MICRO-OVENABLE PACKAGES AND RETORTABLE PACKAGES

The advent of modern urban dynamic lifestyle has created a demand for ready-to-eat food to be met by food product manufacturers. The urban middle and upper middle class consumers have little time to do their cooking in a conventional manner and welcome ready to eat food products.

Micro-ovenable Popcorn Packages

The market for domestic appliances has also witnessed tremendous growth with respect to the availability of sophisticated appliances such as the microwave-oven, which has now been accepted as a modern domestic appliance for food cooking.

In view of the above developments, the market needs innovative packages, which can be micro-waved and hence can be used for the packaging of ready-to-eat food products.

Microwave Packaging

Microwave package is a package, which can be used for cooking or heating the product in a microwave oven. Thermal conductivity of the package can affect the heat transfer between food and oven. The package alters the heating pattern of the contained food, by releasing or tapping the water vapour inside the package, thereby cooking the product under controlled pressure and temperature. Two types of microwave packages are available. One of them allows microwaves to pass through the material, they are called microwave transparent materials. Most of the conventional packaging materials are transparent to microwave. Paper, glass and all plastic materials such as polyethylene, polypropylene, polyester, nylon, polystyrene, poly vinyl chloride are all microwave transparent materials. Microwaves heat the product without interfering with these packaging materials. Their application in microwave package development depends upon their thermal stability and compatibility with the product under high temperature and pressure.

The other type called microwave active package, involves use of packaging material that directly affects the cooking of the product inside the pack. In these types of packages, the microwaves are modified by use of susceptors, reflectors or a guidance system. The size, shape, location and composition of microwave active package can alter the environment both inside the package and in the oven cavity. The food that are unsuitable for re-heating in the microwave oven use these packaging materials.

A microwavable package should perform all the functions of a conventional package plus microwavability. The packaging requirements for micro-ovenable products are as follows:

- Allow rapid microwave heating
- Barrier to oxygen, moisture, micro-organisms
- Compatibility with product
- Withstand processing and storage conditions
- Retain solvent and odour in packaging material during storage and cooking
- Provide physical strength
- Cost effective

For good microwave performance it is necessary to consider the following points:

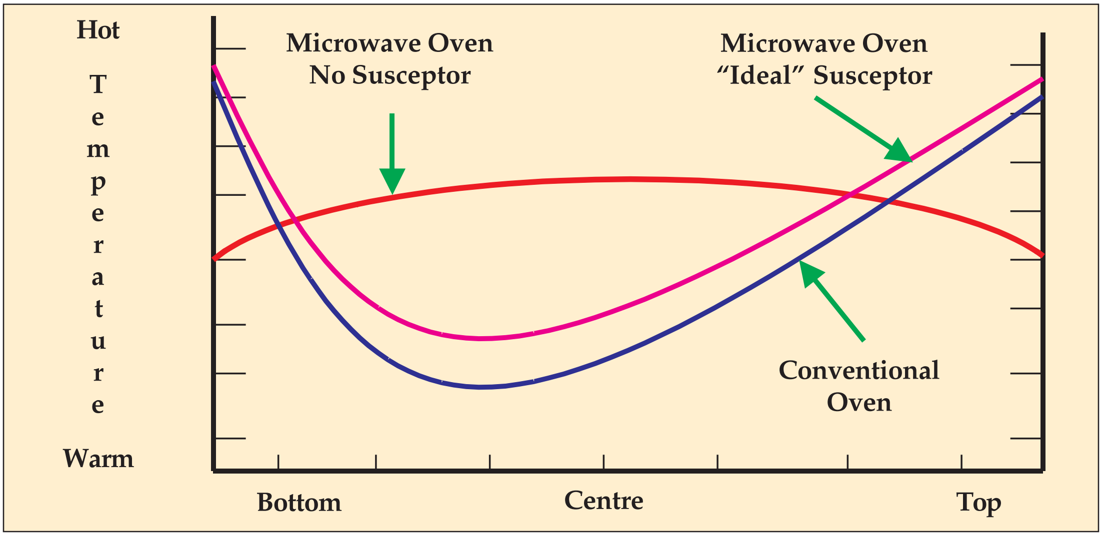
- Uniform distribution of heat within the pack
- The product package lay out
- Safety of the consumer
- A device to show heat distribution inside the package
- Safety methods of opening device
- Insulated label
- A means for holding the pack after re-heating

Micro-ovenability requires understanding the product and its heat transfer properties, conversion of microwave energy into heat energy by the package and its contents, marketing, production, storage and distribution needs.

Many factors influence microwave package development. Product characteristics such as shape, size, density, presence of salts, minerals, amount of free and bound water, heating characteristics of the product during thawing, initial and final cooking temperature variation in product species and product composition, all affect microwave heating. The storage temperature, size and shape of the package as well as power distribution in the microwave ovens are also some of the important factors.

In microwave package development, it is important to know the amount of energy converted and the way in which heat transfer takes place inside the package and product. The amount of heat required to process the food inside the package is the same in conventional as well as microwave heating. The difference is in the source of energy, energy conversion and the way in which heat transfer takes place. The energy inside a microwave oven is an oscillating electrical and magnetic field, perpendicular to each other. A microwave oven contains a device called magnetron, which converts low frequency (60 cycles/sec) electrical energy into a high frequency (2450,000,000 cycles/sec) electromagnetic field. Microwave heating depends on fundamental principles that must be considered in both product and package design. In conventional heating, food is placed in a high temperature environment and it absorbs heat from the oven over a time. In a microwave oven, food is placed in an electromagnetic field at ambient (room) temperature and heat is generated by the food's own ingredients and some times by the packaging. The temperature gradients that might be observed if the same food were heated in a conventional and microwave oven are given in Figure 1.

