COURSE TITLE: FOOD PACKAGING

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LECTURE 1

1.0 PACKAGING

Is the use of containers and components plus decoration or labeling to

(i) Protect

(ii) Contain

(iii) Identify

(iv) Merchandise

(v) And facilitate use of products.

One or a combination of these elements may be involved.

Today virtually every manufactured or processed food product required packaging in some phase of production or distribution.

Increasingly this packaging function requires specialized skills, machinery and facilities to produce packages that meet one or more of four basic demands

1. To make it easier and safer to transport
2. To protect the product against contamination or loss
3. To protect against damage or degradation
4. To provide a convenient means of dispensing to the exterior

The Addition of printing or other decoration to the exterior of packages serve

(a) To identify the contents as to types and quantity

(b) Identify the manufacturers brand and quality grade

(c) Attract the buyer's attention

(d) Persuade buyer to purchase

(e) Instruct purchaser on how to use the product

BACKGROUNG:

Food containers and their utilization go back to the dawn of history. Food items to be stored or transported called for packaging. May different things were used

- Leaves
- Hollowed-out plant limbs
- Gourds
- Skins
- Reed Baskets
- Earthenware vessels

In time containers were improved or developed to meet the special needs of nomadic tribes

- Agragrians
- Merchants, traders and even for religions and war

The antecedents of some modern containers such as glass bottles and certain pactaging practices like lebelling are very old.

Glass bottles were used in Egypt more than 4,000 year ago. Marks and signatures, symbols and seals of various types appeared on the very first glass bottles used in commerce. The carliest paper originated from China about 200 B.C. Egyptians and Greeks used it about 500 B.C. and the Arabs learned the art from the Chinese during the Chinese invasion of 751 AD.

The tin can owes its origin to the discovery in 1200 AD by Bohemian artisans of a hot dip process for plating tin onto thin sheets of iron. The Romans used lead in many ways including water pipes and ointment jars.

Until about 1800, the making of packages was a craft or an art. It was the industrial revolution which produced advances in containers invention and fabrication resulting in the container forms we are familiar with today.

- Metal cans
- Glass jars
- Collapsible tube
- Folding Carton
- Corrugated shipping case
- And crown caps for bottles.

During the latter part of the 19th century into the early part of the 20th century, the groundwork was laid for mechanized production of all standard container forms. Simultaneously with this, linotype, photoengraving, process colour-printing and several graphic-art processes were developed thus completing the combination of container + effective decoration which has made modern packaging possible.

Between 1900-1930 several revolutionary products were discovered:

- Glassine
- Kraft paper
- Cellophane
- Aluminium foil

These provided the basis for a whole new development in

FLEXIBLE PACKAGING

The search for new materials thus stimulated by these discoveries has lead to spectacular discoveries since 1940 when

- Polyethylene
- Polyester
- Polypropylene
- Stretchable paper
- Steel foil
- Ionomers and a host of improved, coated or
- Laminated materials were introduced

Development of sophisticated merchandizing techniques was occurring parallel to that in packages making. It is these two mutually related factors which lead to the flood of packaged products that has never stopped growing in volume and variety. We are now in the era of CONVENIENCE PACKAGING.

Right along with these developments, machinery has been evolved for all phases handling, filling, closing, labeling and shipping of packaged products. Lines of machinery tailored to the needs of every conceivable food product and any type of container can be found. A new science of packaging management and packaging methods has been born.

LECTURE 2

2.0 MODERN PACKAGING MATERIALS AND PACKAGE FORMS

2.1 A RIGID PACKAGING MATERIALS AND PACKAGE FORMS

2.1.1 GLASS CONTAINERS

Glass = Limestone + Sand + Soda Ash + Alumina

Colorants may be added to the melt or introduced later

ADVANTAGE

- It is strong, rigid, chemically inert
- It is an excellent barrier against solids, liquids and gases
- It does not deteriorate appreciably with age
- It is low-cost (7/1b in finished delivered container)
- Its transparency (gives excellent product visibility)
- Attractive finishes of a variety of types are possible
- Extremely versatile, as to size and shape

