Modern Food Packaging Technologies: Regulatory Aspects and Global Trends

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Welcome to the NPTEL online certification course on Modern Food Packaging Technologies, Regulatory Aspects and Global Trends. In the last lecture we have seen the printing and labeling of plastic materials. Now the Retort Pouches and in this we will be covering the topics like Introduction, Structure of Pouch, Manufacturing of Pouches, Filling of Pouch, Sealing of Pouch, Processing and Sterilization of Pouches, Critical Factors in Thermal Processing of Pouch, Post-Retort Handling, Quality Assurance, Self-Life, Advantages and Disadvantages and then Applications. The Retort Pouch is a rectangular flexible laminated plastic four side hermetically sealed pouch in which food is thermally processed. It is a lightweight, high quality, durable, convenient and self stable pack. Foods packed and processed in retort pouches are in successful commercial use for a wide variety of food stuffs in several countries particularly Japan.

They were originally developed in 1950s and 1960s in America through research and encouragement from US army. The materials from which retort pouches are made are either aluminum foil, bearing plastic laminates or foil free plastic laminate films. These must be inert, heat sealable, dimensionally stable and heat resistant to at least 121 degree Celsius for typical process times. They should have low oxygen and water vapour permeability, be physically strong and have good aging properties.

The table one gives different types of retort pouches. The aluminum type which is embedded in the aluminum is sandwiched in two types of plastics that is PET aluminum cast PP or PET OPA aluminum and cast PP. This is generally used for a small pouches sold in decorated boxes for curry, sauces, household dishes, strong pouches widely used small to 3 kgs of size. The transparent type is aluminum is eliminated and PET OPA and CPP and this is transparent type pouch which is used for rice, chilled hamburger, sticks, vegetables, fish, dumplings etc. The transparent barrier type that is silicon oxide PET OPA CPP, PET metalized aluminum OPP CPA CPP, OPA PBDC CPP or OPA EVOH and CPP are laminated pouches and this is used for highest barrier for transparent pouch, good transparency type, stiff metalized vacuum packaging, high barrier appropriate for vacuum packaging.

The structure of retort pouches, most pouches are either 3 or 4 ply laminates with an inner layer in contact with the food of polypropylene, a barrier layer of aluminum EVOH silicon

oxide or aluminum oxide, a polyamide layer and an outer polyester layer. The polypropylene provides the critical heat seal integrity, flexibility, strength and taste and odor compatibility with a variety of food products. The inherent characteristics of polyester and polypropylene enable the pouches to be processed at up to 135 degree Celsius. The figure presents a typical that retort pouches comprising of 4 plies or the 4 different constituents. Manufacturing of pouches, the first step in the manufacture of laminate for pouches involves printing the polyester film.

Excellent print quality, multiple color registration, repeat length and long run economy are associated with gravure printing which is usually employed. The printed polyester film can be adhesive laminated to the aluminum foil and then laminated to the polypropylene or the printed polyester film can be laminated to a pre mounted foil polypropylene base laminate. In either case, the adhesive is applied to a substrate and then passed through an oven which sets the adhesive. The combining of the two webs is done on a heated roll by employing pressure. Pouches are pre formed or formed as an in line operation with filling and sealing.

In either event, they are formed from roll stock by feeding a single roll along its center line or by bringing two separate rolls together to heat shield side. A testing procedure is necessary to ensure adequacy of pouches regardless of the forming techniques used. In addition to dimensional and aesthetic properties, pouches should be tested for seal strength and for internal burst resistance. There are several retard pouch filling and sealing systems commercially available. Bottom form pouches are processed on roll stock horizontal form fills and seal machines.

These units also thermo form plastic materials giving them the versatility to package a wide variety of meat, cheese and prepared foods. Roll fed bottom stock is formed in a mold with a combination of compressed air, vacuum and stamping in a horizontal position. This permits easy filling of placeable items both units permit vacuum evacuation and gas flushing prior to sealing with roll fed lead stock. Sealing heat is applied to the top only. Hence, the heat resistant polyester exterior of the top stock and not the heat sensitive oriented polypropylene film exterior of the form bottom is exposed to high temperature contact.