Figure 1: Temperature Gradients in Microwave and Conventional Heating of Food



The rapidly varying electric field of microwaves is responsible for most of the heating of food in a microwave oven. In developing products for microwave processing, it is important to recognize that microwaves are a form of energy, not a form of heat and are only manifested as heat on interaction with a material as a result of one or more energy transfer mechanisms. There are two main mechanisms by which microwaves produce heat in food.

Dipole Rotation

Most food products exhibit heating because the water in them is excited by oscillation of the microwave field. The water molecules in the food, which are randomly oriented under normal conditions try to realign themselves with the rapidly changing, alternating electric field. In this field, the molecules act as miniature dipoles and while oscillating around their axis in an attempt to go to the proper positive and negative poles, gain potential energy. This gained energy is released as random kinetic energy or heat i.e. the intermolecular friction which is created by oscillation is manifested as a heating effect. This results in the disruption of hydrogen bond between water molecules and heat is generated by molecular friction. The heat is then transferred by the conventional conduction.

Ionic Polarisation

Ionic polarisation occurs when ions in solution move in response to an electric field. Ions carry an electric charge and are accelerated by the electric field. Kinetic energy is given up by the field, to the ions, which collide with other ions, converting kinetic energy into heat. At microwave frequencies, numerous collisions occur and much heat is generated.

Product Characteristics in Package Development

Microwave heating is also dependent on the physical state, shape, size and composition of the material.

Mass

The rate at which food inside the microwave package heats, depends upon the mass of individual pieces as well as total mass.

Density

Penetration depth decreases with increase in product density.

Geometry

Shape and size of the product is important in microwave heating. Reflective properties of the product surface can create uneven heating. Ends, sharp edges and corners gets heated faster than the bulk material. The most uniform heating is observed in donut shaped products.

Composition

Dielectric properties of a product depend upon its composition. Thermal conductivity, specific heat and heat of fusion of a product affects its rate of heating and heating uniformity. Water absorbs microwave energy very efficiently. As compared to water, fats and oils have lower dielectric constants and specific heat; therefore, oil requires less absorbed energy to raise the temperature of a mass oil compared to an equivalent mass of water.

Temperature

Temperature has direct effect on the dielectric properties of the material.

Homogeneity

Product homogeneity is very important in microwave heating. Dielectric heating predominates early in the heating process while thermal properties of individual components dominate at later stages of heating. As the temperature gradients are increased within the food, the heat transfer takes place by conduction and convection.

Therefore, to achieve desirable and appropriate cooking, the product has to be packed in suitable packaging materials. Packaging materials react to microwaves in three ways.

Packaging materials:

- Transmit the radiation
- Reflect the radiation
- Absorb the radiation

By proper package design, the amount of energy transmitted, reflected and absorbed can be varied, controlled and proportioned. The total amount of energy is always the same. Hence, the role of packaging in microwave heating is very important. The package dimension, shape and material of construction can change the way in which the product is heated inside the package.

The types of packaging materials can be divided into four categories.

Microwave Transparent Materials

In these types of packages, microwaves penetrate the transparent material - like light passes through glass - and are absorbed by the product. Most of the conventional packaging materials are transparent to microwaves. Paper, glass and all types of plastic materials such as polyethylene, polyester, polystyrene etc. are all microwave transparent materials. Microwave will heat the product without interfering with these packaging materials. These materials hold the food while cooking, but do not directly affect the quality of the re-heated food. Their application in microwave package development depends upon their thermal stability and compatibility with the product under high temperature and pressure.

Microwave Absorbent Materials

These materials absorb microwave energy and re-emit that energy as heat energy. These materials are called susceptors. They are mainly used to achieve localised effects such as crisping and browning. A susceptor is defined as a material, which converts microwave energy into heat, sufficient to produce a surface temperature well above that reached in the adjacent food material mainly by absorption of microwaves. Susceptors consist of microwave interactive films, usually extremely thin films of metals such as aluminium or stainless steel, which are coated onto flexible polyester or other plastic base. This, in turn, is bonded to a support structure usually made of paper or paperboard. The thickness of such films is usually measured in Angstrom as they are very thin. When placed in a microwave field, a current flows through the metallic film, and if the surface resistivity of the film is at the appropriate level, very rapid heating will occur by the conversion of the microwave energy into heat. Temperature of 120°C and higher can be achieved within one minute. Susceptors can also be used to form a box or carton around the food piece to provide hot air. Flexible susceptors are also used as wraps round the food, or bags into which the food is placed. It is a combination of metal and plastic. To produce susceptor films, metal (usually aluminium) is either vacuum, flake or electron beam deposited or sputtered onto a plastic substrate. Molecules in the metal absorb microwave energy and become agitated, creating radiant heat to cause surfaces to crispen and brown.

Susceptors convert microwave energy into heat energy. This makes the surface of the package hot for browning and crisping of the product. The absorption mechanism is strongly dependant on the structure of the film, and it is the micro structure which is the key factor in determining the heat behaviour. The effectiveness of microwave susceptor film depends on the conductivity of the metallised substrate. Two types of materials are available for producing susceptors (a) resistive coatings and (b) ferromagnetic / electronic materials.

