9.8.1 Canned Fruits And Vegetables

9.8.1.1 General[1-2]

The canning of fruits and vegetables is a growing, competitive industry, especially the international export portion. The industry is made up of establishments primarily engaged in canning fruits, vegetables, fruit and vegetable juices; processing ketchup and other tomato sauces; and producing natural and imitation preserves, jams, and jellies.

9.8.1.2 Process Description[3-6]

The primary objective of food processing is the preservation of perishable foods in a stable form that can be stored and shipped to distant markets during all months of the year. Processing also can change foods into new or more usable forms and make foods more convenient to prepare.

The goal of the canning process is to destroy any microorganisms in the food and prevent recontamination by microorganisms. Heat is the most common agent used to destroy microorganisms. Removal of oxygen can be used in conjunction with other methods to prevent the growth of oxygen-requiring microorganisms.

In the conventional canning of fruits and vegetables, there are basic process steps that are similar for both types of products. However, there is a great diversity among all plants and even those plants processing the same commodity. The differences include the inclusion of certain operations for some fruits or vegetables, the sequence of the process steps used in the operations, and the cooking or blanching steps. Production of fruit or vegetable juices occurs by a different sequence of operations and there is a wide diversity among these plants. Typical canned products include beans (cut and whole), beets, carrots, corn, peas, spinach, tomatoes, apples, peaches, pineapple, pears, apricots, and cranberries. Typical juices are orange, pineapple, grapefruit, tomato, and cranberry. Generic process flow diagrams for the canning of fruits, vegetables, and fruit juices are shown in Figures 9.8.1-1, 9.8.1-2, and 9.8.1-3. The steps outlined in these figures are intended to the basic processes in production. A typical commercial canning operation may employ the following general processes: washing, sorting/grading, preparation, container filling, exhausting, container sealing, heat sterilization, cooling, labeling/casing, and storage for shipment. In these diagrams, no attempt has been made to be product specific and include all process steps that would be used for all products. Figures 9.8.1-1 and 9.8.1-2 show optional operations, as dotted line steps, that are often used but are not used for all products. One of the major differences in the sequence of operations between fruit and vegetable canning is the blanching operation. Most of the fruits are not blanched prior to can filling whereas many of the vegetables undergo this step. Canned vegetables generally require more severe processing than do fruits because the vegetables have much lower acidity and contain more heat-resistant soil organisms. Many vegetables also require more cooking than fruits to develop their most desirable flavor and texture. The methods used in the cooking step vary widely among facilities. With many fruits, preliminary treatment steps (e. g., peeling, coring, halving, pitting) occur prior to any heating or cooking step but with vegetables, these treatment steps often occur after the vegetable has been blanched. For both fruits and vegetables, peeling is done either by a mechanical peeler, steam peeling, or lye peeling. The choice depends upon the type of fruit or vegetable or the choice of the company.

Some citrus fruit processors produce dry citrus peel, citrus molasses and D-limonene from the peels and pulp residue collected from the canning and juice operations. Other juice processing

