

VACUUM PACKAGING

A vacuum is simply the absence of air. Vacuum packing is a method of packaging that removes air from the package prior to sealing. The single most important reason for creating a vacuum in food packaging is to remove oxygen from around the thing that we are going to store. Because, Air is made up of about 21% oxygen. Most bacteria associated with food spoilage need oxygen to grow (aerobic). If less oxygen is available they can't able to survive. This method involves (manually or automatically) placing items in a plastic film package, removing air from inside, and sealing the package. Vacuum sealing is a type of packaging called reduced oxygen packaging, also known as ROP.

Removing the air that surrounds food inhibits growth of bacteria, mould and yeast, because these and other spoilage micro-organisms need oxygen to grow. Once moist air is removed and the pouch is sealed, oxygen levels continue to drop where carbon dioxide levels increase. The low oxygen, high carbon dioxide environment significantly reduces the growth of normal spoilage organisms, allowing longer shelf life.

The purpose of vacuuming is to preserve the quality of the product as good and as long as possible, and to ensure that the taste, flavour, colour, aroma, nutrition value are not lost.

Advantages of Vacuum Packaging

- The intent of vacuum packing is usually to remove oxygen from the container to extend the shelf life of foods.
- Minimizing the growth of aerobic microorganisms which spoil the product.
- The lack of oxygen also reduces the amount of spoilage due to oxidation.
- With flexible package forms, to reduce the volume of the contents and package.
- Preventing the evaporation of volatile components
- Vacuum Packaging allows for money saving quantity buying. Products such as cheese, continental small goods, fish, bacon, coffee and nuts, processed meats and many other food items may be bought in bulk at a lower price and then pre-packaged by either a central warehouse or in each supermarket or restaurant outlet.
- Vacuum packaging reduces product shrinkage. There is no moisture loss or evaporation in a sealed vacuum bag. Therefore, the weight you package will be the weight you sell.
- Vacuum packaging reduces trim losses by eliminating oxidation and freezer burn.
- Vacuum packaging can enhance product quality. Vacuum packaged meat held at 32° to 35°F does not hinder -aging or tenderising.
- Vacuum packaging allows more efficient use of time. Food can be prepared in advance without loss of freshness, so slack times are more productive and busy times are more manageable.

Equipments use in vacuum packaging:

1. External vacuum sealers

External vacuum sealers involve a bag being attached to the vacuum-sealing machine externally. The machine will remove the air and seal the bag, which is all done outside the machine.

2. Vacuum chamber machines

Single chamber sealers require the entire product to be placed within the machine, the lid is closed and air is removed. Then, there is a heat seal inside the chamber that will seal the bag. After sealing the bag the chamber is refilled with air by the automatic opening of a vent to the outside. The lid is then opened and the product removed.

3. Double vacuum chamber machines

They are simply a pair of chambers with two seal bars to seal the pouch. The air is pulled from the entire chamber during the vacuum process, the bag is sealed and then the air is let back in the chamber.

4. Automatic belt vacuum chamber machines

Automatic belt chamber sealers require the entire product to be placed in a plastic bag or pouch within the machine. The product travels on the conveyor belt, it is automatically positioned in the machine on the seal bar, the lid is closed and air is removed.

5. Thermoforming (Roll-stock) Vacuum Packaging Machines

Vacuum Packaging in large production facilities can be done with thermoforming machines. These are Form-Fill-Seal style machines that form the package from rolls of packaging film (webbing). Products are loaded into the thermoformed pockets, the top web is laid and sealed under a vacuum, producing vacuum packaged products. Thermoforming can greatly increase packaging production speed. Thermoformed plastics can be customized for size, color, clarity, and shape to fit products perfectly, creating a consistent appearance.

6. Gas Flush Chamber Machines

Some packaging applications need to have all of the air removed but cannot have a tight package that a vacuum normally produces—think of potato crisps and sandwiches. The solution is to remove the air and to replace it with something else which does not allow the product to oxidise. Carbon dioxide and nitrogen are both inert gasses which can be used to produce an environment where all of the air has been removed but where the packaging is not drawn down tight on to the product.