There are numerous applications for using this type of packaging technology, however, a susceptor being a one sheet device, its storage life-span is affected by oxidation and it tends to be less effective when wet. Susceptors are produced as sleeves, pads, trays, cartons or containers and even see-through wraps, which can take the form of the food product. Non uniform heating, overheating and scorching are possible problems with susceptors. Susceptors used should be properly evaluated for safety in package development.

Microwave Shielding Material

Shielding materials are those materials, which reflect the microwaves without absorbing or transmitting. All metal containers, heavier metalised plastic and foil laminates reflect microwaves. No energy penetrates through the shielding material and hence by using these materials in package development, the product is prevented from microwave over heating. Shielding materials are good conductors of heat. Examples of shielding materials include foil, foil laminated to a sulphate or aluminium sheet converted into pans and trays. Arcing is the major problem in shielding materials. Arcing is prevented by coating the shielding material with non-conducting electrical insulators or by laminating the materials with plastic or paperboard.

Field Intensifying Material

Microwaves like light, can be reflected, scattered, focussed and modified. The packaging material, which is used to modify the electromagnetic fields are called field intensifiers. They are mainly used to:

- Vary the cooking time of a product
- Control the amount of energy going into the product
- Modify the heat transfer properties inside the package
- Control the amount of microwave energy absorbed by the package
- Enhance browning and crispening of the product
- Control heating rate of the product
- Provide differential heating of multi-component food

Microwavable Packages

Material selection is based on cost and barrier properties. Following are some of the microwavable packages:

Flexible Microwavable Packages

They are made from susceptors, laminated to paper and other high heat resistant plastic material in the form of bags, overwraps, sleeves and boil-in-bag. These are packaging materials incorporated with microwave active components in roll stock form, which is used to make packages on vertical form-fill-seal machines, horizontal wrapping machines and inline thermoform fill-seal packaging machines.

Microwave Safe Coated Aluminium Tray

Aluminium trays are coated with vinyl and epoxy resins to absorb microwave energy and prevent arcing. They are sealed with transparent lidding material or foil laminates. A snap on re-closable plastic dome is used for microwave heating. They can go from freezer to microwave or conventional oven without loosing rigidity.

Rigid Plastic Tray

They are made from the materials, which can be used in combination or as monolayers, like PET, PP, nylon, PC, polysulphone, HDPE or engineered plastics. They are sealed by heat sealable lidding materials, overwrapped/shrink wrapped or sealed inside a microwavable bag. Because of their inline formability into different attractive shapes and sizes, easy availability of material and possibility of blending different material of different performance and cost parameters to meet the end use makes them more attractive.

Paper Board Containers

Polyester-coated paperboard containers are most common microwavable packages. These packages are moulded in different shapes and sizes. They are formed on a conventional tray making, carton forming and folding carton making machine. They are the least expensive microwave transparent material.

Crystallized Polyester (PET)

Crystallized polyester containers are very popular for microwave packaging as well as conventional oven cooking. They are self-serving and reusable. Crystallized Polyester is vacuum formed from shed stock into different shapes, is stiff and has a good appearance. The containers are sealed with transparent / non-transparent lidding material in a high speed tray sealing machine, are easy to handle, sturdy, attractive, cost competent and can be compartmentalised for multi-component food.

Moulded Pulp Containers

Moulded pulp trays are much stronger than pressed trays. They are very stiff and have quality appearance. These containers are economical and are made in attractive designs and colours. Due to their strength, appearance and compatibility they are used as self-serving containers. They are dual ovenable and are sealed on standard tray sealing machine.

Retort Packaging

Food is spoiled principally by the action of micro-organisms. Thermal processing destroys these harmful micro-organisms by heat. The aim of thermal processing is to bring the food as rapidly as possible to a temperature at which unwanted organisms are killed, and to hold the food at that temperature long enough to render the food "commercially sterile".

Retort is a form of thermal processing of food. Retort packaging materials are defined by ASTM as "Those capable of withstanding specified thermal processing in a closed retort at temperature over 100°C. Retort processing is the most acceptable form of food preservation. It represents a unique combination of package process and product technologies with potential, functional, quality and economic benefits. Retort pouch has been developed as an alternate to metal and glass for packaging of processed food products. The term "Retort Pack" is used to describe a flexible or semi-rigid package into which food products are placed, sealed and sterilised at temperature greater than 100°C. Usually food with pH above 4.5 is packaged by this process. They are sterile and shelf-stable.

Retortable packages maintain their material integrity as well as their required barrier properties for the designated product during package handling, thermal processing and subsequent handling and transport abuse. For shelf-stable food, the material used must be retortable and still maintain extended barrier characteristics against such effects as light, moisture, oxygen, microbial penetration etc.

The selection of a polymer and combination is based on the requirement of barrier properties. Retort packages are available in the form of flexible pouches of co-extruded and/or laminated films of PET, PC, and PP with aluminium foil, thermoformed when it comes to trays and containers by injection blow moulding process. It has the advantage of combining shelf stability of canned food with texture and nutritive value of frozen food.

Composition

The main requirement for a plastic material is that it will withstand the rigours of heating and cooling process. Again, it is necessary to control the overpressure correctly to maintain a balance between the internal pressure developed during processing and the pressure of the heating medium. The main plastic materials used for heat processed food are polypropylene and polyester.

These are usually fabricated with an oxygen barrier layer. For see through film it may be ethyl vinyl alcohol, polyvinylidine chloride and polyamide. These multilayer materials are used to manufacture flexible pouches and semi rigid containers. Currently in India flexible packaging material available usually consists of aluminium foil which is usually laminated to polyester at the top and cast polypropylene as the inside layer. Semi rigid containers are not popular in India in view of the non-availability of suitable material for retort processing.