Now, the filling of pouches while the technology of high barrier plastic materials has been evolved so have the adaptations or design of equipment for filling and sealing. There are many factors that must be considered during filling. First it is necessary to minimize residual head space and provide a hermetic seal. Second tempering of the pouches is sometimes necessary before filling. This means holding it at a warm temperature usually approximately 30 degree Celsius and usually presents a more consistently flexible pouch

to the filler.

Third the sealing area must be as clean as dry as possible and there cannot be any solid particles in the sealing area as this can lead to channels through the seal. Both as with any heat process food the fill volume must be strictly controlled so as not to overfill or underfill. Overfilling can result in excessive strain on the seals and possible under processing. The examples are inline and pre made pouches are filled vertically. Vertical form filled seal machines can be used for liquid products.

Another method employs a wave of pouch material which is formed on a horizontal bed into several adjacent cavities. The cavities are filled while the seal areas are shielded. This method is especially useful for filling placeable products. Thereafter the filled cavities are simultaneously sealed from the top using a second wave fed from the reel. Now sealing of pouches the seals and sealing machines like fillers are constantly being refined and speed has improved from 30 to 60 pouches per minute to the current production rate of 120 to 150 pouches per minutes.

Sealers incorporate either one of two common satisfactory sealing methods namely hot bar and impulse sealing. Both methods create a fused seal whilst the pouch material is clamped between opposing jaws thereby welding the opposing seal surfaces by applying heat and pressure. Exact pouch sealing conditions depend on the materials and machinery used, but monitoring of seal temperature, jaw pressure and dwell time is essential. Pouch closure is normally accompanied by some means of air removal either by steam flushing or or by drying a vacuum in a sealed chamber or simply in the case of liquid food products flattening the pouch by squeezing between two vertical plates. Efficient air removal prevents ballooning and rupturing during retorting.

Excess air can also be adversely affect heat penetration. While some very limited condensate moisture may be tolerated a sealed area clean of contamination is essential. Irrespective of method of pouch presentation to the sealing station grippers engage on each side stretching the pouch opening and preventing wrinkles. The closure sealing is then carried out cooling after the sealing is essential to prevent wrinkling on the seal area. All seals whether side bottom or closure seals must be regularly tested.

Performance is the ultimate measure of a good seal and the performance standard is the hermetically sealed can. Seals can be examined visually and sample pouches should routinely be subjected to internal pressure resistance test that is 280 kilo Pascal for 30 seconds in a suitable test jig. Seals made in this way should not yield significantly. Satisfactory seal tensile properties should also be confirmed on 13 mm sections regularly cut from the various seals. Visual inspections at best are never wholly successful.

However, inspection of all pouches before and after retorting can ensure a low rate of defects. Channel leaks, product contamination and weak seals can be detected using a ultrasonic technique. Now, the pressing and sterilization of pouches under proper conditions retortable flexible containers can be processed in batch retorts or in continuous retorts static or agitating. The heating medium may be saturated steam, steam air mixtures or water with air pressure is high.

Dr. I. J. Pflug of the University of Minnesota established overall heat transfer coefficients of various heating media. He found that saturated steam has the highest coefficient hot water rates next and steam air mixtures had the lowest heat transfer coefficients. Hot water with over reading air pressure was selected as the processing medium because it has a higher heat transfer coefficient and because it is easier to control than the steam air mixture. Uniform heat distribution within the sterilizer during processing is most important. Heat sealed containers such as pouches and semi rigid trays can be agitated during processing as long as adequate precautions are taken to continue the pouch or tray to prevent leakage leakers due to seal integrity failure puncture or flexing.

