UNIT 3
TOPIC - 3
ASEPTIC PACKAGING SYSTEM

Aseptic packaging can be defined as the filling of a commercially sterile product into a sterile container under aseptic conditions and hermetically sealing the containers so that reinfection is prevented. This results in a product, which is shelf-stable at ambient conditions. The term "aseptic" is derived from the Greek word "septicos" which means the absence of putrefactive micro-organisms.

In practice, generally there are two specific fields of application of aseptic packaging technology:

- Packaging of pre-sterilised and sterile products. Examples are milk and dairy products, puddings, desserts, fruit and vegetable juices, soups, sauces, and products with particulates.
- Packaging of non-sterile product to avoid infection by

Milk in Aseptic Pack

micro-organisms. Examples of this application include fermented dairy products like yoghurt.

Aseptic packaging technology is fundamentally different from that of conventional food processing by canning. In canning, the process begins with treating the food prior to filling. Initial operations inactivate enzymes so that these will not degrade the product during processing. The package is cleaned, and the product is introduced into the package, usually hot. Generally, air that can cause oxidative damage is removed from the interior. The package is hermetically sealed and then subjected to heating. The package must be able to withstand heat up to about 100°C for high acid products and up to 127°C for low acid products, which must receive added heat to destroy heat-resistant microbial spores. Packages containing low-acid (above pH 4.5) food must withstand pressure as well.

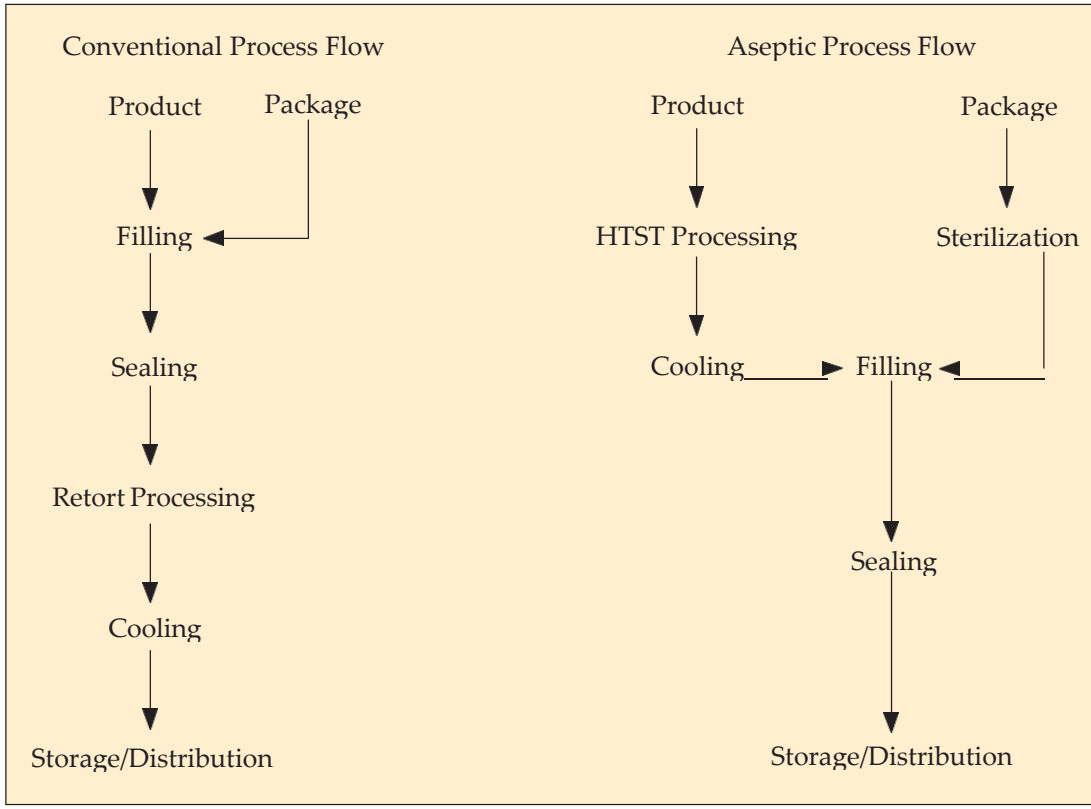
Although conventional canning renders food products commercially sterile, the nutritional contents and the organoleptic properties of the food generally suffer in the processing. Moreover, tinplate containers are heavy in weight, prone to rusting and are of high cost.