Retort Pouch

Retort pouch is a flexible package made from multilayer plastic films with or without aluminium foil as one of the layers. Their most important feature is that, unlike usual flexible pouches they are made of heat resistant plastics, thus making them suitable for processing in retorts at temperature of around 121°C normally encountered in thermal sterilization of food. Besides, retort pouches possess toughness and puncture resistance normally required for any flexible packaging to be machinable in pouch making and packaging operations and also withstand the rigours of handling and distribution. Apart from being heat sealable, the pouch material has good barrier properties to give the desired shelf-life to the product and be suitable for food contact applications.

The typical retort pouch materials currently used are:

1) 9 to 25µ polyester /9 to 25µ aluminium foil / 50 to 85µ polypropylene.
2) 15 to 30µ polyamide / 50 to 75µ cast polypropylene
3) 12µ polyester / 9µ aluminium foil / 15µ oriented polyamide (nylon 6) / 50µ polypropylene

Ready-to-eat Food in Retort Pouch

The 3-ply laminate consisting of PET/ Al foil/PP is the most common material used in retort pouches and is the only one used in India at present. PET or polyester, used as the outer layer in thickness of about 12µ, gives the required strength to the pouch. PET with its excellent glossy surface and printability, is reverse printed so that inks are embedded between the outer layer and the next inner layer to give striking graphics. Aluminium foil used in the thickness of 9 to 25µ serves as the barrier layer, which is responsible for the shelf-life of more than one year obtained for the product. Polypropylene (PP) used as the inner layer usually in the thickness of about 75µ provides the critical seal integrity, flexibility, strength and taste and odour compatibility with a variety of food products.

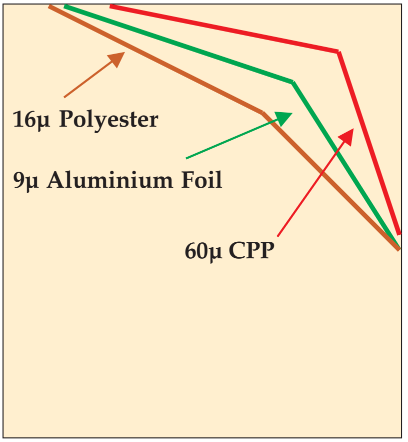
Other materials commonly used in retort pouch structures include nylon, silica-coated nylon, ethylene vinyl alcohol (EVOH) and polyvinyledene chloride (PVDC). Nylon has limited gas barrier properties and, in combination with PP, it is used for products that do not require more than 3 – 6 months shelf-life.

With the more recent availability of high gas barrier material such as EVOH, PVDC and silica-coated nylon, non-foil based retort pouches that give long shelf-life have also become popular.

The retort food manufacturing system consists of food preparing equipment, filling, sealing machines, retorting equipment, sterilisation racks, sterilisation rack transfer equipment, cartoning machine and outer cartoning machine. Retort pouches are either prefabricated, filled and sealed on pouch machine or they are made from roll stock including filling and sealing. Control of temperature, time and pressure are very important for making strong seals. It is also necessary to determine the quality of the product to be filled, for the thickness of the filled pouch dictates the process time. Also, over filling should be avoided for it may cause splashing and may contaminate the seal area.

These pouches are designed such that they can withstand retort temperature and pressure. During retorting, pouches are carefully laid on racks to maximise heat transfer and minimise potential damage to seals or foil structures within the retort; this is usually, but not always accomplished by water immersion. Retorting heat-sealed pouches is a delicate balance between effecting heat penetration and avoiding fusion heat-seal bursting. Retort pressure is controlled very carefully to counter steam pressure developed within the pouch from the heating and residual internal steam pressure during cooling portion of the cycle.

Figure 2: Typical Structure of Retort Pouch



Typical structure used for retort pouch is shown in Figure 2.

The structure of the retortable pouch, in general use today, is a 3-ply laminate composed of 16µ polyester film, adhesive laminated to 9µ aluminium foil, which is either laminated 60µ CPP or is extrusion coated with 60µ CPP.

The basic requirements for retort pouch film are as follows:

- Low gas (Oxygen) permeability
- Low water vapour transmission rate
- Resistance to temperature from below 0°C to at least 121°C to cover possible

storage condition exposures and the minimum sterilisation level for low acid products

- Inertness in terms of resistance to penetration by food components and low migration of film components in conformance with food and drug regulations
- Heat seal-ability and capability of being handled on automatic fabricating and filling equipment
- Good ageing properties
- Physical strength to resist any handling abuse during manufacturing and during distribution cycles

The retort pouch has been considered as the most significant advancement in food packaging since the metal can, and has become a feasible alternative to the metal can and glass containers. The retort pouch has a number of advantages over the metal can.

Advantages of Retort Pouch

The success of retort pouch and its widespread adoption by many food manufacturers can be traced to the many advantages that it offers compared to canned and frozen food packages.

The pouch with its thin cross-sectional profile, compared to cans takes about 30% - 50% less time to reach sterilizing temperature at the center of the food. Due to shorter process time, the product near the surface is not overcooked. Moreover, the rate of destruction of sensory and nutritional factors is greater than that of micro-organisms at lower temperatures and quick heat penetration in retort pouches helps in better quality retention. Because of the shorter process time, many products can be processed without losing colour, flavour and texture.