Disadvantages of Vacuum Packaging

- If you are storing bulky food items, or foods that have sharp corners, during the oxygen removing process, these sharp corners can puncture the bags.
 - Vacuum sealing is the bags are not completely impervious to air, so after a couple years, they begin to leak. When leaks occur, the opened seals allow oxygen, insects and other enemies of your food to enter
 - Cost- Buying a vacuum packaging machine can be expensive. The initial cost of a machine can be between \$50 and several hundred dollars, depending on the quality and size of the machine.
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- Anaerobic bacteria presence in the packaging may cause problem leads to deterioration of product even without oxygen.

Factors Affecting Vacuum Packaging

The success of vacuum packaging depends on

- Characteristics of the food product to be packaged.
- Reliability/choice of the packaging machine and packaging material.

1. Characteristics of the food product to be packaged

Sometimes the form, nature and consistency of food products can be a problem for the packaging operation. This is the case for granular or porous products. Due to their structure, they comprise and hold a discreet quantity of air in the gaps between one particle and another or in the pores. To effectively evacuate the package of these types of products, it may be necessary to prolong the packaging time or arrange the products in such a way as to facilitate the air extraction. The same problem can be applied to oversized products with unusual forms that are characterised by pockets of –dead air. It is necessary to arrange the product in such a way as to ensure that no air is trapped in these critical points. Powder products also cause problems in the packaging phase. During air evacuation, the lighter powder particles can be dragged by the outgoing airflow creating problems in the sealing phase of packaging. The solution in this case may be found by regulating the filling level.

2. Choice of packaging material

The same problem can be applied to oversized products with unusual forms that are characterised by pockets of –dead air. It is necessary to arrange the product in such a way as to ensure that no air is trapped in these critical points. Powder products also cause problems in the packaging phase. During air evacuation, the lighter powder particles can be dragged by the outgoing airflow creating problems in the sealing phase of packaging. The solution in this case may be found by regulating the filling level.

Application of Vacuum Packaging

Fish

To preserve, retain colour, taste and prevent freezer burn, there is no better way of storing fish than vacuum packaging. To get the best results, it is important that the fish is as fresh as possible. The length of time that fish have been held on ice or in chilled storage greatly affects the storage time of the frozen product. Experiments have shown that lean fish held for two days on ice will last up to 12 months in a freezer before any loss in quality is noticeable.

Seafood

The vacuum packing process will prevent loss of flavour and will improve the appearance of products which have been frozen. There are very large differences between the permeability of packaging materials, with cellophane and polyethylene (used in cheap plastic bags) offering very little protection to seafood products compared to quality vacuum bags. All seafood products should be stored in the fridge or freezer even if they have been vacuum packed.

Cooked Products

Cooked meats and vegetables must be produced under hygienic conditions and should be packed as soon as possible after cooling has been completed. The vacuum packed products must be stored at or below 8°C at all times during its shelf life (3°C or below is recommended as a target temperature). Temperatures above 8°C will encourage growth of *Clostridium botulinum* and other bacteria. A shelf life of no greater than 10 days from the day of cooking is ensured by vacuum packaging.

ACTIVE PACKAGING

- It is a technique used for extending the shelf-life of seafood or fresh foods by addition of active agents that absorb or release a compound in the gas phase.
- Compounds in packaging include CO₂, O₂, water vapour, or volatiles.
- Active agents can be useful in a package, such as oxygen or carbon dioxide scavengers, moisture absorber and oxygen or carbon dioxide emitter.
- Active packaging systems have also been studied, in which specific bioactive substances are combined with the packaging material or within the package resulting in the retardation of the microbial growth and lipid oxidation.
- It was reported that the use of carbon dioxide emitters in fish can control the G/P ratio and volume reduction compared with traditional MAP.
- The O₂ scavengers were used for improving the effect of shelf-life extension of catfish. It can also be used to reduce O₂ in high fat products to prevent chemical deterioration e.g., oxidative rancidity and aerobic microbial spoilage.

