-cleaning to prevent the accumulation of silt, dirt, leaves, etc.
22. Drains and water inlets should be of adequate size to permit rapid draining and refilling. Drains should be at the lowest point with no inside collar or projection. Water inlets should discharge above the water line. Overflow and make-up rates should meet maximum production requirements.
23. Drain pans, where necessary, should be sloped for adequate drainage, with outlets properly conducted to the sewer.

They should be wide enough to prevent spillage, and open or detachable for easy cleaning.

The preceding list is not unique, and the items, in most cases, are generally applicable to food processing other than canning. Equipment recommendations for much canning equipment encompassing these items only, would be inadequate. In this connection it is appropriate to review some of the design and operating recommendations made by the NCA Committee for Post-Processing Can Handling. In the canning industry “processing” refers to retorting or cooking the sealed cans of food.

Post-Processing Can Handling

Food preservation by canning depends upon the fulfillment of two conditions: (a) the destruction by heat of bacteria capable of spoilng the food product (known as the “process”), and (b) the prevention of bacterial recontamination of the product by means of the sealed container. Although heat processes have been developed that will insure the destruction of organisms normally present in the canned product, there remains the hazard of re-entry of bacteria during post-processing can handling operations.

Spoilage Factors

The three main factors in spoilage resulting from post-processing can handling operations are: (a) the condition of the can double seams, (b) the presence of bacterial contamination in cooling waters or on can runways, and (c) excessive abuse due to poor construction, operation, or adjustment of the filled can handling equipment. Rough can handling and resulting leaker spoilage potential relates to:

a. The type of can runways.
b. The wetness - dryness of can runways.
c. Microbiological buildup on runways.
d. Crate dumping and can unscrambling.
e. Speed of handling cans.
f. Rolling vs. conveying cans.
g. Prevalence and type of can bumpers.
h. Type of can elevators and lowerators.
i. Degree and prevalence of small dents near seams from cans slamming into each other.
j. Type of labelers.
k. Type of cases.

Briefly this adds up to (a) the amount of moisture and microbiological contamination picked up under the double seams, and (b) the amount of shock and strain exerted on the cans and can seams (rough handling, denting, etc.) causing aspiration into the can of minute amounts of bacteria laden moisture.

If cooled cans can be dried or left in the retort baskets until dry, the spoilage hazard is materially
reduced, but not necessarily eliminated. Modern methods of straight line rapid handling through cooling, labeling, and casing make the attainment of such favorable conditions more difficult.

The Continental Can Company published in May, 1963, an excellent bulletin titled "Spoilage of Canned Foods Due to Leakage" by V. S. Troy, J. M. Boyd, and F. J. Folinazzo (1). They also concluded that "rough handling of cans in the filled can handling system is the major cause of 'leaker-type' spoilage in cans showing no structural defects . . . . Contamination of filled can handling equipment . . . contribute(s) to this type of spoilage."

**NATIONAL CANNERS ASSOCIATION EQUIPMENT COMMITTEE RECOMMENDATIONS**

With results of research available, and the knowledge and experience of technical representatives from canning companies, the Committee for Sanitation of Canning Equipment was able to publish "Recommendations for Post-Processing Can Handling," which made recommendations concerning operating precautions and sanitary design.

**OPERATING PRECAUTIONS**

1. Inspect can seams frequently to insure that they are properly formed, and that seamer adjustments have not exceeded tolerances.

2. Periodically inspect the can handling system from the closing machine to the caser. Where rough handling of the cans is apparent, smooth out the operation to minimize can seam and body damage. Automatic casers must be adjusted carefully to prevent violent can to can contact, or can seam to can body contact.

3. Do not allow cans to drop freely into crates from closing machine discharge tables.

4. Do not overfill the retort crates. This will eliminate protruding cans which could be crushed by the crate bales, or by crates placed on top of them in the retort.

5. Prevent sharp impacts between filled crates or against protruding points.

6. Operate crate dumps smoothly to prevent impact denting.

7. Chlorinate all cooling waters to a point where there is at least one part per million chlorine residual at the discharge end of the can cooler.

8. Thoroughly scrub and sanitize all tracks and belts which come into contact with the can seams at intervals frequent enough to prevent bacterial build-up.

9. Replace all worn and frayed belting, can retarders, cushions, etc., with new non-porous material.

10. Run cans through a can dryer immediately on leaving the cooling system or tip the full retort baskets to drain water trapped on can ends and allow the cans to dry in the retort crates before discharge into the can handling unit, to lessen the recontamination hazard. High velocity air blasts over the body and ends of cans will remove excess water and aid in keeping the can tracks dry. Bacteria may develop on can handling equipment in a film of water, lubricants or other material. Bacterial contamination at the juncture of the body and double seam can be significant as a cause of spoilage.