Retort pouch products are processed to achieve commercial sterility and hence are shelf-stable at room temperature without requiring refrigeration or freezing.

Retort pouched food products can be reheated quickly, usually by the boil-in-the-bag method. The retort pouch product can be consumed as such without heating or it can either be heated quickly by keeping the pouch in boiling water for about 3 minutes or by opening the pouch, removing and heating the food product directly in the bowl in microwave oven for a minute. Frozen food, in contrast, require thawing and heating for about half an hour.

Opening of the "retort pouch" is simple compared to a "can" since it can be done by tearing across the top at a notch in the side seal or by cutting with scissors.

Retort pouches weigh less and take up less storage space thus reducing distribution costs.

The cost of the retort pouch is less than half of the metal can of the same size, and the overall energy costs starting from manufacture to consumption are much less in the case of the former.

It is self-evident that the cost advantages offered by retort pouch makes it a more affordable package compared to a "can" or a "glass bottle" thus making it an ideal package for marketing ready-to-eat Indian dishes in the Indian market.

The shelf stability at room temperature of ready-to-eat food in retort pouches is achieved by the use of sterilization technology that is also used in canning, wherein all the life-threatening and hazardous-to-health micro-organisms are completely destroyed and the micro organisms capable of inducing spoilage of the food are reduced in numbers to the extent that not more than 1 in 1,000 or 10,000 packages get spoiled. In other words, the contents are biologically stable at ambient temperature and do not require low temperature storage. These "commercially sterile" food products have a shelf-life of at least 1 year when the pouch is made of aluminium foil laminate, provided the hermetic seal of the package is not compromised. Though the use of a paperboard carton as an outer package is not essential, it is normally used to give the pouch better handling properties and make it amenable for shelf display.

It may also be noted that at the same time, production of retort-pouched food requires better control on the various operations involved compared to canning since there are many critical issues that need to be addressed.

Thus, to describe in brief, retort pouches have several advantages viz.:

- **From Processor's Point of View**
  - Shorter sterilisation cycle due to thin profile of containers. Hence, there is 30% - 40% reduction in processing time compared to cans
  - Less deterioration of flavour, taste, colour and nutrition-due to reduced exposure to heat
  - Empty containers save almost 85% of space during warehousing when compared with empty cans.
  - Being light in weight, transportation charges are less
- **From Consumers Point of View**
  - Easy to handle
  - Easy to cook
  - Easy to open

Applications of Retort Pouches

The following types of food may be packed in the retort pouch: Meat, sauces with or without particulate, soups, fruits and vegetables, speciality items like potato salad, bakery products, pet food and other products. Some of the eateries that have been packed are meatballs and gravy or tomato sauce, chicken stew, beef stew, ravioli, spaghetti and meat, barbeque chicken, sukiyaki, and others.

Some of the ready-to-eat Indian food packed in retort pouches available in the market are: Madras Lentil Rice Pongal, Mumbai Pav Bhaji, Malabar Mixed Vegetables, Navrathan Kurma, Mixed Vegetable Curry, Rajma Masala, Channa Masala, Dhal Fry, Palak Paneer, Plain Rice, Veg. Noodles, Veg. Pulav, Alu Mutter, Tomato Rice, Veg. Kurma, Mysore Sambhar Rice, Bangalore Vegetable Upma, Alu Chole, Tadka Dal.

Semi-Rigid Retortable Thermoformed Containers

These semi-rigid plastic containers are a tray or tub with a supporting body and a peelable lid. Thermoforming, cold impact forming and co-extrusion have recently advanced the state-of-the-art of retort packaging. Originally, the trays were made of aluminium foil, laminated with CPP as the exterior layer. Recently, high barrier plastics have replaced this in order to be micro-ovenable. Two plastics that are being used are PVDC(saran) and EVOH. The lidding material generally comprises of a laminate of PET/Al foil/CPP. The primary structure of these containers is PET/EVOH or PVDC/CPP sandwiched with appropriate tie layers and fillers.

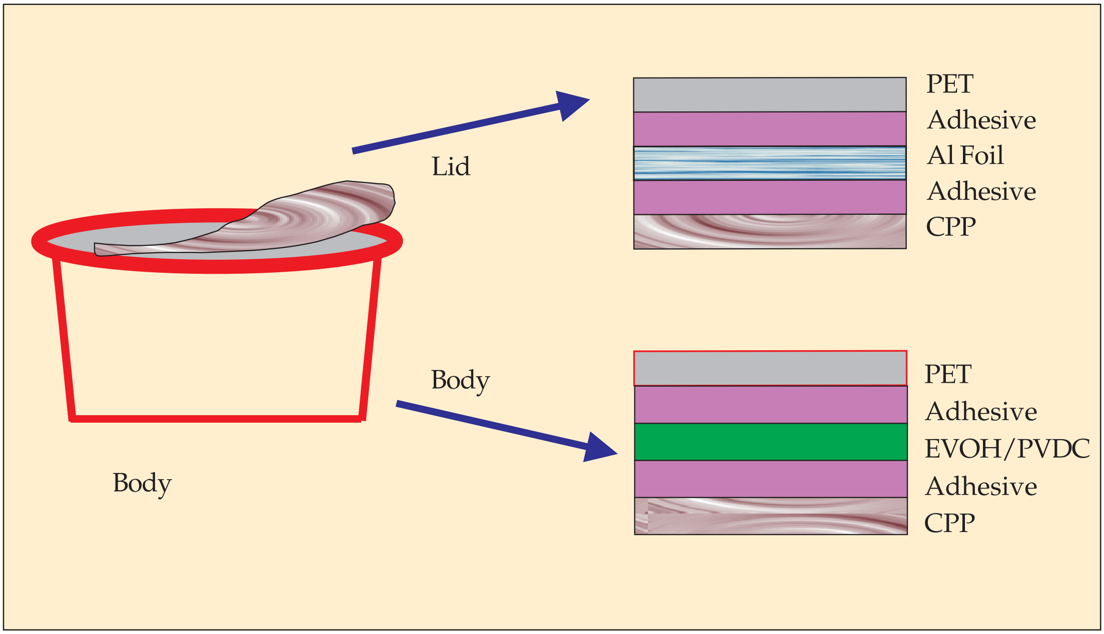
The RTF (rotary thermoformed) process co-extrudes multiple layer sheeting directly on to a rotary drum where it is thermoformed into multi-cavities whilst the sheet is still above the melt temperature of polypropylene. Cooling occurs during thermoforming and the formed sheet passes directly to a filling and lidding station prior to being severed into individual containers. The structure may contain 2 – 8 layers in thickness from 6 – 80 milli (0.006 – 0.080) inches. A typical RTF container has seven layers: Polypropylene / regrind / adhesive tie-layer / EVOH / adhesive tie layer / regrind / polypropylene.

