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Small-scale Food Equipment

Food Processing for Entrepreneurs Series

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This publication provides information about small-scale food process equipment to entrepreneurs who may be contemplating either fabricating equipment or purchasing new or used equipment.

The entrepreneur starting a small food manufacturing business often faces a problem in finding equipment suitable for processing a unique product in small batches. S*pecial* equipment suitable for processing small runs of product often is not available or is too expensive for start-up businesses. This problem is not entirely unique to starting a small food business. There are no standardized food plant designs or equipment layouts. One must take the best equipment that is available, and then sequence available units of equipment to work as efficiently as possible. For some food manufacturers the safest and most economical plan for laying out a processing line is to call an equipment manufacturer, submit the problem and have the equipment manufacturer submit layout plans with the most up-to-date equipment. Purchasing a new processing line is a luxury most beginning entrepreneurs do not have. Literature and general plans of equipment placement from equipment venders can be useful in planning a food processing facility. Small-scale production and limited financial resources usually necessitate purchasing the most suitable used equipment available and/or fabricating equipment for special applications.

Equipment Requirements

Equipment kind, arrangement and amount are determined by the product being processed, the quantities of each product processed, the size and type of containers into which the food is to be packed, and the need for special operations that impart unique qualities to the food. While it is possible to process limited quantities of most foods with minimal special equipment, one should remember that adequacy of equipment is essential to efficient operation and optimization of manufacturing costs. Each piece of food manufacturing equipment must have certain qualities. The most important quality is that the equipment performs the function for which it was designed in a safe, efficient and economic manner. The machine must be as simple in design as possible with sufficient sturdiness to minimize the need for frequent repairs. The machine must do its work cleanly and be designed such that it can easily be cleaned and sanitized. Food process equipment should be constructed without sharp corners, as these are difficult to clean and can harbor food spoilage microorganisms that may contaminate food. There should be no dead end piping, and all pipes should be joined with sanitary joints that have no crevices and are that easy to disassemble and clean. Equipment should be cleaned with high pressure water sprays in combination with alkaline or mild acid detergents and non abrasive scrubbing. Wash temperatures usually are hot but not above 140°F since high temperatures cause coagulation of food proteins that can form films on equipment surfaces. Organic matter must be cleaned from equipment before that equipment can be adequately sanitized.

Materials

Food equipment must be made from materials that are durable, that will not facilitate undesirable changes in the color or flavor of foods, that will not corrode, and that are non-toxic. Many metal ions when introduced into foods darken the foods and/or result in oxidative off-flavors. Historically food contact surfaces of vessels made from less expensive metals were tinned to protect the foods from inclusion of copper, aluminum or iron ions. These metal ions impart off-flavors and darken some foods. Tinned utensils are found on the used equipment market, but the tin coatings are thin and tin is relatively soft and is lost in normal use thus requiring frequent retinning. Copper vessels are used in the confectionary industry, but should be avoided for use in general food processing. Very small quantities of copper in a food can induce profound rancidity and changes in color. Aluminum is a good heat conductor, it is light weight and can be easily shaped, but it is easily tarnished and corroded by common cleaning compounds or fruit acids. Electrolysis also is a problem if aluminum is in contact with iron in a moist environment. Aluminum will go into solution and be corroded. Iron is lower on the electromotive scale than aluminum and will not corrode while there is an aluminum electrode to corrode. Galvanized (zinc coated) metals and soft solder (lead containing) should not be used in food applications because both zinc and lead are toxic and enter solution when in contact with acid foods.

Stainless Steel

The preferred material for food contact surfaces is stainless steel. Stainless steels are corrosion resistant steels that contain up to 20 percent chromium and have low carbon contents. The most common stainless steel types used in the food industry are 304 and 316. These numbers refer to the composition of the respective steels. Stainless steel 304 is a standard food grade steel that contains 68.5 percent iron, 19 percent chromium, 9.25 percent nickel, 2.0 percent manganese, .08 percent carbon, and 0 percent molybdenum. Stainless steel 316 contains 65.35 percent iron, 17 percent chromium, 12 percent nickel, 2.0 percent manganese, .08 percent carbon and 2.5 percent molybdenum. 304 stainless steel is quite satisfactory for most food equipment, but 316 stainless is more corrosion resistant. If one is working with hot, high acid foods or acidified foods, 316 may be the material of choice even though it is more expensive than 304 stainless.

There also are other grades of stainless steel. As the grade number of stainless steel increases within a stainless steel series there is an increase in the hardness of the steel. Generally the harder the steel the more difficult it is to cut, form, shape or weld. If the number is followed by an **H** or an **R** the steel has been hardened and will be more difficult to shape or machine.

When stainless steel is manufactured it undergoes an acid cleaning process that develops a uniform protective layer of oxide film on the surface. This process, which improves the steel's resistance to corrosion, is called passivation. When stainless steel is thoroughly cleaned this film forms and protects the surface from discoloration and corrosion. It is important to thoroughly clean and rinse stainless equipment after use. A clean stainless steel surface will passivate itself in normal exposure to air. If you have equipment custom fabricated or repaired it is good to have weld areas polished to smoothness. A smooth surface improves cleanability and will reduce the possibility of corrosion. Any area that you have formed or machined or has had surfaces cleaned by grit blasting or mechanically cleaned with ordinary wire brushes, steel wool or abrasives containing free iron will benefit from cleaning and rinsing. Brushing with soap followed by thorough rinsing usually is sufficient to protect the metal. Specialty machine shops often clean stainless steel in hot acid after fabrication or machining.

