9.8.3 Pickles, Sauces, and Salad Dressings

9.8.3.1 General[1]

This industry includes facilities that produce pickled fruits and vegetables, salad dressings, relishes, various sauces, and seasonings. The two vegetables that account for the highest production volume in the U. S. are cucumbers (pickles) and cabbage (sauerkraut). Sauces entail a wide diversity of products but two of the more common types are Worcestershire sauce and hot pepper sauces. Salad dressings are generally considered to be products added to and eaten with salads. In 1987, 21,500 thousand people were employed in the industry. California, Georgia, Michigan, and Pennsylvania are the leading employment States in the industry.

9.8.3.2 Process Description[2-3]

Pickled Vegetables —

In the U. S., vegetables are pickled commercially using one of two general processes: brining or direct acidification (with or without pasteurization), or various combinations of these processes. For sodium chloride brining, fresh vegetables are placed in a salt solution or dry salt is added to cut or whole vegetables whereupon the vegetables undergo a microbial fermentation process activated by the lactic acid bacteria, yeasts, and other microorganisms. Direct acidification of fresh or brined vegetables, through the addition of vinegar, is a major component of commercial pickling. This process may be accompanied by pasteurization, addition of preservatives, refrigeration, or a combination of these treatments. While cucumbers, cabbage, and olives constitute the largest volume of vegetables brined or pickled in the U. S., other vegetables include peppers, onions, beans, cauliflower, and carrots.

In the United States, the term "pickles" generally refers to pickled cucumbers. Three methods currently are used to produce pickles from cucumbers: brine stock, fresh pack, and refrigerated. Smaller quantities are preserved by specialized brining methods to produce pickles for delicatessens and other special grades of pickles. Pickling cucumbers are harvested and transported to the processing plants. The cucumbers may be field graded and cooled, if necessitated by the temperature, prior to transport to the plants.

The brine stock process begins with brining the cucumbers through the addition of salt or a sodium chloride brining solution. The cucumbers undergo a fermentation process in which lactic acid is formed. During fermentation, the cucumbers are held in 5 to 8 percent salt; after fermentation, the salt content is increased weekly in 0.25 to 0.5 percent increments until the final holding strength is 8 to 16 percent salt. The cucumbers, called brine stock, are then graded and cut (optional), before being desalted by washing in an open tank with water at ambient temperature to obtain the desired salt level and processed into dill, sour, sweet, or other pickle products. Containers are filled with the cut or whole pickles, and sugar and vinegars are added. Preservatives are also added if the product is not pasteurized. The containers are then vacuum sealed and pasteurized (optional) until the temperature at the center of the cucumbers reaches about 74°C (165°F) for about 15 minutes. The product is then cooled, and the containers are labeled, packaged, and stored.

The fresh pack process begins with grading of the pickling cucumbers, followed by washing with water. The cucumbers are then either cut and inspected before packaging, or are sometimes "blanched" if they are to be packaged whole. The "blanching" consists of rinsing the cucumber with

warm water to make it more pliable and easier to pack in the container. It is not a true blanching process. Containers are filled with the cut or whole cucumbers, and then salt, spices, and vinegars are added. The containers are then vacuum sealed and heated (pasteurized) until the temperature at the center of the cucumbers reaches about 74°C (165°F) for about 15 minutes. The product is then cooled, and the containers are labeled, packaged, and stored.

The refrigerated process begins with grading of the pickling cucumbers, followed by washing with water. The washed cucumbers are packed into containers, and then salt, spices, vinegars, and preservatives (primarily sodium benzoate) are added. The containers are then vacuum sealed, labeled, and refrigerated at 34° to 40°F. In this process, the cucumbers are not heat-processed before or after packing.