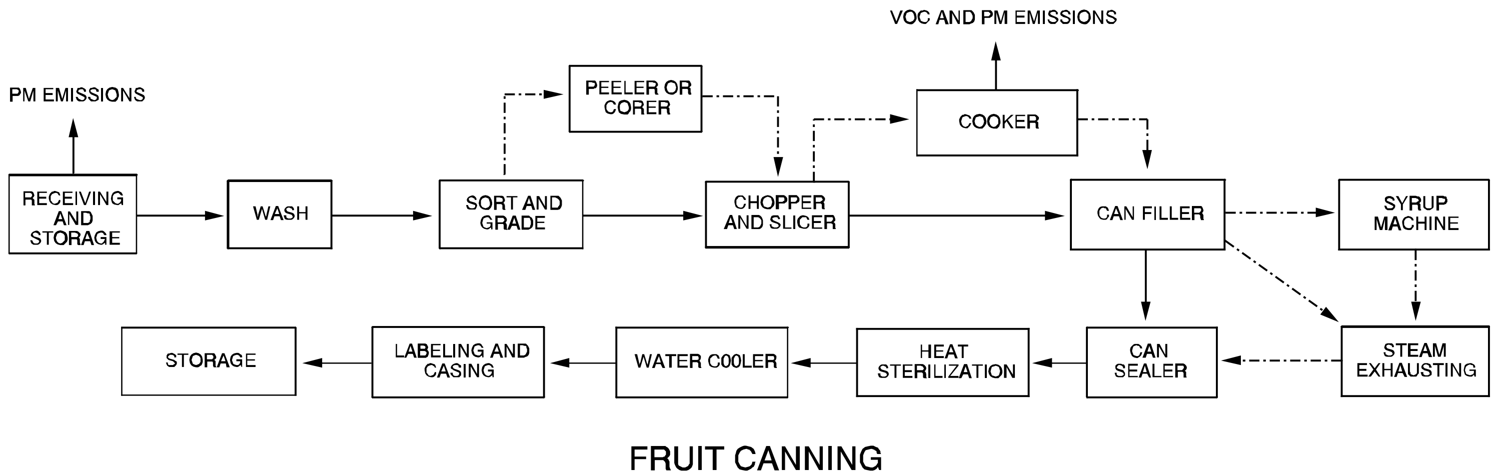

Figure 9.8.1-1. Generic process diagram for fruit canning.

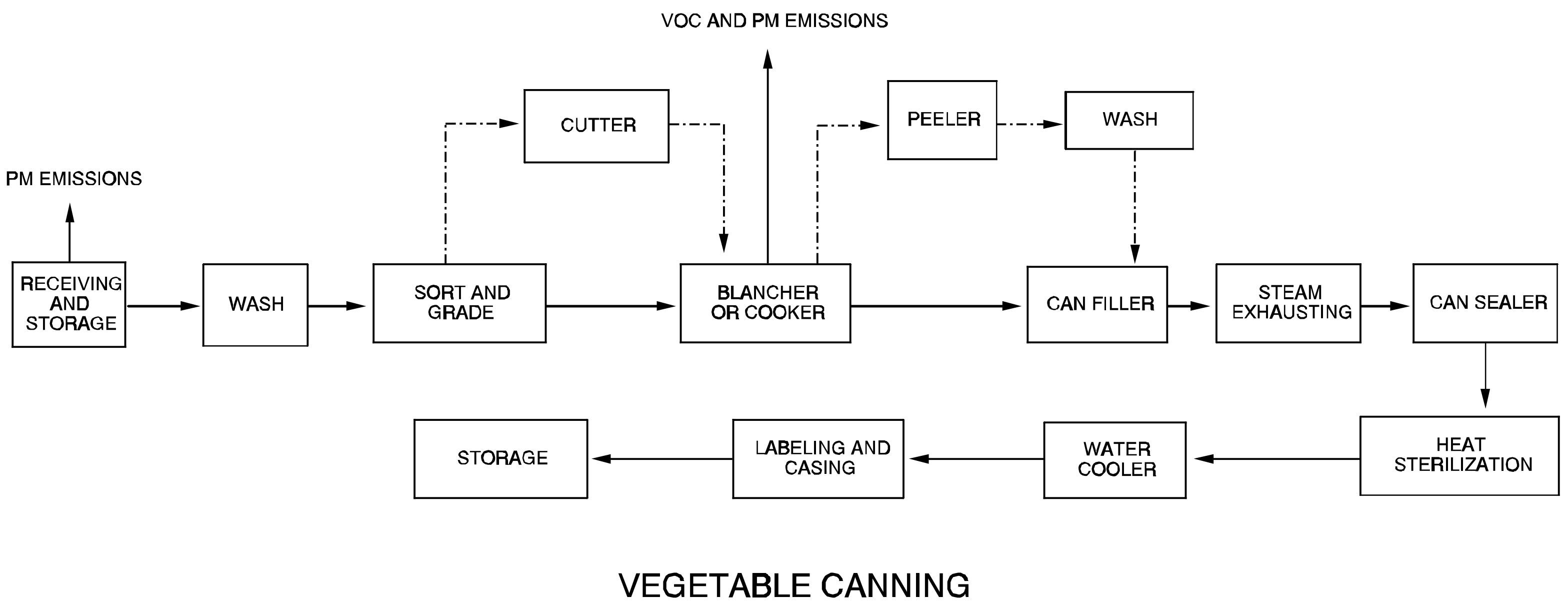

Figure 9.8.1-2. Generic process diagram for vegetable canning.