Advantages of Aseptic Packaging Technology

The three main advantages of using aseptic packaging technology are:

- Packaging materials, which are unsuitable for in-package sterilisation can be used. Therefore, light weight materials consuming less space offering convenient features

fIgure 1: Conventional Canning v/s Aseptic Packaging



and with low cost such as paper and flexible and semi-rigid plastic materials can be used gainfully.

- Sterilisation process of high-temperature-short time (HTST) for aseptic packaging is thermally efficient and generally gives rise to products of high quality and nutritive value compared to those processed at lower temperatures for longer time.
- Extension of shelf-life of products at normal temperatures by packing them aseptically.

Besides the features mentioned above, additional advantages are that the HTST process utilises less energy, as part of the process-heat is recovered through the heat exchangers and the aseptic process is a modern continuous flow process needing fewer operators.

Aseptic Processing – Methodology

Aseptic processing comprises the following:

- Sterilisation of the products before filling
- Sterilisation of packaging materials or containers and closures before filling

- Sterilisation of aseptic installations before operation (UHT unit, lines for products, sterile air and gases, filler and relevant machine zones)

- Maintaining sterility in this total system during operation; sterilization of all media entering the system, like air, gases, sterile water
- Production of hermetic packages

Sterilization of Products

In aseptic processing, the design to achieve commercial stability is based on the well-founded principles of thermal bacteriology and integrated effect of time/temperature treatment on spores of micro-organisms.

Pre-sterilization of a product usually consists of heating the product to the desired UHT temperature, maintaining this temperature for a given period in order to achieve the desired degree of sterility, with subsequent cooling, usually to ambient temperature and sometimes to an elevated temperature to achieve right viscosity for filling. Heating and cooling should be performed as rapidly as possible to achieve the best quality, depending upon the nature of the product. A fast heat exchange rate is desired for cost reasons.

Various heat transfer methods are used, but essentially the systems can be divided into direct and indirect heat exchange methods.

Some of the latest methods of sterilisation of products include:

- Microwaves
- Electrical resistance heating
- High voltage discharge
- Ultra high pressure

Sterilisation of Aseptic Packaging Materials and Equipment

- Sterilisation Agents: Heat, chemicals and radiation have been used, alone or in combination, for sterilization of aseptic equipment and packaging materials. Practical considerations and regulatory requirements have limited the number of sterilants, which are used for aseptic systems.
  - Heat

  Initially, heat was used as the sterilant for aseptic systems as a natural extension of thermal processing. Product supply lines and fillers are commonly sterilized by 'moist' heat in the form of hot water or saturated steam under pressure. 'Dry' heat, in the form of superheated steam or hot air, may also be used to sterilize equipment. However, due to the relatively high dry heat resistance of bacterial endospores, the time-temperature requirements for dry heat sterilization are considerably higher than those for moist heat sterilization.

  Since, relatively large masses of metal are often present in aseptic filling and packaging systems, high temperatures and relatively long holding periods are necessary to assure

that appropriate sterilization has occurred. Systems employing moist heat are frequently sterilized at temperatures ranging from 121°C to 129°C, while 176°C to 232°C is used for sterilization by dry heat. In addition, sterilization of air by incineration usually is conducted at temperatures ranging from 260°C to 315°C.

- Chemicals

Hydrogen peroxide is the overwhelming choice for use as a chemical sterilant. Other chemicals which have been used as sterilants, primarily for use in systems for acid food, include various acids, ethanol, ethylene oxide and peracetic acid.

Hydrogen peroxide is not an efficient sporicide when used at room temperature. However, the sporicidal activity increases substantially with increasing temperatures. Therefore, most aseptic packaging systems use hydrogen peroxide (at concentrations of 30 to 35%) as a sterilant for packaging materials followed by hot air (60°C to 125°C) to dissipate residual hydrogen peroxide.