DISADVANTAGES

- Weight – heavy
- Fragility in transport, Not easy to dispose of

2.2 TYPES OF GLASS CONTAINERS

	(i) BOTTLES	(ii) JARS	(iii) TUMLERS	(iv) JUGS	(v) CARBOYS	(vi) VIALS & AMPOULES
Shape Uses	High usage narrow necks large bodies liquids or small size solids	Wide-monthed short-necks liquids solids semi-liquid liquid sauces & pastes	Open-ended No necks at all Jams & Jellies	Large sized Bottles with handle short narrow-necks used for liquids in ½ gallon & larger sizes	Heavy shipping containers shaped like short necked bottles 3 gallons & larger capacity used with wooden crate Holder & of the protective frames	Small container principally for pharmaceuticals, Spices, food colorants

2.3 CONSIDERATIONS IN CHOOSING GLASS CONTAINERS FOR FOOD

DIMENSIONS AND "FINISH":- Ensure that volume is adequate product is easily filled and dispensed

Proper closure can be selected

"FINISH":- Refers to type of and dimensions of neck and mouth of container i.e THREAD, LUD, FRICTION, SNAP-ON, ROLL-ON

Many standard finishers are listed by the glass containers manufactures institute

COLOUR:- Influence type of light reaching the food

ABILITY TO RESIST THERMAL SHOCK:- This is important in heating and cooling operations.

LECTURE 3

3.0 METAL CANS

Consists of steel base sheet with a tin coating. The tin is applied by hot dip or electrolytically. Electrolytic application can be done differentially so that the two sides of the tin plate have different thickness of tin coating.

3.1 LAQUERS, Enamels

Besides the tin coating other organic coatings are also applied. These coatings must be non-toxic and free from odors and tastes. They must not come loose during processing or storage

These coatings consist of

INTERIOR	EXTERIOR
Acrylics	Acrylics
Alkyds	Alkyds
Butadienes, epoxyamine	Oleoresins
Epoxyester, epoxy-phenolics	Phenolics
Oleoresins, Phenolics	Vinyls
Vinyls	

Since 1959 – Aluminum is being used for beers, concentrated frozen fruit huice, frozen baked goods, powdered mil, condensed milk. An interior coating is generally necessary for Aluminum.

Advantages of metal cans	Disadvantages
1. Strong	1. Heavy
2. High speed manufacturing, filling and closing	2. cannot be re-closed
	3. Not disposable

3.2 COMPOSITE CONTAINERS

This is made from 2 or more constituent materials

Usually = Paper Board Body + Metal or plastic Ends

Two types:

(a) Spiral wound containers – made in cylindrical shapes where two or more plies of board are glued together around a mandrel

(b) Convolute – wound composites – produced by straight winding.

3.3 AEROSOL CONTAINERS

Uses

Beverage concentrates

Cocktail mixes

Cake icings

Pancake mixes

Syrups

Salad Dressings and seasonings

3.4 RIGID PLASTIC PACKAGES

Advantages

- Low cost
- Ease of Fabrication

Disadvantages

- Lack of product compatibility
- Low barier properties
- Plastic deterioration
- Low heat resistance
- Fragility at low temperature.

3.5 MAIN TYPES OF PLASTIC CONTAINERS

Thermoformed	Injection-Molded	Blow-Molded
Heart treated plastic is	Used in high volume	Used where containers have

formed around a mold. They may be pressure or vacuum formed. Plastics used are polyvinyl chloride polystyrene, poly-propylene ABS (Acrylonitrile butadiene styrene) Cellulose acetate. Trays are made with – this method	applications for jars bottles and tubs. Plastics used are: polypropylene, polystyrene. Has outstanding clarity	small neck diameter compared with rest of body. Plastic used are: Polyvinyl chloride polypropylene, polycarbonate, Cellulose Acetate Polystyrene polyethylene, polyacetate.

3.6 SOLID AND CORRUGATED FIBERBOARD CONTAINERS

Used to fabricate shipping cartons and cases

Used in wholesale and industrial shipping.

3.7 WODDEN BOXES AND CRATES

Used when timber is plentiful and inexpensive for shipping purpose.

3.8 CYLINDRICAL SHIPPING CONTAINER

Have high stacking strength

Can be rolled in Handling

They are made from fiberboard

Glass, metal, plastic or wood

Glass containers have been used as liners for other shells from: steel aluminium, fiberboard or wood

BARRELS Metal barrels made of steel or aluminium

DRUM

PAIL

KEG Small barrel

CASK Large, light wooden barrel

3.9 CONTAINERIZATION

Purpose is safe transport of goods from point of manufacture to sales point economically. Concept is to use as freight, container which is delivered directly to factory from loading point. At point of use container is directly off-loaded.