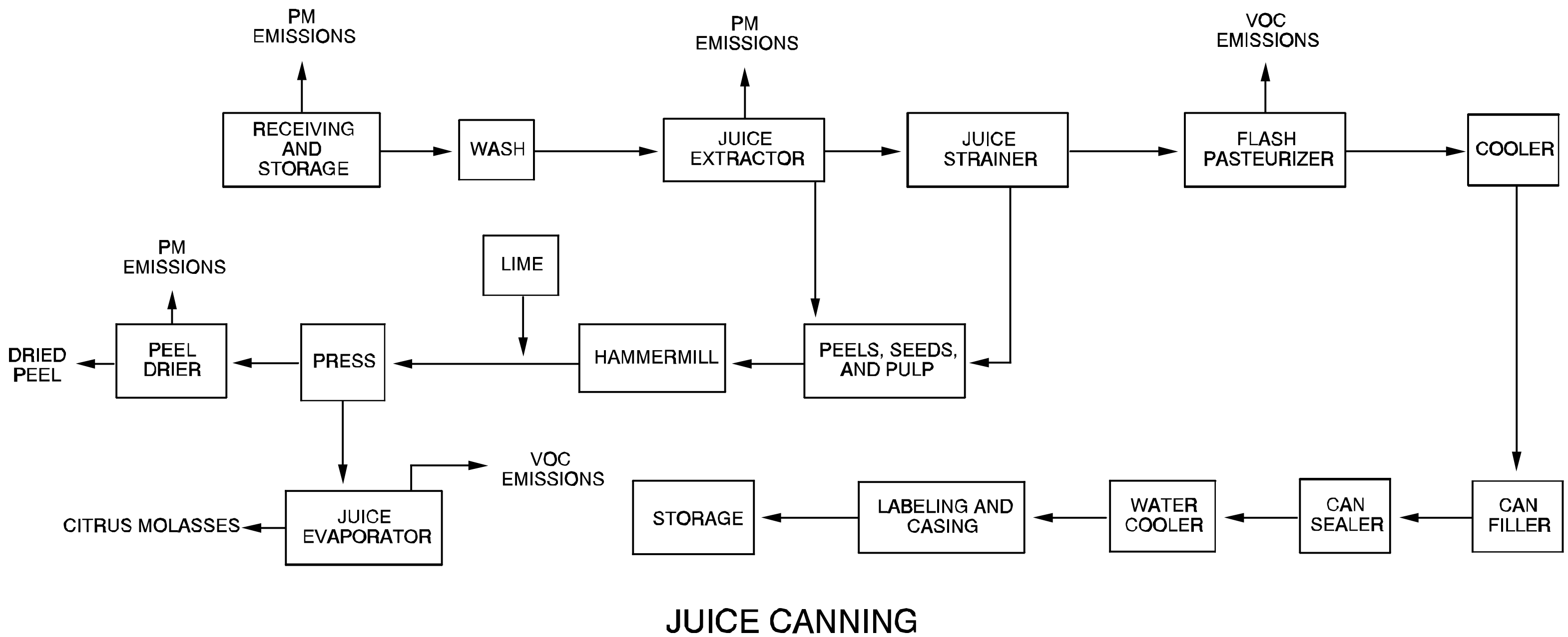

Figure 9.8.1-3. Generic process diagram for juice canning.

facilities use concentrates and raw commodity processing does not occur at the facility. The peels and residue are collected and ground in a hammermill, lime is added to neutralize the acids, and the product pressed to remove excess moisture. The liquid from the press is screened to remove large particles, which are recycled back to the press, and the liquid is concentrated to molasses in an evaporator. The pressed peel is sent to a direct-fired hot-air drier. After passing through a condenser to remove the D-limonene, the exhaust gases from the drier are used as the heat source for the molasses evaporator.

Equipment for conventional canning has been converting from batch to continuous units. In continuous retorts, the cans are fed through an air lock, then rotated through the pressurized heating chamber, and subsequently cooled through a second section of the retort in a separate cold-water cooler. Commercial methods for sterilization of canned foods with a pH of 4.5 or lower include use of static retorts, which are similar to large pressure cookers. A newer unit is the agitating retort, which mechanically moves the can and the food, providing quicker heat penetration. In the aseptic packaging process, the problem with slow heat penetration in the in-container process are avoided by sterilizing and cooling the food separate from the container. Presterilized containers are then filled with the sterilized and cooled product and are sealed in a sterile atmosphere.