Alternate materials under investigation are HIPS, crystallized polyester and polycarbonates. In addition to providing the barrier properties required, these containers survive the high temperature required for filling and processing, whether aseptic, hot fill or retort up to 135°C. The structural integrity is such that the dimensional stability is maintained throughout the retort process. The design of the container and rigidity of its flange affect ability to easily remove a fusion sealed membrane from the container.

These high barrier containers require lidding materials whose barrier properties are either equal to or better than the container itself. The lidding system must be abuse resistant, printable, sealable (preferably by heat) and easy to open. The lidding materials currently available are extensions of retort pouch technology. The exterior is polyester for printability, scuff and tear resistance. Heavy gauge aluminium foil is used for stiffness and to provide light, moisture and oxygen barrier. CPP films or proprietary coatings provide the interior heat seal component. Presently, trays are thus sealed with lid of PET(Polyester)/ Aluminium foil/ CPP. They can also be sealed with lid of PP/EVOH/PP/PET. While some of these lid structures can be removed without the use of scissors or knife, early testing indicates that they provide a completely hermetic high integrity seal and will be able to survive the abuse of shipping and handling.

Typical structure of lid and body of high barrier multi-layer plastic retortable semi-rigid tray is shown in Figure 3.

Figure 3: Typical Structure of Lid and Body of Retortable Semi-rigid Tray



Advantages of Retortable Trays

The advantages of retortable trays are as follows:

- The thin profile of the container or tray provides rapid heat transfer for both preparation and for sterilization during processing. A 30% - 40% reduction in processing time is possible, with savings of energy.
- Reduced heat exposure results in improvements in taste, colour and flavour; there are also less nutrient losses.
- Food can be consumed directly from the semi-rigid container (i.e. tray).
- Storage space of the tray in a paperboard carton is not larger than that for cans; disposal space is less.
- Trays do not corrode externally and there is a minimum of product-container interaction.
- The container lid may be peeled open or cut with a knife.
- The container cost is less than the conventional rigid type containers presently in use. However, with the protective overwrap, the costs could be about the same as that of metal cans.
- The energy requirements for tray construction are less than that for cans.

Retortable Pressure Formed Plastic Containers

These are scrapless containers, manufactured by die cutting co-extruded barrier sheetings cut into billtets. Scrap from this operation is reground and incorporated into inner layers of the laminate. The billets are placed in a mould, preheated and compression moulded. Scrap is said to be about 9-10%, compared to 40% from traditional thermoforming processes.

Peelable heat seal lidding material are of two types (a) polyester film/adhesive/aluminium foil/adhesive/polypropylene film, or (b) oriented polypropylene film/adhesive/aluminium foil/adhesive/cast polypropylene film is used as lidding material.

Retortable Injection Blow Moulded Plastic Containers

In this, multilayer co-extruder is coupled with an injection blow moulding machine to produce a cylindrical seamless can with sturdy flanges that will accept a seamed on metal can lid. The lid can incorporate a ring tab pull for easy opening because the process is scrapless, there is no need for regrind layers. Deeper draws can be achieved by thermoforming process. The container base is shaped to nest the lid of a can beneath, which permits stable stacking. The container is claimed to offer substantial economics over metal cans, as well as attractiveness and easy opening. It will have slower heat transfer during retorting, and retains the disadvantages of cylindrical shape versus the thinner retort pouch.