MODIFIED ATMOSPHERIC PACKAGING (MAP)

It is defined as enclosure of food in a package in which the atmosphere inside the package is modified or altered to provide an optimum atmosphere for increasing shelf life and maintaining food quality.

The modified atmospheric packaging can also be described as the process by which the shelf life of a food product is increased by enclosing it in an atmosphere so that it slows down the degradation process such as the growth of microorganisms and development of oxidative rancidity. Modified atmospheric packaging can result in significant increase in shelf life without losing many of the attributes of the fresh fish. Many food products such as meat, poultry, fish, vegetables etc, are now being packed in modified atmosphere.

MAP is employed mostly in the case of non respiring products, e.g., meat, cheese, fish, baked goods etc. in MAP the air in the pack of food, fish or fish products is replaced with a mixture of combination of gases. CO₂, N₂, and O₂ are the gasses generally used in the modified atmosphere packaging. The composition of gasses depends on the nature of the product. The proportion of each component will be fixed for a given product at the time of introduction of the gas mixture into the pack. However, there will be no further control of any sort on the composition of gasses. It cannot be expected that the composition of the atmosphere at the time of sealing will be maintained throughout the storage period even if the packaging film is intact and properly sealed. The gas mixture may undergo through changes during the period of storage because of the gasses diffusing into and out of the package at different rates as well as the gasses being absorbed or given off by the product. Biochemical activities may modify the atmosphere.

MAP is used to delay deterioration of foods that are not sterile and whose enzymatic systems may still be operative. With the exception of baked goods, MAP is always used in association with chill temperatures, usually taken as -1°C to $+7^{\circ}\text{C}$. Holding food at chill temperatures is widely used as an effective short-term preservation method, which has the effect of retarding the following occurrences:

1. Growth of microorganisms
2. Postharvest metabolic activities of intact plant tissues, and post slaughter metabolic activities of animal tissues
3. Deteriorative chemical reactions, including enzyme-catalyzed oxidative browning, oxidation of lipids, chemical changes associated with colour degradation, autolysis of fish and loss of nutritive value of foods in general
4. Moisture loss

Composition of gas mixture

Various combinations of gasses have been studied for their effect on extension of shelf life of fish. One of the widely accepted combinations for lean fish is 40% CO₂, 30% N₂, and 30% O₂. For fatty fish, a combination of 60% CO₂, 40% N₂ has been found most suitable. The temperature of storage also affects significantly the shelf life of the product. With the above combination of gasses extension of shelf life achieved at 0°C is up to nine days for lean fish, whereas at 2°C it is only five days.

Advantages and Disadvantages of Modified Atmosphere Packaging (MAP):

Advantages

- Shelf life increase from 50% to 400%
- Reduced economic losses due to longer shelf life
- Decreased distribution costs, longer distribution distances and fewer deliveries required
- Provides a high quality product
- Centralized packaging and portion control
- Improved presentation—clear view of product and all-around visibility
- Little or no need for chemical preservatives
- Sealed packages are barriers against product recontamination and drip from package
- Odorless and convenient packages
- Retardation of Senescence
- Post harvest diseases and decay is prevented.
- Nutritional qualities retained.

Disadvantage

- Added costs for gases, packaging materials and machinery
- Temperature control necessary
- Different gas formulations for each product type
- Special equipment and training required
- Potential growth of food-borne pathogens due to temperature abuse by retailers and consumers
- Increased pack volume adversely affects transport costs and retail display space
- Loss of benefits once the pack is opened or leaks
- CO₂ dissolving into the food could lead to pack collapse and increased drip
- slowing down in the cooling rate of the packaged products
- Increased potential for water condensation within the package, which may encourage fungal growth.

EQUIPMENT FOR MAP

Equipment for MAP must generally be capable of removing air from the package and replacing it with a mixture of gases.