To provide a closer insight into the actual processes that occur during a canning operation, a description of the canning of whole tomatoes is presented in the following paragraphs. This description provides more detail for each of the operations than is presented in the generic process flow diagrams in Figures 9.8.1-1, 9.8.1-2, and 9.8.1-3.

Preparation –

The principal preparation steps are washing and sorting. Mechanically harvested tomatoes are usually thoroughly washed by high-pressure sprays or by strong-flowing streams of water while being passed along a moving belt or on agitating or revolving screens. The raw produce may need to be sorted for size and maturity. Sorting for size is accomplished by passing the raw tomatoes through a series of moving screens with different mesh sizes or over differently spaced rollers. Separation into groups according to degree of ripeness or perfection of shape is done by hand; trimming is also done by hand.

Peeling And Coring –

Formerly, tomatoes were initially scalded followed by hand peeling, but steam peeling and lye peeling have also become widely used. With steam peeling, the tomatoes are treated with steam to loosen the skin, which is then removed by mechanical means. In lye peeling, the fruit is immersed in a hot lye bath or sprayed with a boiling solution of 10 to 20 percent lye. The excess lye is then drained and any lye that adheres to the tomatoes is removed with the peel by thorough washing.

Coring is done by a water-powered device with a small turbine wheel. A special blade mounted on the turbine wheel spins and removes the tomato cores.

Filling –

After peeling and coring, the tomatoes are conveyed by automatic runways, through washers, to the point of filling. Before being filled, the can or glass containers are cleaned by hot water, steam, or air blast. Most filling is done by machine. The containers are filled with the solid product and then usually topped with a light puree of tomato juice. Acidification of canned whole tomatoes with 0.1 to 0.2 percent citric acid has been suggested as a means of increasing acidity to a safer and more desirable level. Because of the increased sourness of the acidified product, the addition of 2 to 3 percent sucrose is used to balance the taste. The addition of salt is important for palatability.

Exhausting –

The objective of exhausting containers is to remove air so that the pressure inside the container following heat treatment and cooling will be less than atmospheric. The reduced internal pressure (vacuum) helps to keep the can ends drawn in, reduces strain on the containers during processing, and minimizes the level of oxygen remaining in the headspace. It also helps to extend the shelf life of food products and prevents bulging of the container at high altitudes.

Vacuum in the can may be obtained by the use of heat or by mechanical means. The tomatoes may be preheated before filling and sealed hot. For products that cannot be preheated before filling, it may be necessary to pass the filled containers through a steam chamber or tunnel prior to the sealing machine to expel gases from the food and raise the temperature. Vacuum also may be produced mechanically by sealing containers in a chamber under a high vacuum.

Sealing –

In sealing lids on metal cans, a double seam is created by interlocking the curl of the lid and flange of the can. Many closing machines are equipped to create vacuum in the headspace either mechanically or by steam-flow before lids are sealed.

Heat Sterilization –

During processing, microorganisms that can cause spoilage are destroyed by heat. The temperature and processing time vary with the nature of the product and the size of the container.

Acidic products, such as tomatoes, are readily preserved at 100°C (212°F). The containers holding these products are processed in atmospheric steam or hot-water cookers. The rotary continuous cookers, which operate at 100°C (212°F), have largely replaced retorts and open-still cookers for processing canned tomatoes. Some plants use hydrostatic cookers and others use continuous-pressure cookers.

Cooling –

After heat sterilization, containers are quickly cooled to prevent overcooking. Containers may be quick cooled by adding water to the cooker under air pressure or by conveying the containers from the cooker to a rotary cooler equipped with a cold-water spray.

Labeling And Casing –

After the heat sterilization, cooling, and drying operations, the containers are ready for labeling. Labeling machines apply glue and labels in one high-speed operation. The labeled cans or jars are the packed into shipping cartons.