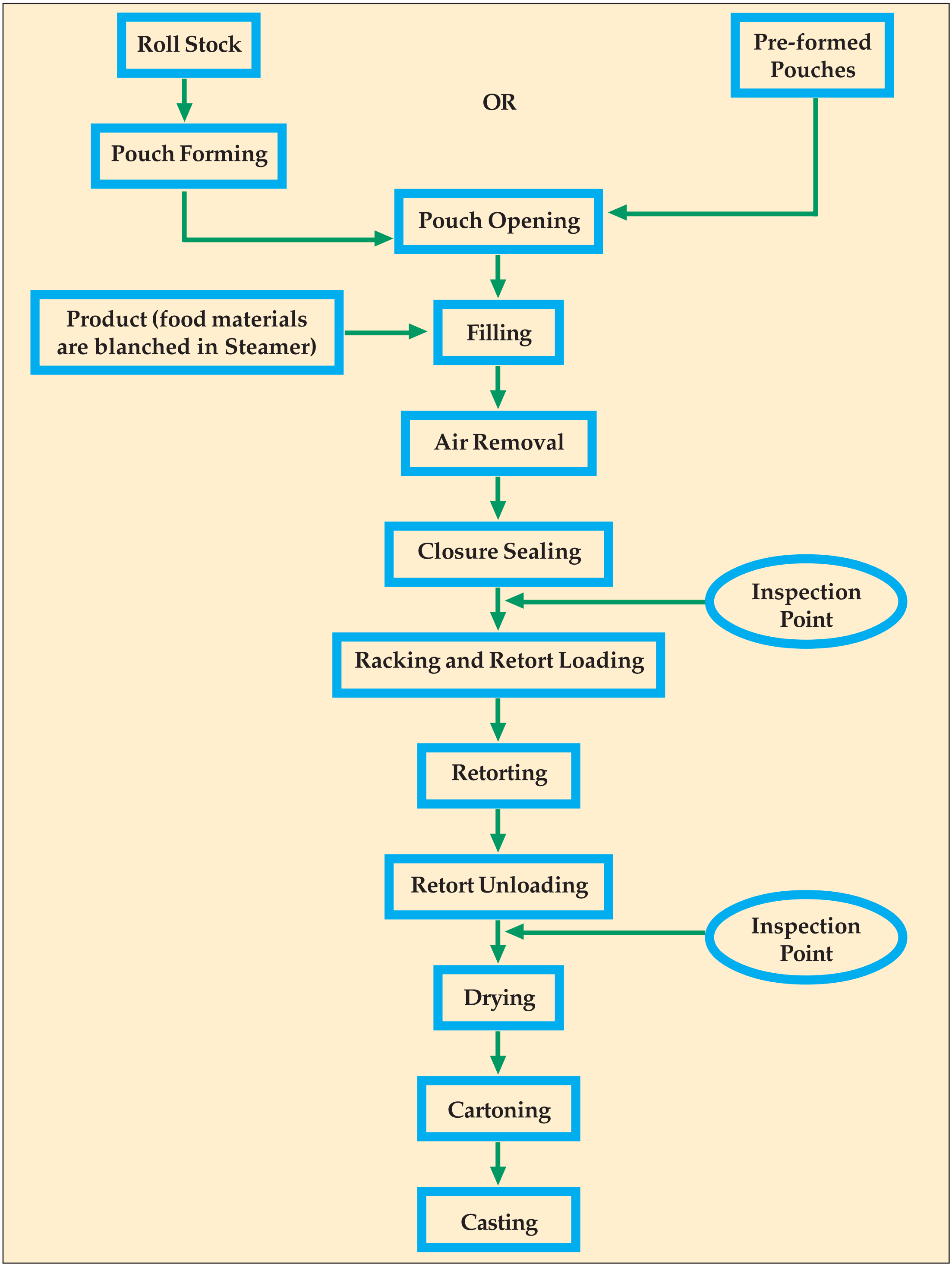
Processing of Food in Retort Pouches

The first step in the manufacture of laminate for pouches involves printing the polyester film. Excellent print quality, multiple colour registration, repeat length and long run economy are associated with graver printing which is usually employed. The printed polyester film can be adhesive laminated to the aluminium foil and then laminated to the polypropylene or the printed polyester film can be laminated to a pre-mounted, foil polypropylene base laminate. Food grade epoxy phenolic adhesive is generally used. In either case, the adhesive is applied to a substrate and then passed through an oven, which sets the adhesive (i.e. dry lamination). The combining of the two webs is done on a heated roller by employing pressure. The manufacture of retort pouch packs involves a series of lengthy operations. Pouches are preformed, or formed as an in-line operation with filling and sealing. In either event, they are formed from roll stock by folding a single roll along its centre or by bringing two separate rolls together heat seal side to heat seal side. Figure 4 gives a flow chart for typical retort pouch production.

Filling

Filling the pouches with raw material is the first step in the process. Filling systems range from manual to automatic with variations and combinations of both. The essential requirement is that the pouch seal be kept free from contamination with the product since this could impair sterility, either by spoilage or resultant leakage at the seam. Systems capable of dispensing product components of various types including fresh food pieces, slices and sauces are available. Liquids and liquid-solid mixes can be closed using rotary valve piston dosers. Solids can be dispensed using dry fillers. Where the product has to be arranged in the pack with fishes like sardine, mackerel etc. there is alternative to hand filling.

Figure 4: Flow Chart for a Typical Retort Pouch Production System



Air Removal

Removal of air from the filled pouch, is done to remove the bulk of the air from retort pouches before they are sealed. Removal of air from the filled pouch is normally effected on an automatic line and is necessary for several reasons, like:

- To ensure product stability
- To avoid pouch bursting during retorting
- To assist uniform heat transfer
- To allow detection of spoilage (swelling)
- To facilitate cartoning

If too much air is left in the pouch there is a danger that it will inflate and burst during sterlisation or re-heating. Inflation of the pouch during sterilisation will also impair heat transfer to the pouch contents. The residual air should be less than 2% of the volume of the pouch contents. For liquid products, it is possible to exclude much of the air by squeezing the pack, so as to raise the liquid level to just below the line of seal during sealing operation. Packs containing solid products can be vacuum-sealed using chamber machines.