Can-drying methods which remove the visible water after contamination of the double seam may not be adequate for spoilage prevention. Chlorinated cooling water deposited by the cans on the runways will tend to depress bacterial growth, however, the effect rapidly dissipates as the distance of travel from the cooler increases.

11. Wet conditions can be deliberately created by continuously running or spraying water containing 3 to 5 ppm of free residual chlorine on the can tracks. Adequate control of continuous dripping must be provided and the cans must be dried before entering the labeler.

12. Can-transporting belts and elevators, unless completely dry, should be continuously sprayed at the beginning of the return with water containing 3 to 5 ppm of free residual chlorine.

**SANITARY DESIGN**

Under present day production pressures, post-retort and/or post-cooling equipment must be designed to minimize pick-up of bacterial contamination around the double seams. The design must also prevent shock, strain, or even small denting of the cans, particularly on or near the seams. The engineering and design objectives of post-retort can lines should include the above considerations: (a) minimize contamination and (b) prevent shock, strain, and denting (rough handling). The following are recommendations to help accomplish these objectives:

1. Keep handling to a minimum. All switchbacks, quarter turns, lowerators and other changes of can direction or orientation should be engineered to minimize can damage with consideration given to can speed, size, and weight. In general, sharp reversals of direction should be avoided. Quarter turns should have a long radius to handle the cans gently.

2. The need for "bumpers" should be avoided, but where necessary they should be of non-absorbent, easily cleaned material. Fabrics, wood, or absorbent core belting are not satisfactory, since these materials harbor bacterial populations that cannot be eliminated. The combination of contamination at the site of the bump and the resultant can shock and seam strain is a known cause of leaker spoilage, and the harder the bump, the greater the hazard. Such bumping also increases the spoilage hazard from contamination picked up from subsequent equipment.

3. If possible, eliminate the rolling of cans, where can-to-can contact may occur. Each can should be positively controlled as far as practical, such as by flat belts or cables. The drive mechanism of belts and cables should be automatically controlled, so cans cannot slam into each other or have seams strained or damaged by belts and cables continuing to run under jammed (stopped) cans. Line-flow controls, if properly installed, will permit an even flow of cans without jamming, and will shut off power driven belts or cables when conveyors are full.

4. When cans are rolled, the slopes, can spacing and can speeds should be engineered to prevent cans bumping into each other. This is a common cause of seam strain and damage. Can track adjustments and can and guide clearance tolerances should be such as to assure that any unavoidable can-to-can contact will be seam-to-seam contact and not seam-to-body contact.
5. When cans are rolled the double seams should not contact the runway surface except in coolers. In angle iron runways, (Figure 1) installation of metal half-rounds, as illustrated, is one possible way to keep the can double seams from contacting wet or damp angle iron guides. In the type of construction illustrated, drill weep holes to prevent water accumulating in the tracks behind the half rounds. Weep holes must be large enough not to clog.

6. Round-bar open runways (Figure 2) accomplish the same purpose. With larger size heavy cans a larger can body support area may be necessary to prevent damaging the can body. In all cases, use drip pans or install so as to prevent water from one can track dripping onto another track or cans below. Also consider safety, housekeeping, appearance, and comfort hazards caused by dripping water.

7. Where cans pass between belts or other retarders, and on some elevators, cut away the contacting material so that the can double seams ride free of contact (see illustration). Also do not slow the can to the extent that the following cans will bump into it.

8. At palletizers and other take-off and transfer points, provide for a continuous and gentle deceleration of the cans. Can-to-can impact can be prevented by use of take-off belts to move each can out of the way of the following can. Do not run cans at high speed into a dead-end where they are stopped suddenly by bumping into the can ahead.

9. Dirt and organic debris, as well as bacterial contamination, will accumulate on can handling equipment. The equipment must be designed and installed so that it can be cleaned. This means it must be accessible for cleaning. Since water, detergents and sanitizers will be used, drainage must be provided. In some installations, drip pans or other shields will be necessary. Dry steam cleaning in problem areas may be adequate.

This discussion has included only one of the equipment recommendations. The purpose was to emphasize the individualistic nature of canning equipment design. Sanitary equipment specifications can be helpful, but must be practical and functional as well. The food processing industries are fortunate in having many experienced and qualified technologists and engineers who are aware of the necessary performance characteristics of food handling equipment, and, at the same time, are cognizant of the value of equipment sanitation from the viewpoints of economy, public health protection, and esthetics.

REFERENCES