- Radiation

Gamma-radiation has been used for decades to decontaminate packaging materials for use in aseptic systems for packing acid and acidified food. Due to the penetrating powers of gamma-radiation, packages are treated in bulk at commercial irradiators. A dose of approximately 1.5 Megaradians (Mrad) is commonly used to decontaminate containers for acid and acidified food. Recently, processes for low acid food aseptic filling and packaging systems are also being accepted. Doses required to sterilize containers for use with low acid food are considerably higher than those required for acid and acidified food.

Other types of radiation are not widely used in aseptic systems. Ultraviolet (UV-C) light has been used to decontaminate food contact surfaces. The low penetration and problems associated with 'shadowing', limit the use of UV-C for aseptic systems packaging of low acid food. While equipment size, speed and costs have precluded use of electron beam irradiators until now; it is only a matter of time before such a system is developed.

Filling

- Once the product has been brought to the sterilisation temperature, it flows into a holding tube. The tube provides the required residence time at the sterilisation temperature. The process is designed to ensure that the fastest moving particle through the holding tube will receive a time/temperature process sufficient for sterilisation. Since there is some loss of temperature as product passes through the holding tube, the product temperature must be sufficiently high on entering, so that even with some temperature drop, it will still at least be at the prescribed minimum temperature at the exit of the holding tube. No external heating of the holding tube should take place.
- A deaerator is used to remove air, as most products, which are aseptically processed, must be deaerated prior to packaging. The air is removed to prevent undesirable oxidative reactions, which occur as the product temperature is increased during the process. The deaerator generally consists of a vessel in which the product is exposed to a vacuum on a

continuous flow.

- The sterilised product is accumulated in an aseptic surge tank prior to packaging. The valve system that connects the surge tank between the end of the cooling section and the packaging system, allows the processor to carry out the processing and packaging functions more or less independently. The product is pumped into the surge tank and is removed by maintaining a positive pressure in the tank with sterile air or other sterile gas. The positive pressure must be monitored and controlled to protect the tank from contamination.