Effective vacuum packs can also be produced by injecting steam into the packs to displace the air prior to sealing. Here, saturated or superheated steam is injected into the filled pouches just prior to making the top seal. Condensation of water vapour minimises the amount of headspace gas when cooled. Super heated steam is less effective than saturated steam, but superheated steam is often used because it causes less moisture condensation in the seal area.

Sealing

Hot bar sealing is preferable to impulse sealing. If impulse sealing is used, it should provide two sides heating and the sealing elements should be 6 mm wide rather than the normal 3 mm. The pouch should be double sealed to reduce the risk of seal defects. The over seal should extend over the mouth of the pouch to prevent mould growth in any product contamination above the closure seal.

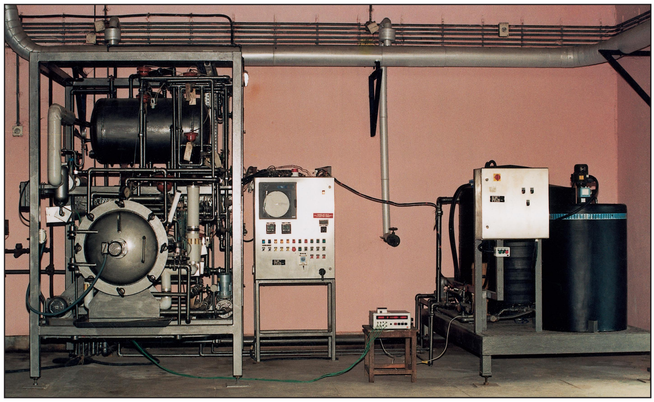
Traying

After the pouches are sealed, it is transferred to a retort rack or tray on which each pouch is accommodated in a separate compartment or slot. This ensures that the flexible pouches present similar dimensions with uniform exposure to the heating medium. Ideally, these trays should be pocketed to prevent pouch movement and super imposition during retorting. An additional mesh restraint over the retort trays can be used to restrict pouch inflation and distortion in the retort.

Processing

The pouches are then heat processed in an over pressure autoclave. Work carried out at CIFT has shown that oil sardines packed in retort pouches having composition polyester / aluminium foil / cast polypropylene remained in an excellent condition even after a period of 3 years. Recently CIFT has developed a process for the heat processing of mackerel curry in retortable pouches.

Mackerel curry packed in indigenous retort pouch and processed to a F_o value of 8.43 so at can be kept at room temperature for 18 months in acceptable condition.



Overpressure Autoclave for Processing Retort Pouch

The flexible pouches manufactured indigenously employing the configuration recommended by CIFT has opened the way for commercialisation of fish curry in retortable pouches. The process relies on heat sterilisation and in many respects analogous to canning with the imported tin can being replaced by a cheaper indigenous heat resistant flexible pouch. In comparison to frozen food, the retort pouch provides a longer shelf-life and does not require refrigeration, energy expensive methods of distribution and storage. No chemical additives are added as most of the bacteria are killed by heat sterilisation. Mackerel and Seer fish curry, fresh water fish Rohu curry processed in a pilot scale in flexible pouch using an overpressure autoclave, remained in good condition for a period of more than 1 year at room temperature. Test marketing of mackerel curry conducted by MPEDA has shown that the product had good acceptability and there is a good demand for fish curry in flexible pouches.

Today, we are importing lot of tin cans for the preservation of various food products. With the availability of indigenous retort pouches it can function as an excellent import substitute. Besides cost reduction, retort pouch packages have unique advantages like boil-in-bag facility, ease of opening, reduced weight and does not require refrigeration for storage. Processed food products can be kept for long periods at room temperature. The energy saving is more in processing in flexible pouches compared to cans. On a comparison of total costs, including energy, warehousing and shipping, the pouch looks even more favourable. There is 30 to 40% reduction in processing time compared to cans, solids fill is greater per unit, empty warehousing is 85% smaller and weight of the empty package is substantially lower. Less impairment of texture and flavouring particularly of fish and meat products due to reduced exposure to heat. This results in better taste, colour and flavour of retort pouch product. Retort pouch technology finds application in the preservation of fish curry, fish sausage, fish paste, chicken curry, coconut masala curry, coconut beverage, kheer/payasam, mushroom curry, tuna in oil etc.

Mackerel Curry Processed in Retort Pouch and Packed in Duplex Carton

Conclusion

Dynamic lifestyle along with availability of sophisticated appliance such as microwave oven has created demand for ready-to-eat food along with appropriate packaging media (micro-ovenable packaging). Retrot pouches and semi-flexible retortable thermoformed containers are the most popular microwavable packaging currently used. Today's working parents and busy homes rely on its convenience and the services it provides.

Extremely lightweight and moulded to promote easy handling, plastic containers allow consumers to enjoy the savings by way of "large economy size" be it beverages, detergents or other similar products. Plastic packaging, which can be transparent without being fragile, enables consumers to have a luxury of seeing what they are buying.

Cast polypropylene, polyester, polyamides, oriented polyamide, aluminium foils form the basic structure of a microwavable packing. Co-extruded and/or laminated films of PET, PC and PP not only give good barrier properties but also give the advantage of combining shelf stability of canned food with texture and nutritive value of frozen food.

References

1. Modern Processing, Packaging and Distribution System for Food by Frank A Paine
2. Modern Food Packaging, IIP Publication
3. Packaging India, Oct-Nov '89, Vol. 22, No. 4, Microwavable Package Development for Frozen Seafood, 13-17 by S. R. Shetty
4. Packaging India, Apr-May '92, Vol. 25, No. 1, Packaging for Microwave, 25, 27, 29 by N. G. Mokashi