In the sauerkraut process the cabbage is harvested, transported to the processing plant, washed, and prepared for the fermentation by coring, trimming, and shredding. The shredded cabbage is conveyed to a fermentation tank where salt is added up to a final concentration of 2 to 3 percent (preferably 2.25 percent), by weight. After salt addition, the mixture is allowed to ferment at ambient temperature in a closed tank. If insufficient salt is added or air is allowed to contact the surface of the cabbage, yeast and mold will grow on the surface and result in a softening of the final sauerkraut product. When fermentation is complete, the sauerkraut contains 1.7 to 2.3 percent acid, as lactic acid. Following fermentation, the sauerkraut is packaged in cans, plastic bags, or glass containers; cans are the most prevalent method. In the canning process, the sauerkraut, containing the original or diluted fermentation liquor, is heated to 85° to 88°C (185° to 190°F) by steam injection in a thermal screw and then packed into cans. The cans are steam exhausted, sealed, and cooled. After cooling, the cans are labeled, packed, and stored for shipment. In the plastic bag process, the sauerkraut, containing the fermentation liquor, is placed in plastic bags and chemical additives (benzoic acid, sorbic acid, and sodium bisulfite) introduced as preservatives. The bags are sealed and refrigerated. Small quantities, approximately 10 percent of the production, are packaged in glass containers, which may be preserved by heating or using chemical additives.

Sauces —

A typical sauce production operation involves the mixture of several ingredients, often including salts, vinegars, sugar, vegetables, and various spices. The mixture is allowed to ferment for a period of time, sealed in containers, and pasteurized to prevent further fermentation. The production processes for Worcestershire sauce and hot pepper sauces are briefly described as examples of sauce production.

The name "Worcestershire Sauce" is now a generic term for a type of food condiment that originated in India. In the preparation of the true sauce, a mixture of vinegar, molasses, sugar, soy, anchovies, tamarinds, eschalots, garlic, onions, and salt is prepared and well mixed. Spices, flavorings, and water are added and the mixture transferred to an aging tank, sealed, and allowed to mature and ferment over a period of time. The fermenting mixture is occasionally agitated to ensure proper blending. After fermentation is complete, the mixture is processed by filtration through a mesh screen which allows the finer particles of the mixture to remain in the liquid. The product is then pasteurized prior to bottling to prevent further fermentation. Following bottling, the product is cooled, labeled, and packaged.

Hot sauce or pepper sauce is a generic name given to a large array of bottled condiments produced by several manufacturers in the U. S. The hot peppers, usually varieties of *Capsicum annum* and *Capsicum frutescens*, give the products their heat and characteristic flavor; vinegar is the usual liquid medium. Manufacturing processes vary by producer; however, in most, the harvested hot

peppers are washed and either ground for immediate use or stored whole in brine for several months until processed. In processing, the whole peppers are ground, salt and vinegar added, and the mixture passed through a filter to remove seeds and skin. The end-product, a stable suspension of the pulp from the pepper, vinegar, and salt, is then bottled, labeled, and stored for shipment.

Salad Dressings —

Salad dressings (except products modified in calories, fat, or cholesterol) are typically made up of oil, vinegar, spices, and other food ingredients to develop the desired taste. These dressings are added to many types of foods to enhance flavor. There are U. S. FDA Standards of Identity for three general classifications of salad dressings: mayonnaise, spoonable (semisolid) salad dressing, and French dressing. All other dressings are nonstandardized and are typically referred to as "pourable".

Mayonnaise is a semisolid emulsion of edible vegetable oil, egg yolk or whole egg, acidifying ingredients (vinegar, lemon or lime juice), seasonings (e. g., salt, sweeteners, mustard, paprika), citric acid, malic acid, crystallization inhibitors, and sequestrants to preserve color and flavor. Mayonnaise is an oil-in-water type emulsion where egg is the emulsifying agent and vinegar and salt are the principal bacteriological preservatives. The production process begins with mixing water, egg, and dry ingredients and slowly adding oil while agitating the mixture. Vinegar is then added to the mixture and, after mixing is complete, containers are filled, capped, labeled, and stored or shipped. Improved texture and uniformity of the final product is achieved through the use of colloidalizing or homogenizing machines.