I. Form-fill-seal machines:

FFS machines can either form pouches (vertically or horizontally), or thermoformed trays with a heat sealed lid, from rollstock.

II. Chamber machines:

Here, the filled package (either a preformed pouch or tray inside a bag) is loaded into a chamber, a vacuum is pulled and the package is then flushed with the gas mixture and heat sealed.

III. Snorkel machines:

Snorkel machines operate without a chamber. The product is placed inside a large flexible pouch (or bag) and positioned in the machine. Snorkels or probes are inserted into the pouch and remove air, after which the vacuum is broken by the addition of the desired gas mix. The probes are then removed and the package is heat sealed.

CONTROLLED ATMOSPHERIC PACKAGING (CAP)

Controlled Atmosphere Packaging (CAP) is a system whose objective is to extend the shelf life by altering the gaseous environment in and around the food product. CAP is a storage method in which the concentrations of oxygen, carbon dioxide and nitrogen are altered and temperature and humidity of product's atmosphere is regulated. It is specifically used for perishable foods like meat, poultry, fish, high-moisture pasta and fruits like apple, pears and some vegetables. CAP can also be termed as '*Gas Flushing*'. This is because a mixture of different gases is flushed or inserted in the package while replacing the air which extends the shelf life.

In controlled atmosphere packaging also, a mixture of gasses of known composition is introduced into the pack. The essential difference of CAP from MAP is that in the former, the composition of gas inside the package is continuously controlled throughout the period of storage. This is achieved by including within the package chemical agents of various sorts. To prevent the product from contamination these agents are packed in sachet preamble to gasses being scavenged or produced by these agents. The CAP technique is mainly employed in bulk storage of products.

Role of Gases in Controlled Atmosphere Packaging

In controlled atmosphere storage, the atmosphere is controlled by adjusting the levels of three particular gases – Oxygen, Carbon dioxide and Nitrogen, where each gas plays a specific role mentioned as below:

1. **Oxygen:** Preserves the red colour of meat.
2. **Carbon dioxide:** Prevent the development of moulds and bacteria.
3. **Nitrogen:** Being an inert gas, it prevents respiration and enzymatic activity.

Advantages of Controlled Atmosphere Packaging (CAP)

1. The storage life/shelf life of various fruits and vegetables can be increased by 2 to 4 times the normal life by employing Controlled Atmosphere storage technology.
2. Controlled atmosphere packages allow reaching markets that are geographically far from the point of packaging for sensitive materials.
3. Retardation of Senescence
4. Some physiological disorders like chilling injury are prevented.
5. Post harvest diseases and decay is prevented.
6. Nutritional qualities retained.

Disadvantages of Controlled Atmosphere Packaging (CAP)

1. CAP stored produce deteriorate/decay rapidly when exposed to normal atmospheres during marketing.
 2. The involvement of bulky and sophisticated equipment limits the use of CAP technology during transport and retail storing of fruits and vegetables.
 3. Sophistication of packages and intense control of atmosphere leads to higher costs.
 4. Internal browning
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5. Sometimes, increased concentration of carbon dioxide leads to anaerobic respiration thus leading to off flavour development.
6. Irregular ripening of bananas and tomatoes.

DIFFERENCE BETWEEN MAP AND CAP

Sl. No.	Modified Atmospheric Packaging (MAP)	Controlled Atmospheric Packaging (CAP)
1	In this type of packaging the composition of gasses once modified is not changed thereafter. There is no control over processes and gasses composition changes inevitably due to the processes such as the respiration of fruits, vegetables and their products.	In this type of packaging, there is control over the storage atmosphere once the composition of gasses has been altered. As the gas composition changes due to respiratory activities, it is possible to add fresh air to reach pre determined composition.
2	Less Precise	More precise than MAP
3	No provision to alter the gasses composition.	Gas Scavengers and scrubbers are present to control oxygen and carbon dioxide level.
4	It is generally used for non respiring products where microbial growth is a major spoilage parameter.	It is generally used for the packaging of the respiring food products like fresh meat, poultry and fish.
5	Relatively cheap than CAP and economic.	Capital intensive and expensive process.
6	Generally used for long distance transport of mangoes, apple, bananas etc.	Used for transporting and storage of apples, pears, nuts and dry fruits.

