NEW TECHNOLOGIES FOR ASEPTIC PACKAGING OF LIQUID AND CRUSHED PRODUCTS

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ABSTRACT

Aseptic packaging is an alternative technology to classical heat treatment in autoclaves. Aseptic packaging can be defined as filling of commercially sterile product into sterile containers under aseptic conditions and hermetically sealing of containers in order to avoid recontamination. In comparison to conventional process, aseptic packaging is preferred for heat sensitive and nutritional foods & beverages for obtaining a finished product with better sensory qualities and higher nutrient retention. The main limitation of aseptic packaging is the higher investment in equipments and facilities. However we can not ignore their numerous advantages in costs reduction and product quality. Thus, aseptic packaging of food products is one of the most significant technology of food processing and there is a big scope in this area

1. Introduction

Aseptic packaging is a technology with a great potential use in liquid and crushed food products. It is an alternative technology to classical heat treatment in autoclaves. The liquid or crushed product flows continuously through a heat exchanger followed by a cooler also in continuous, for filling the cold product in an aseptic chamber after the necessary minimum treatment at one container designed according to this technology.

In conventional process the package is cleaned, and the product is introduced into the package, usually hot. Then, the package is hermetically sealed and subjected to heating. The package must be able to withstand heating up to about 100°C for high acid products and up to 125°C for low acid products. Packages containing low-acid (above pH 4.5) food must withstand pressure as well.

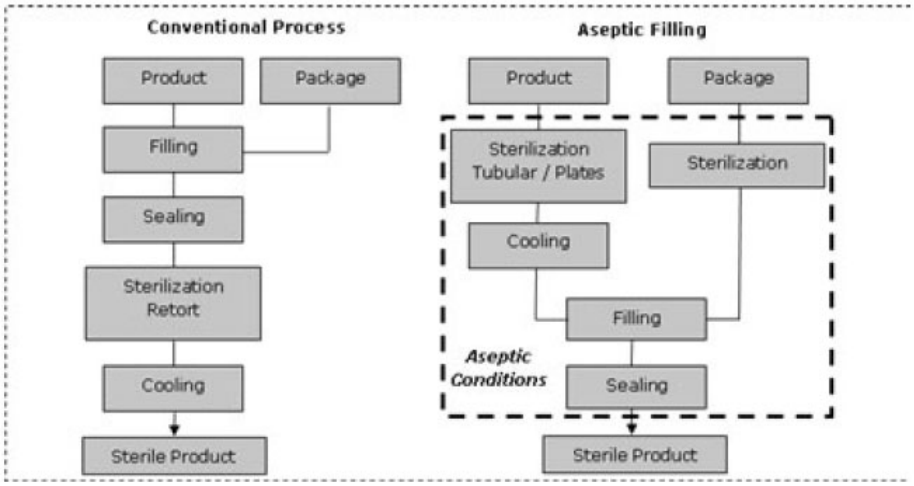

Figure 1

Aseptic Packaging classical markets are dairy and infant food (meals and fruits), to which are added clinical nutrition (health-care) and elderly. It is also extensible to other culinary products of this profile: bouillons, creams, soups, sauces, concentrates, purees, juices and other drinks.

Thus, liquid or crushed products, especially with high value added, and the possibility of including pieces of about 5 mm. in the recipe, depending on the texture.

In conventional process the nutritional contents and the organoleptic properties of the food generally suffer during the processing. The new technology provides more natural, nutritious and healthy products (free of by-products and pack migrations) to not expose at excessive heat treatments that "swelter or burn" the food. Next example, a comparison autoclave heat treatment (conventional) vs. continuous (aseptic) for the same product.

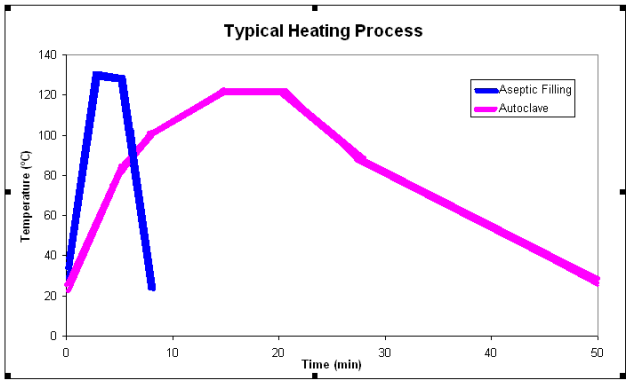

Figure 2.