9.8.1.3 Emissions And Controls[4,6-9]

Air emissions may arise from a variety of sources in the canning of fruits and vegetables. Particulate matter (PM) emissions result mainly from solids handling, solids size reduction, drying (e. g., citrus peel driers). Some of the particles are dusts, but others (particularly those from thermal processing operations) are produced by condensation of vapors and may be in the low-micrometer or submicrometer particle-size range.

The VOC emissions may potentially occur at almost any stage of processing, but most usually are associated with thermal processing steps, such as cooking, and evaporative concentration. The cooking technologies in canning processes are very high moisture processes so the predominant emissions will be steam or water vapor. The waste gases from these operations may contain PM or, perhaps, condensable vapors, as well as malodorous VOC. Particulate matter, condensable materials, and the high moisture content of the emissions may interfere with the collection or destruction of these VOC. The condensable materials also may be malodorous.

Wastewater treatment ponds may be another source of odors, even from processing of materials that are not otherwise particularly objectionable. Details on the processes and technologies used in waste water collection, treatment, and storage are presented in AP-42 Section 4.3; that section should be consulted for detailed information on the subject.

No emission data quantifying VOC, HAP, or PM emissions from the canned fruits and vegetable industry are available for use in the development of emission factors. Data on emissions from fruit and vegetable canning are extremely limited. Woodroof and Luh discussed the presence of VOC in apricots, cranberry juice, and cherry juice. Van Langenhove, et al., identified volatile compounds emitted during the blanching process of Brussels sprouts and cauliflower under laboratory and industrial conditions. Buttery, et al., studied emissions of volatile aroma compounds from tomato paste.

A number of emission control approaches are potentially available to the canning industry. These include wet scrubbers, dry sorbants, and cyclones. No information is available on controls actually used at canning facilities.

Control of VOC from a gas stream can be accomplished using one of several techniques but the most common methods are absorption, adsorption, and afterburners. Absorptive methods encompass all types of wet scrubbers using aqueous solutions to absorb the VOC. Most scrubber systems require a mist eliminator downstream of the scrubber.

Adsorptive methods could include one of four main adsorbents: activated carbon, activated alumina, silica gel, or molecular sieves. Of these four, activated carbon is the most widely used for VOC control while the remaining three are used for applications other than pollution control. Gas adsorption is a relatively expensive technique and may not be applicable to a wide variety of pollutants.

Particulate control commonly employs methods such as venturi scrubbers, dry cyclones, wet or dry electrostatic precipitators (ESPs), or dry filter systems. The most common controls are likely to be the venturi scrubbers or dry cyclones. Wet or dry ESPs could be used depending upon the particulate loading of the gas stream.

Condensation methods and scrubbing by chemical reaction may be applicable techniques depending upon the type of emissions. Condensation methods may be either direct contact or indirect contact with the shell and tube indirect method being the most common technique. Chemical reactive scrubbing may be used for odor control in selective applications.

References for Section 9.8.1

1. U. S. Department of Commerce, International Trade Administration, U. S. Industrial Outlook 1992--Food and Beverages.

2. 1987 Census of Manufacturers, MC87-1-20-C, Industries Series, Preserved Fruits and Vegetables.

3. B. S. Luh and J. G. Woodroof, ed., *Commercial Vegetable Processing*, 2nd edition, Van Nostrand Reinhold, New York, 1988.

4. J. L. Jones, et al., *Overview Of Environmental Control Measures And Problems In The Food Processing Industries*. Industrial Environmental Research Laboratory, Cincinnati, OH, Kenneth Dostal, Food and Wood Products Branch. Grant No. R804642-01, January 1979.

5. N. W. Deroiser, *The Technology Of Food Preservation, 3rd edition*, The Avi Publishing Company, Inc., Westport, CT, 1970.

6. J. G. Woodroof and B. S. Luh, ed., *Commercial Fruit Processing*, The Avi Publishing Company, Westport, CT, 1986.

7. H. J. Van Langenhove, *et al*., *Identification Of Volatiles Emitted During The Blanching Process Of Brussels Sprouts And Cauliflower*, Journal of the Science of Food and Agriculture, 55:483-487, 1991.

8. R. G. Buttery, *et al*., *Identification Of Additional Tomato Paste Volatiles*, Journal of Agricultural and Food Chemistry, 38(3):792-795, 1990.

9. H. J. Rafson, *Odor Emission Control For The Food Industry*, Food Technology, June 1977.