Tetra Brik Aseptic

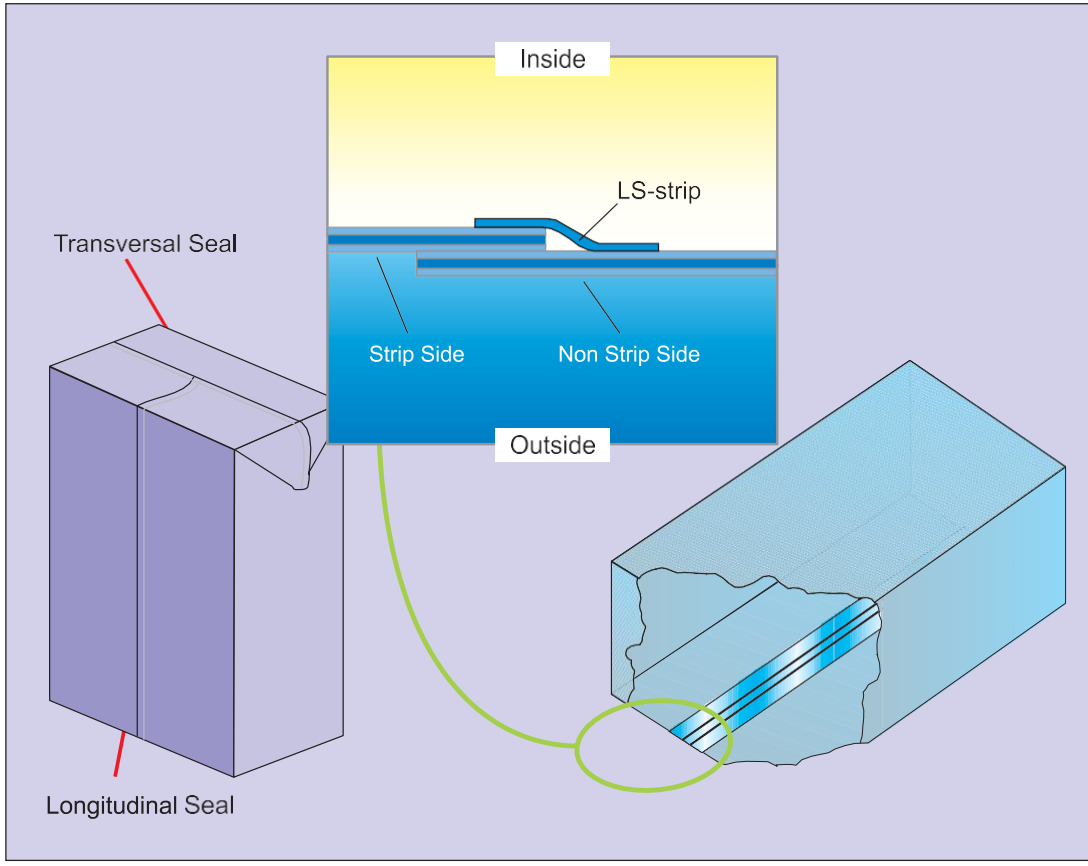
Tetra Brik Aseptic with Spin Cap

Tetra Rex

Seals and Closures

Any aseptic system must be capable of closing and/or sealing the package hermetically to maintain sterility during handling and distribution. The integrity of the closure and seal is therefore of paramount importance. The integrity of the heat-seals used in most aseptic

Figure 2: Sealings



systems is principally influenced by the efficiency of the sealing system used and by contamination of the heat seal area by the product. To avoid recontamination, the production units, which are tight are required. Two systems are manufactured in the Tetrapak system- the longitudinal and the transverse seam.

In the longitudnal system, a flat web of packaging material is used, supplied in reels. This flat material web is formed into a tube, which is sealed longitudinally resulting in a cylinder shaped structure. The strength of this longitudinal seam is determined partly by an "overlap seal" and partly by a plastic longitudinal strip. This strip is first sealed to one edge of the packaging material web and–once the packaging material tube has been formed – sealed to the inner surface of the packaging material. Both these operations, the strip application and the actual longitudinal sealing are done by using sterile, hot air and pressure (Figure 2).

Transversal sealing is done below the level of the product in the packaging material tube. By constantly moving sealing and pressure jaws, pressure is applied from the outside of the packaging material tube squeezing the product from the sealing area. An electrical impulse

is passed through the sealing jaw and heat is transferred from the outside to the inside plastic layer of the packaging material. The polyethylene layer is heated, melted and pressed together between a pair of jaws. While pressure is maintained, the melted plastic layer cools down and a bonding is effectuated between the two opposite packaging material surfaces: they are sealed transversally.

Maintenance and preventive maintenance is needed to ensure satisfactory seam quality as well as to prevent damage of the packaging material in general, which may interfere with the tightness of the container. Thus, units are produced which are sufficiently tight to prevent re-infection of the product.

Types of Aseptic Packs

Consumer Packages

A great variety of packages may be aseptically filled now as listed.

- Carton Boxes: Some of the existing aseptic carton boxes may now be filled with particulates, also aseptically.
- Bags and Pouches: 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 a Japanese machine uses closed pouches from a reel with sterile interior surfaces, the exterior of which is sterilized in a hydrogen peroxide bath when the web with pouches enters the aseptic cabinet. The bags are then cut from the web, filled and sealed.
- Cups and Trays: These are either used pre-made or formed, filled and sealed in thermoform/ fill/seal machines. Both types of machines 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.
- Bottles and Jars: 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. In a recent development, returnable bottles are filled aseptically, which up to now were applied only for UHT – treated milk.

Fruits, Juices in Tetra Pack with and without Spin Cap

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.

- Metal Cans: As mentioned earlier, only 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, such as rice.

- Plastic Cans: An aseptic machine for filling and closing of two-piece plastic cans, 'gourmet cans', was recently developed. Cans and lids with easy opening feature consist of PP/ EVOH/PP. They are sterilized with hydrogen peroxide, UV radiation and heat-sealed inductively. The can is presently offered for liquids only – for example coffee.
- Composite Cans: These may, at present, not be filled with particulate food, but only with fruit juice wit long fibers.