POLYMERIC PACKAGING

Packaging affects everybody's lives in some way on a daily basis. Packaging could be used in various ways using various materials. The main goal of packaging is to protect the contents from damage and leaking. One of the most commonly used materials in packaging is plastic, or polymers. Plastics are so commonly used in packaging because it is easily moulded or transformed.

A polymer is defined as a substance that has a molecular structure consisting chiefly or entirely of a large number of similar units bonded together, e.g., many synthetic organic materials used as plastics and resins. Some of the most common polymers include:

- polyethylene terephthalate (PET)
- high density polyethylene (HDPE)
- polyvinyl chloride (PVC)
- low density polyethylene (LDPE)
- polypropylene (PP)
- polystyrene (PS)

Polymeric film materials such as cellophane, poly-olefins, polyamide, vinyl polymers and others are widely used to package food and agricultural products. To impart special properties to such packaging materials, they may be subjected to diffusion stabilization in softening solutions. The layers contacting the product in these multi-layer materials are typically made of modified polyolefin. These multi-layer materials are expensive and poorly adapted for technological processes. Polymer plastic is also useful for packaging food. The barrier resins that plastic packaging provides help to preserve freshness and extend shelf life. By preserving foods in polymer packaging, food companies are able to reduce waste, which is beneficial to the environment.

Advantages and common use of Polymeric Packaging in Modern Packaging

The uses that polymers are put to in modern packaging are many and varied and the requirements demanded of them include being able to:

- Withstand high temperatures when the food is placed in the oven or microwave either before distribution or in the consumer's home.
 - Maintain its properties in cold temperatures when the food is stored frozen or chilled and when thawed.
 - Have high or low barriers depending on the product and its ability to breath or withstand the migration of odours, greases and fats.
 - Be formed into a rigid format or flexible form depending on use and function.
 - Form a strong seal to protect contents.
 - Have good puncture or scuff resistance.
 - Have tear resistance or where required to have 'easy tear' functionality to aid opening.
 - Resist chemicals, e.g. in the case of bottles for liquid bleach.
 - Prevent the ingress of UV light.
 - Be formed into a required shape and hold that shape.
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- Snap or break — this is an important feature in multipacks e.g. use of Polystyrene (PS) in yoghurt pots to allow one pot to be separated from another.
- Be flexible and allow the contents to be squeezed out e.g. ketchup, toothpaste — here LDPE would tend to be used.
- Bend but not break, e.g. PP in dual chamber pots where the content of one chamber needs to be mixed into the other before eating.
- Provide protection as in the use of Expanded polystyrene (EPS) in packaging electrical goods and in the protection of other durable products to ensure they arrive undamaged.
- Provide insulation to maintain the cool chain, as in boxes for fresh fish during distribution — this where EPS offers unique benefits.
- Provide transparency so that the contents of a pack can be inspected.
- Be recycled back into food contact applications or other applications.

SMART & ACTIVE PACKAGING

Smart packaging provides enhanced functionality that can be divided into two submarkets: Active packaging, which provides functionality such as moisture control, and intelligent packaging, which incorporates features that indicate status or communicate product changes and other information.

The way in which active and smart packaging can secure the quality and freshness of products is a highly topical issue for both the food processing and packaging industries. Active packaging systems are designed to safeguard food quality. Over the coming years we will see moves towards the broad-based market introduction of active and smart packaging. Smart packaging materials monitor the state of packaged products permanently providing information on their freshness. New systems accelerate and optimise the preparation of meals.