Similar to can processing times can be further reduced using agitation especially in trays and institutional size pouches. The seal strength decreases dramatically as retort temperature is increased. At 24 degree Celsius burst pressure in a pouch may be greater than 207 kilo Pascal, but at 121 degree Celsius the pressure drops to about 48 kilo Pascal. It should be noted that after a pouch has been cooled back to room temperature the seal regains 90 percent of its original strength. It has been clearly shown that heat sealed flexible containers respond to pressure volume relationship containers respond to pressure volume relationships according to theory.

Since the most critical container differential pressure occurs at the start of the cooling cycle superimposed air pressure adequately controls pouch expansion and prevents bursting. It is possible to calculate the required total process pressure and consequently the amount of override pressure beyond that of saturated steam. It is also possible to process pouches in saturated steam alone bringing in an over pressure during cooling as long as there are good controls of container headspace and of pressure variations during processing. Three heating mediums are developed for processing flexible containers one is steam air, water with over reading, air pressure and saturated steam. Whatever the heating medium both heat distribution and heat penetration profiles are critically important for each product line.

For this reason racking configuration is important in container processing and should be designated for the specific container and retort system. Horizontal racks are preferred for

vertical although both orientations have been successfully used even with screen type trays the container should not completely cover the tray. Some middle area should be left empty to create a chimney effect for circulation purposes. Containers should be secured in position to prevent shifting and overlapping due to water flow pressure. However, if the tray duct around each container is too tight the configuration will transmit pressure to the sealed area it can also lead to under processing the product.

Racks must keep containers from touching each other during processing they should provide for adequate circulation of the heating medium perforated stainless steel or aluminum racks are commonly used. The critical factors in thermal processing of pouches a critical factor is any property characteristics condition aspect or other parameter variation of which may affect the scheduled process and attainment of commercial sterility. The major critical factors that affect thermal processing of retort containers are the following. These are the minimum head space, product consistency, maximum filling or drained weight, initial temperature, processing time, processing temperature, temperature distribution, container orientation, residual gas in head space and in food, processing and racking systems, processing medium, product heating rates, materials from which pouch rack is constructed, divider sheet, hole size and spacing. Now, the post retort handling following pressure cooling and removal of racks or trays from the retort the pouches must be dried inspected and placed in some form of outer packaging.

Drying of pouches is achieved through a combination of pack residual moist temperature to encourage evaporation and a system of high velocity air knives in a dry to drive of the remaining water. When dry pouch seals may once again be visually inspected for leaks ruptures or weak points that have been shown up during retorting. This should not involve manual handling of the individual pouches. Systems are available for the transfer of the pouches from the retort racks to conveyor belts, then to the pouch driers and on to inspection conveyors prior to secondary packaging. Now, the quality assurance a successful pouch packaging quality system requires selection and continued monitoring of the most suitable laminate materials.

Second regular testing of formed pouches for seal strength, product resistance and freedom from taint. Careful selection, maintenance and control of fillings, sealing, processing and handling machineries. A specifications for the control of product formulation, preparation which includes viscosity, aeration, fill temperature etc and filling that is in going mass and absence of seal contamination. Post sealing inspection and testing of closure seals to confirm fusion, absence of defects and contamination. The control of critical parameters influencing processing lethality such as maximum pouch thickness and residual air content.

A standardized retorting procedures applying only recommended process times and temperatures confirmed to achieve adequate lethality. Regular inspection and testing of retort equipment and controls to ensure uniform heat distribution. Visual inspection of all pouches to check sealing after processing, handling only of dry pouches and packing into collective or individual outer packaging specially tested to provide adequate subsequent abuse resistance. It should be routine that all stocks are held 10 to 4 days prior to distribution and these should be free of blown spoilage on dispatch. Careful stop selection and training at all levels.