2. Aseptic packaging system requirements

An aseptic packaging system must meet a series of requirements:

- The container and method of closure must avoid the passage of organisms into the sealed container during storage and distribution. It is also desirable for the container to have barrier properties to minimize chemical changes in the product during storage.
- The container or part of it exposed to the product must be sterilized, after it is formed and before being filled.
- The container must be filled without contamination by organisms either from the equipment surfaces or from the atmosphere that surrounds the filler. Filling is done in aseptic conditions into a sterile zone, an enclosed area that is supplied with a sterile atmosphere (air sterilized by heating or filtration).
- Closure must be sterilized immediately before it is applied. The closure must be applied and sealed in place to prevent contamination, while the container is still within the sterile zone.

3. Aseptic packaging lines, materials and packages.

Aseptic package has not only to protect the product but also to maintain the quality of the product. Hence the structure as well as composition of aseptic packaging are more complex and vary depending on product application, package size and package type.

There are five basic types of aseptic packaging lines:

- Fill & Seal: Pre-formed containers made up of thermoformed plastic, glass or metal are sterilized, filled in aseptic environment and sealed.
- Form, Fill & Seal: Roll of material is sterilized, formed in sterile environment, filled and sealed. e.g. tetra packs
- Erect, Fill & Seal: Using knocked, down blanks, erected, sterilized, filled and sealed. e.g. Gable-top cartons, Cambriblock.

- Thermoform, Fill & Seal: roll stock, sterilized, thermoformed, filled and sealed aseptically. e.g. Creamers, plastic soup cans.

- Blown-Mold, Fill & Seal. Material is sterilized, blown-mold formed, filled and sealed aseptically. e.g. gel bottles.

Factors such as seal strength and integrity, package shape, stiffness and durability, as well as barrier properties determine the choice and/or combination of materials required.

There are many options of packaging materials available with their own technical advantages:

- Glass: Impermeability, inert material, product visibility, axial strength, withstands vacuum and pressure.

- Tin plate: Impermeability, container strength, easily heat-processable, withstand vacuum and pressure.

- Aluminum: Impermeability, lightweight metal easily formed, container axial strength, withstands pressure.

- Paper & board: Infinite variety of paper types, ease of decoration, infinite variety of cartons and cases, adjunct to all other packaging materials.

- Rigid plastics: Properties variable, light weight, choice of container shape, in-house manufacture.

- Flexible plastics: Properties variable, very lightweight, tailor-made sizing

Generally to achieve all required properties, aseptic packages incorporate more than one material in the structure that is assembled by lamination or co-extrusion process.

A great variety of packages forms and systems may be used in aseptic packaging:

- Carton systems: This type of aseptic packaging system includes Form-fill-seal cartons and prefabricated cartons. Some of the existing aseptic carton boxes may now be filled with particulates, also aseptically.

- Cup and tray systems: The aseptic packaging of food into cups can be into Pre-formed plastic cups and Form-fill and seal cups. These are either used pre-made or formed, filled and sealed in thermoform/fill/seal machines. Both types of packages exist for filling particulates and also in packs suitable for microwave heating. Usually polypropylene-based multilayer materials with EVOH barrier are applied for this purpose

- Bottle and jar systems: Glass containers and plastics bottles fall into this category. The bottles can further be divided into; a) Non sterile bottles; b) Sterile blown bottles; c) Single station blowing, filling & sealing. Glass bottles may be aseptically filled with food containing small particles, for instance for baby food. Jars may be filled with larger particles - 12mm cube size or larger - if one dimension is smaller. Basically, the same products can be filled into plastic bottles and jars as into glass containers. Closing is usually done by heat-sealing aluminium lids. For this reason, much attention has to be paid to avoid contamination of heat-sealing rims.

- Sachet and pouch systems: This system classified into Form-fill-seal systems and Lay flat tubing. Pillow pouches are usually used for packaging of milk; three-sided sealed pouch, however, is suitable also for aseptic packaging of particulates up to particle sizes of 12µ and bag sizes from 1-5 litres. For standing pouches, it could be used closed pouches from a reel with sterile interior surfaces, the exterior of which is sterilized in a hydrogen

peroxide bath when the roll of pouches enters the aseptic cabinet. The bags are then cut from the web, filled and sealed.