Today, product managers in the food industry are faced with the question of whether the active and smart systems currently available on the market offer advantages for the respective merchandise packaged and which of these systems offer the greatest benefits. Despite applying the very latest developments in the quality protection of packaged products during distribution, logistics and storage factors can occur that impair the quality. These include:

- Light-induced spoilage - for instance, the taste of light (milk), oxidation in beer, browning/colour changes in juices and rancidity in products containing fat;
- Enzymatic/oxidative perishing of products with a longer shelf life. This includes rancidity, aroma and colour changes in dry and frozen products, to name but a few;
- Microbiological spoilage of fresh products, which typically takes the form of mould on fresh vegetables, among other things.

Active and smart packaging developments worldwide focus on a number of functions:

- Binding residual oxygen existing in the headroom inside packaging;
- Catching dripping water and controlling the humidity in the headroom inside packaging;
- Absorbing ethylene in order to slow down fruit ripening;

- Introducing anti-microbial agents;
- Absorbing odours;
- Filtering out determined wavelengths of light that damage the packaged goods;
- Displaying ambient conditions such as temperature and gas concentration inside the packaging; and
- Detecting detrimental microorganisms inside the packaging.

So far, three viable solutions have crystallised as marketable technical solutions for oxygen scavengers. Either additional sachets containing an oxygen absorber are introduced or respective labels are attached to the inside. Finally, there is also the possibility of incorporating the technology into the packaging material itself.

Even now, indicator systems in the shape of labels are stuck on/into the packaging. Their change in colour indicates that inside the packaging microbes have already reached substantial, and therefore probably critical, numbers. The current trend now is to incorporate such systems into the packaging material.

In contrast to indicator systems these so-called Smart Active Labels make it possible to permanently track ambient parameters such as time, temperature, gas concentrations etc, thereby ensuring the precise monitoring of the food.

Consumers want to know whether the cold chain of a product has been interrupted. Here the use of thermo-chromic printing inks makes sense. These are water-repellent inks that visually display whether goods have been stored in line with the recommended best-before

shelving instructions. Once the colour has changed it will not return to the original shade. Such properties give consumers the assurance that products are suitable for consumption.

ACTIVE PACKAGING AND WHY WE NEED IT

Active packaging was created to help preserve the freshness and safety of various products



What is Active Packaging?

Active packaging was created to help preserve the freshness and safety of various products. Products can include food items, beauty products, drink containers, and the like. In its simplest form, this type of packaging is deliberately enhanced with certain materials (often chemical or biological agents) either in or on the packaging to aid the package in keeping its contents fresh and safe. The packaging is already there to keep a product free of contamination, but this new technology has allowed this simple concept evolve and become even better.

Why Do We Need Active Packaging?

This is an important new technology because it allows for our food and beverage supply, personal care products, or other perishable items to last longer. We no longer need to feel as concerned about food perishing quickly or our favourite face moisturizer going rancid and becoming contaminated with bacteria after a short period of time.

What are the Regulations?

Active packaging is closely regulated by the global Food Safety Authorities since it still comes in contact with the food or beverage people are consuming. For instance, the European Union makes sure these type of packaging are manufactured in complete compliance with the EU food regulation, such as, good manufacturing practices to ensure the food supply remain safe. The chemical or biological additives mustn't alter the composition of the food or product or change the quality of a product in a negative way. That can include changes to taste, texture, smell, or appearance.



Example Sachets in Food Packaging

In food packaging, the agent used to protect the freshness of the meat usually interacts with the oxygen and moisture levels. Often, the chemical/biological agent is activated by UV light or another outside source. The contents are found mostly in two distant forms, either a sachet or pad.

Oxygen absorbing sachets are generally placed in meat packages, baked goods, pizzas, coffees and most other dried foods. Some of these sachets can release ethanol, which acts as an antimicrobial agent to lengthen the self-life of products with a high moisture content.

Inside Packaging Material Itself

Plastics

Due to some of the limitations of sachets, many food products and personal care products, use preservation agents in the actual packaging material. In liquid items, water bottles, tightly wrapped foods (in plastic) like cheese or crackers, etc., oxygen-absorbing polymer materials are placed directly into the plastic package. This will keep the food fresh and free of moisture and bacteria for an extended period of time.