Now, the shelf life of the retorted pouch products. As shelf life is determined by many factors such as storage, temperature and the barrier properties of the particular film used. In general satisfactory shelf stability in excess of 2 years is easily obtained for a wide range of products in foil bearing pouches. Foil free laminates will demonstrate shelf stability commensurate with oxygen permeability of the particular laminate used and the sensitivity of the product. Commercial experience confirms however, that product stability from 4 weeks to 6 months after navel nitrogen flushing of the outer container has been successful in extending the shelf life of product in foil free pouches.

Now, the advantages retort pouches combine the advantage of the metal can with the frozen boil in the bag. The attribute of flexible containers offer benefits for the consumer, retailer and manufacturer alike. The thin profile of the pouch or container provides rapid heat transfer for both preparation and for sterilization during processing. A 30 to 40 percent reduction in processing time is possible with energy savings. Reduced heat exposure results in improvements in taste, color and flavor.

There are also fewer nutrient losses. Preparation of products that need to be heated to severe temperature can be accomplished in 3 to 5 minute by emerging the pouch in boiling water or placing the plastic container in a microwave oven. Storage space of the retort pouches or container in a paper board carton is no larger than that for cans disposal space is less. Shelf life of retort pouch products is equivalent to that of foods in metal cans. Refrigeration or freezing is not required by packers, retailers or consumers. Pouches and containers do not corrode externally and there is minimum of product container interaction.

Opening the pouch requires only tearing the pouch across the top at the notch in the side seam or by using scissors. The container lid may be peeled open or cut with a knife. The flexible container is safer in that a consumer would not be cut as on a metal can or be faced with broken glass as with glass jars. Empty retort pouches and nesting containers offer processors a reduction in storage space and lighter weight compared with empty cans and equal number of retort pouches. Use 85 percent less space and are significantly lighter.

Advantages for the retailer include savings in shelf space and the shape makes it easier for the retailer to handle and display the product. The use of a flat carton as an over wrap to hold one or two pouches provides for better product identification on the shelf than cans. The pouch also offers the opportunity to market multi packs for example, entry in one pouch accompaniment such as rice in another. For example, entry in one pouch and accompaniment such as rice is in another. Energy requirements for container construction are less than that of cans.

Now the disadvantages thermal processing of flexible containers is more complex and processes have to be established for each product in particular type and size of container. The filling and sealing equipment and thermal processing systems for flexible products are generally more expensive than for cans. Filling is slower and more complex. There are limitations in the size of containers that can be reasonably handled and processed. Retort pouches at present require over wrapping such as carton and may be required for semi rigid containers.

Since the pouch is a flexible container the direction of leakage is more difficult than with a conventional type container. Pouches and semi rigid containers may be punctured. Products in the pouches may lose their shape. Now the applications the retort pouches are used in several countries for a wide range of process self-sustainable products from solid meat packs such as polongies to sliced meat in gravy, high quality entries, fish, sauces, soups, vegetables, fruits, drinks and baked items. Current markets for pouches are foil free pouches have been utilized particularly for vegetables where high visibility is desired and a short life and a short shelf life from 4 weeks to 6 months is acceptable.

Shelf-standing pouches have been used for fruit juices and other drinks, soups and sauces. Mass scattering size pouches for the institutional trade up to a capacity of 3.5 kg approximately equivalent to the A10 can have found ready application for prepared vegetable products such as carrots, peeled potatoes and potato chips. Provision of military field rations. Reduced heat exposure offers an opportunity for using retort pouches to process heat sensitive products not currently suited to cleaning especially in high temperature short time processing where opportunities exist for optimum nutrient and flavor retention.

A wide variety of products are packed such as curries, stews, hashes, prepared meats, fish in sauce, mixed vegetables all being popular dishes. Several factors which contributed to the success of pouches in the far east are limited refrigeration facilities when these packs were introduced particularly in homes resulting in demand for ambient shelf vegetable products. Social changes causing working housewives to look for convenience. The

popularity of foods such as sauces which are pumpable and ideal for pouches. Thank you very much.