Design Considerations When Shopping for Used Equipment or Fabricating Equipment

One must remember that food process equipment should be designed for sanitary operation and ease of maintenance and cleaning.

1. Food contact surfaces should be constructed of non-corrosive and non-toxic materials.
2. Surfaces of equipment in contact with foods must be easily cleaned and accessible for inspection.
3. All machine parts should be designed for quick disassembly and reassembly. This facilitates cleaning and repair. All machine parts in contact with food should be accessible for cleaning.
4. Surfaces of equipment in contact with food should be smooth and continuous. Rough spots, crevices and open seams should be avoided or repaired.
5. Sharp corners in equipment are difficult to clean. Cooking kettles, holding tanks and similar units should have long curves at the juncture of the bottom and side walls. Pipelines and ducts should be curved or rounded.
6. Equipment such as kettles, vats, bins or mixers should have sectional covers that are free from seams, crevices or hinges in which dirt might collect.
7. Dead-end areas in all equipment should be avoided. Such areas are difficult to clean and may allow the growth of spoilage organisms.
8. Metals such as lead (soft solder), cadmium, antimony and zinc must not be used in fabricating food equipment. Copper or copper containing alloys are not suitable for most food applications.
9. Equipment must be designed to avoid the loss of small parts such as bolts, keys or washers into the food. Mixing blades should be welded to or continuous with the drive shaft. The shaft and blades should be removable at a point above the surface of the product.
10. Swivel joints, stuffing boxes or glands in which food might accumulate or harbor spoilage organisms should not be used.
11. Food products should be protected from lubricants and condensates. Moisture condensing on piping or ceilings may drop into open kettles or holding vats and contaminate the food with dirt or peeled paint.
12. Drive shafts should be sealed to keep lubricants from reaching the food.
13. Food piping systems must have sanitary thread, and threaded parts must be accessible for cleaning. Sanitary valves that are easily disassembled for cleaning should be used.
14. Coupling nuts on piping and valves should have sufficient clearance to allow ease of disassembly and cleaning.

Steam Kettles

The steam kettle usually is the first item of equipment the starting food entrepreneur purchases. It is one of the most common pieces of equipment in small scale processing. Because this equipment is commonly used in restaurants and in institutional kitchens it usually is available on the used market.

The steam kettle is designed to make heating and cooking very fast and efficient. A typical steam kettle is a large vessel with a rounded or hemispherical bottom. The kettle has a "jacket" or double wall covering the bottom and at least a portion of the sides. This "jacket" provides a space for the heating medium to circulate, thereby heating the cooking surface. The heating medium is generally steam, but in some kettles hot water is contained in the jacket to heat the food. Steam has many advantages as a heating medium. Steam provides uniform heating and rapid heat transfer by giving up its latent heat of vaporization to the heating surface of the kettle. When steam gives up its heat of vaporization it condenses to water. The rate of heating easily is controlled by controlling the flow of steam into the jacket through a steam valve or a thermostat. Steam can be supplied to the kettle by an independent boiler through piping or it can in "self-contained kettles" be produced in the kettle. Self-contained kettles heat water with gas (gas-fired kettles) or with electric energy to generate steam under pressure in the jacket of the kettle. The temperature of the steam in the steam jacket increases with increasing pressure. Most modern kettles are rated at 45 or 50 psig (pounds per square inch gauge) as the maximum pressure although some older kettles are rated with a maximum pressure as low as 30 psig. All kettles should be equipped with an automatic pressure relief valve. If an external boiler is used an effective means of condensate (water) removal such as a steam trap is needed to maintain effective heat transfer.

A wide variety of sizes and options are available in steam kettles. If one has a boiler a direct steam kettle would normally be preferred. Small plants that do not have a boiler usually must rely upon self-contained kettles. The steam jacket capacity or height of the jacket on the kettle also varies with kettles. The bottom of the kettle is always jacketed. The jacket may extend up the side of the kettle various distances to a full jacket. The height of the jacket will help to define the rate of heating. A full jacket is desirable where one wishes to rapidly heat a product as fast as possible, but may have disadvantages if it is desirable to maintain heat on the product while filling containers or drawing the product from the kettle. In this case one could encounter scorching or burn-on as the product is drawn down below the upper level of the steam jacket. Some large kettles have more than one jacketed area allowing one to supply heat as needed to different areas of the steam kettle. Common options for steam kettles include: one piece (lift off) or two piece covers, tilt and pour capacity, different sizes and types of drain valves, strainers, baskets for blanching and agitators.

When shopping for used steam kettles one should have a list of the features that would be desirable for a given processing application. It would be wise to shop for newer kettles with the food contact surface constructed from a single piece of stainless steel and free of unfinished seams or cracks. A stainless steel outer shell or jacket also is desirable. Occasionally one encounters older kettles at auctions that have an outer jacket constructed of mild steel. Such a jacket corrodes with age resulting pinpoint leaks. During the war years some kettles were made with sheet metal outer jackets that were overlain with reinforced resin. Such kettles should be avoided. Most used equipment dealers stock only newer equipment that would give reasonably trouble-free service. It is possible to purchase a used kettle in good condition for a fraction of the cost of new cost from most food service distributors or dealers of used food processing equipment.

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