Salad dressing is a spoonable (semisolid) combination of oil, cooked starch paste base, and other ingredients. During salad dressing production, the starch paste base is prepared by mixing starch (e. g., food starch, tapioca, wheat or rye flours) with water and vinegar. Optional ingredients include salt, nutritive carbohydrate sweeteners (e. g., sugar, dextrose, corn syrup, honey), any spice (except saffron and tumeric) or natural flavoring, monosodium glutamate, stabilizers and thickeners, citric and/or malic acid, sequestrants, and crystallization inhibitors. To prepare the salad dressing, a portion of the starch paste and other optional ingredients, except the oil, are blended and then the oil is slowly added to form a "preemulsion". When one-half of the oil is incorporated, the remainder of the starch paste is added at the same rate as the oil. After all of the starch paste and oil have been added, the mixture continues to blend until the ingredients are thoroughly mixed and then the mixture is milled to a uniform consistency. The salad dressing is placed into containers that are subsequently capped, labeled, and stored or shipped.

Liquid dressings, except French dressing, do not have a FDA Standard of Identity. They are pourable products that contain vegetable oil as a basic ingredient. Dressings may also contain catsup, tomato paste, vinegars, cheese, sherry, spices, and other natural ingredients. Liquid dressings are packaged either as separable products with distinct proportions of oil and aqueous phases or as homogenized dressings that are produced by the addition of stabilizers and emulsifiers. The homogenized dressings are then passed through a homogenizer or colloidalizing machine prior to bottling.

9.8.3.3 Emissions And Controls[4]

No source tests have been performed to quantify emissions resulting from the production of pickles, sauerkraut, sauces, or salad dressings. For most of these industries, processes are conducted in closed tanks or other vessels and would not be expected to produce significant emissions. For some products, in certain instances, the potential exists for emissions of particulate matter (PM) or odor (VOC).

Emissions of PM potentially could result from solids handling, solids size reduction, and cooking. If raw vegetables are transported directly from the field, the unloading of these vegetables could result in emissions of dust or vegetative matter. For those products that involve cooking or evaporative condensation in open vessels, PM emissions may be produced by condensation of vapors and may be in the low-micrometer or submicrometer particle-size range.

The VOC emissions are most usually associated with thermal processing steps (e. g., cooking or evaporative condensation) or other processing steps performed in open vessels. Thermal processing steps conducted in closed vessels generally do not result in VOC emissions. Gaseous compounds emitted from those steps conducted in open vessels may contain malodorous VOC.

Because no emission data are available that quantify any VOC, HAP, or PM emissions from any of these industries, emission factors cannot be developed.

A number of VOC and particulate emission control techniques are potentially available to these industries. These include the traditional approaches of wet scrubbers, dry sorbants, and cyclones. No information is available on controls actually used in these industries. The controls discussed in this section are ones that theoretically could be used. The applicability of controls and the specific type of control device or combination of devices would vary from facility to facility depending upon the particular nature of the emissions and the pollutant concentration in the gas stream.

For general industrial processes, 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. The most common scrubber systems are packed columns or beds, plate columns, spray towers, or other types of towers. Adsorptive methods could include one of four main adsorbents: activated carbon, activated alumina, silica gel, or molecular sieves; activated carbon is the most widely used for VOC control. Afterburners may be either thermal incinerators or catalytic combustors.

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.

References For Section 9.8.3

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

2. G. Fuller and G. G. Dull, "Processing Of Horticultural Crops In The United States", in *Handbook Of Processing And Utilization In Agriculture*, CRC Press, Inc., Boca Raton, FL, 1983.

3. N.W. Desrosier, *Elements Of Food Technology*, AVI Publishing Company, Westport, CT, 1977.

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