Antimicrobial Packaging

This type of packaging has the ability to release antimicrobials from the packaging itself in a self-controlled form. This is a useful form of packaging tech because it will extend the self-life of food/other products considerably longer. It can achieve this goal because it will prevent bacteria growth that leads to products going bad and spoiling.

PACKAGING REQUIREMENTS OF FRESH FISH, FROZEN FISH, CANNED FISH

Packaging is crucial to our modern food distribution and marketing systems. Without protective packaging food spoilage and wastage would increase tremendously. The advent of modern packaging technologies and new methods of packaging materials made possible the era of convenience products. In the past, the packaging emphasizes the expectations of the producers and distributors, but now has shifted towards the consumer since they are becoming more demanding and aware of the choices available. A food package usually provides a number of functions in additions to protection.

Need for Packaging of Fish and Fish Products

Fish is an extremely perishable food and should be handled at all times with great care, in such a way so as to inhibit the growth of micro-organisms. Fish quality deteriorates rapidly and potential life is reduced if they are not handled and stored properly. Most often, the fish landing stations are far away from places where fish is processed or marketed and, therefore, they have to be transported over long distances. Fish must be refrigerated or frozen immediately after landing to prevent microbial deterioration. It is reported that the rate of spoilage doubles with every 5.5°C rise in temperature. Desiccation of chilled and frozen fish during storage causes quality deterioration as well as weight losses. The quality/type of packaging materials and the method of packaging are, therefore, of great importance for preserving the quality of fish. Fish and fish products can be grouped into fresh fish, frozen fish, canned fish, dried fish and other value added fish products. Each category requires special packaging materials and different handling procedures and is, therefore, discussed separately.

(A) Fresh Fish

Fresh fishes are one of the most perishable of all foods. The rate of spoilage doubles every 5.5°C rise in temperature. In our country, the major portion of fish consumed is in its fresh form. The cities of Kolkatta, Delhi and Mumbai receive fish sometimes from places, which are at long distances. The storage period from the time the fish has landed, till it is consumed may be between 10 -15 hours to 5 days. During this period, the fish quality is maintained by chilling the fish and by keeping the temperature low.

Packaging Requirements

The most effective way in which the temperature of wet fish is kept down at the required level is by mixing it with ice. Therefore, the design and material of the container used for transporting fish should have insulating properties to reduce, as much as possible, the rate of melting of ice. In addition, the other requirements of a suitable fresh fish package are to:

- Reduce dehydration
 - Reduce fat oxidation
 - Provide for less bacterial and chemical spoilage
 - Eliminate drip
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- Prevent odour/gas permeation
- Provide adequate mechanical strength to reduce handling damages
- Preferably should be light in weight

(B) Frozen Fish

Frozen fish is the most important inland export of India. Conventionally fish was frozen as blocks in duplex board cartons lined with low density polyethylene (LDPE) and 10 such cartons are packed in a master carton made of 5 ply or 7 ply corrugated fibre board boxes. Nearly 90% of exports of marine products are in the frozen form. The most popular items are shrimp, squid, cuttlefish, lobster etc.

There is now great demand from importing countries for shrimp in individually quick frozen (IQF) form. IQF shrimp is packed into plastic film pouches. The other major IQF products are cooked whole lobster, lobster tail, lobster meat, cuttle fish fillets, boiled clam meat and fish fillets from white lean fish.

Packaging Requirements

The storage of frozen fish is at minus 18-20°C. Freezing of the product and then storage at that temperature does inhibit major changes caused due to deterioration. However, some small changes do take place during storage at freezer temperatures. The factors affecting the quality of frozen fish are:

- Moisture loss/dehydration
- Oxidation/Rancidity
- Flavour/ colour/ appearance retention
- Heat radiation and light.
- Protection against contamination and physical damage
- Convenience of handling the product
- Prevention of leaching while thawing

Therefore, for selection of an appropriate package the above factors should be considered. The packaging material should have good barrier properties i.e. low water vapour and oxygen permeability rates. It should retain the odour inside the package. The packaging material should also be able to withstand sub-zero temperatures.