- Metal can system: It includes hermetically sealed cans. For example, the Dole system is able to apply to cans from steel and aluminium for aseptic filling. The existing slit filler, however, limits applications to liquids with very small particles

- Bulk packaging systems: Several manufacturing firms offer large bulk bags capable of holding several hundred gallons of product for aseptic filling. These bags are normally pre-sterilized with radiation. The bags are stabilized by an outer container during filling and shipping. The outer container may be reused several times, however, the bags and filler valves are used only once. Each bag is equipped with a fitment or valve which, when matched with the correct filler will allow for aseptic filling and emptying of the bag. Depending upon the system the filler nozzle may be sterilized by using chemicals (i.e., hydrogen peroxide) or steam.

4. Experimental methodology

The final decision on the best technology (conventional process or aseptic packaging) is forced to undergo a pilot plant tests.

- Selection of a representative product on the market, with its current formulation and raw materials according to technical specifications.

- Container to be tested, the same in the two technologies: polymer cups, stand-up pouches, bricks, bottles, others. Alternative to classic glass jar with metal lid and rubber or gasket inside and lacquered (twist-off or PT). The project requires an adequate design with barrier material, active and functional compounds (antioxidants, scavengers, etc).

- Culinary cooking (industrial kitchen) similar for the two systems.

- Heat treatment individualized for each technology (target Fo lethal factor, depending on pH). In autoclave, with the current safety margin recommended by the equipment control (cold spots, T distribution, thermal curves, etc). In the continuous one, real T measurements in the exchanger and product flows (holding-time).

- Quality control and comparative in depth of the two final products: organoleptic and sensory control (Consumo-Lab panels), nutritional improvement (T unstable nutrients), furans (by over-heating), packaging migrations.

5. Comparison Aseptic Filling vs Conventional Process.

The advantages of the new technology are deduced from this the results comparison:

- Heat treatments in "aseptic filling" could be conducted at high temperatures for short periods of time, being more respectful of the sensory and nutritional properties of food (more natural products); Improvement of physic-chemical parameters such as: oxidation, acidity, etc; Reduction/elimination of undesirable by-products (furans by over-heating); Elimination of pack migrations (the package receives the product already cold).

- No risk of tightness loss, deformation or collapsed containers. No risk of barrier properties loose due to sterilization process. Accidents in autoclaves caused by pressure fluctuations (CCP critical control point), quite common major accident requiring

a control per unit, or a "recall" of the market in the worst case.

- Economics. Being a continuous process: labour and energy reduction on variable costs and it also contributes a proportional reduction of fixed cost. Lower cost of the package as it receives the product once cold. Less water consumption by using an ozone-CIP cleaning/disinfection. Also lower floor space required for machines installation.

- Lower environmental impact. Reducing the carbon footprint due to lower energetic consumption and packaging material reduction (lower thermal and mechanical requirements).

6. Market, Costs and Profitability.

Infant foods in Spain represent a market of about 75,000 tons, of which 50% are baby jars. In Europe these jars represent 800,000 tons. And all this we must add 15% of that special incipient line (clinical nutrition and third age).

The previously mentioned lower costs associated to Aseptic Filling technology (labour, energy, water, cleaning/ disinfection, environmental taxes and fixed costs) make the investment profitable in about two years (payback more than acceptable). This is despite the investments are 60-65% higher, depending on the volume.

The starting industry in that business is the most benefited by this technology, having no previous mortgage on old equipments. In spite of that any manufacturer should consider this important improvement, using situations of obsolete or saturated lines. This becomes a major business opportunity.

7. ainia Added Value

ainia provides a comprehensive global realization of the project including: the edible product (formulation and raw materials specifications), the most suitable packaging design (materials composition and shape), the most suitable equipment in the market and proper sanitation facilities previous to each production. Including monitoring and quality control for the shelf-life of each product.

The additional **ainia** advantage is that the Center brings improvements made on the classical aseptic filling technology (packaging design, aseptic closure with superheated steam as an alternative to peroxide, ozone-CIP sanitation).

Inclusion if necessary complementary technologies such as: high pressure, high and radio frequency.