(C) Canned Fish

In India tinplate cans with a sulfur-resistant lacquer are the traditional containers for fish and shellfish. However, the high cost of imported tinplate was one of the reasons for the collapse of canned fish exports from India. Aluminium containers offer tremendous opportunities to take care of the packaging needs of food-based products such as canned fish. An indigenously developed aluminium can has been found quite well for heat processing fish and fish-based products. Pull-tab polymer-coated tin-free steel cans are presently manufactured in India and some canneries use them for both internal and export markets.

Packaging Requirements

Canning is the major thermal processing of fish products. A suitable fish package should be

- Hermetically sealable
- Thermally conductive
- Inexpensive
- Sulphur resistant lacquered

Common materials used for manufacturing containers for fish products the world over are tinplate, aluminium and tin free steel (TFS).

Criteria for Selection of Packaging Materials/ Overall Packaging Requirements

1. Gas barrier

Modified atmosphere packaging (MAP) for fish requires a high barrier to carbon dioxide (CO₂), oxygen (O₂) and nitrogen (N₂). The pre-determined gas mixture has to stay inside the package and remain the same. Therefore, packaging films or layers with a high gas barrier are applied. Packaging materials used for MAP are a combination of different substrates. The materials can be as simple as two-ply laminations or as sophisticated as multi-layer co-extrusions, incorporating ethylene/vinyl alcohol (EVAL) as a high barrier substrate. As a coating, polyvinyl alcohol (PVAL) also provides excellent oxygen and aroma barrier properties. However, these properties are dependent on humidity; in other words, with higher humidity more water is absorbed. The water, which acts as a plasticiser, will then reduce its tensile strength, but increase its elongation and tear strength. PVAL is fully degradable and dissolves quickly.

2. Water vapour barrier

Impermeability to water vapour is important for fish packages as its quality is adversely altered by dehydration. Several plastics having good water vapour barriers like PVDC, coated oriented polypropylene (PP-O) and high density polyethylene (PE-HD) are used. Other plastics like polyamides (PA) and polystyrene (PS) have a poor water vapour barrier and yet some other plastics like EVAL can be adversely affected by moisture. Hence, in most packaging applications, the films must be laminated on both sides to protect it from contact with moisture.

3. Heat sealability

A tight seal has to be formed between the tray and lidding material to prevent contamination and dehydration of fish. Since the fish packages are sold in supermarkets along with other food products, the strong fish odour should not be allowed to spread. Low density polyethylene (PE-LD), ethylene/vinyl acetate (EVAC) and polypropylene (PP) are widely used as a heat seal layer in laminates of fresh fish packaging.

4. Gas barrier:

- Fish requires high barrier to CO₂, O₂, N₂.
- The pre-determined gas mixture has to stay inside the package and remain the same mixture. Packaging films or layers with high gas barrier are applied. PVDC Co-polymers, EVOH have the highest barrier to oxygen gas.

5. Water Vapour Barrier:

Impermeability to water vapour is important for fish packages as its quality is adversely altered by dehydration. PVDC, coated OPP and HDPE are used. Other plastics like PA and PS have poor water vapour barrier and yet some other plastics like EVOH can be adversely affected by moisture. films must be laminated on both sides to protect it from contact with moisture.

6. Oil Resistance:

For fatty fish, oil resistant films like polyamides, PVDC and PVC (unplasticised) may be considered. PET and OPP are also used as they provide excellent oil barrier.

7. Drip Absorber:

Fresh fish packaged under modified atmosphere conditions may drip. In order to reduce bacterial growth and provide a clean package interior, absorbent pads are enclosed. Pads made of cellulose are placed under the fish or when an EPS tray is used, are integrated as a layer.

8. Insulation:

Insulation is of particular importance in transport packaging of ice chilled fish. Expanded polystyrene trays and boxes are generally used as retail and transport packages respectively.