LECTURE 4

4.0 SEMI-RIGID PACKAGING MATERIALS AND PACKAGE FORMS

4.1 ALUMINIUM CONTAINERS

Advantages	Disadvantages
1. Convenience in preparation and serving of food. They withstand high temperature foods can be frozen in packages or cooled in it. 2. Protects food as an excellent barrier 3. Very Light	High cost as at now high technology of high capital intensity.

Types: Folded end

Ovals

Pie Plates

Rectangular

Rounds

Squares

Specialty Items

4.2 SET-UP PAPERBOARD BOXES

Four Basic components

(i) Paperboard

(ii) Adhesive

(iii) Coner Stays

(iv) Covering

Advantages : Convenience

Individuality

Strength

Reusability

Excellent Protection

Disadvantage: High cost

4.3 FOLDING PAPERBOARD CARTONS

4.4 MOLDED PULP CONTAINERS

LECTURE 5

5.1 METAL CANS

More than 49 billion metal cans are manufactured in the U.S. annually. This accounts formore than 30% of all units of consumer packaging.

The tin container was invented in 1810 by Peter Durand an English man.

It was introduced to the U.S. in the 1820's. At that time cans generally were made by hand. They were made during the winter months for use along with the next harvest. An expert can maker would produce 5 or 6 cans/hour.

"Sanitary" can was developed about 1900. This paved the way for mechanization.

The Metal Box Company is the only producer in Nigeria. At the moment they are making mainly No Al-type Cans. The total quality of cans manufactured are probably very much below the 10 million mark.

5.2 TIN PLATE CANS

Consist of a steel base sheet with a tin coating.

(a) the steel base plate is usually about 0.01 thick
(b) the tin coating has thickness varying from 15×10^{-6} inches thick
(c) Can enamels (Laquers) are baked organic coatings which are applied to improve stability of can interior when susceptible to damage by food materials packed in it.

The tin plate is an ideal material for food containers. Tin is not completely inert to all food. But corrosion and product chances are small if the proper choice of material is made.

Among the many factors considered by can manufactures are:

1. Chemical composition and physical properties of base plate
2. Thickness of tin coating

3. Application of protective coating or enamels
4. Container construction
5. Relative corrosivity of the product to be canned.

A large number tests are conducted prior to adoption of material.

5.3 A BASE PLATE

This is low carbon steel.

Metalloid content particularly of phosphorus, silicon are critical. Other trace metals of importance are copper, nickel, molyhdenum. The amount of these elements affect the corrosion resistance of the base plate.

Four Basic types of metal are used and a 5th is used for beer can ends

Element	% Permitted				
	Type L	Type MS	Type MR	Type MC	Beer End Stock
Mn	0.25-0.60	0.25-0.60	0.25-0.60	0.25-0.60	0.25-0.70
Carbon	0.12 max	0.12 max	0.12 max	0.12 max	0.15 max
P	0.015 max	0.015 max	0.02 max	0.07-0.11	0.10-0.15
Sulfur	0.05 max	0.05 max	0.05 max	0.05 max	0.05 max
Silicon	0.01 max	0.01 max	0.01 max	0.01 max	0.01 max
Cu	0.06 max	0.10-0.20	0.20 max	0.02 max	0.20 max
Nickel	0.04 max	0.04 max	No limit	No limit	No limit
Chromium	0.06 max	0.06 max	No limit	No limit	No limit
Molybdenum	0.05 max	0.05 max	No limit	No limit	No limit
Arsenic	0.02 max	0.02 max	No limit	No limit	No limit

5.4 CLASSES OF FOOD PRODUCTS AND TYPES OF STEEL BASE REQUIRED

Class Food	Characteristics	Steel Base Rqd
Most strongly corrosive	Highly or moderately Acid Foods	Type L
Moderately corrosive	Acidified vegetables, midly acid food products	Type MR Type MC
Midly corrosive	Low acid foods	Type MR Type MC
Non corrosive	Mostly dry and non processed products	Type MR Type MC

TERM BASE BOX: You will come across this term repeatedly. Originally Tin plate was sold in only one size sheet 14" x 20", 112 sheets – 1 Base Box. Such a package contained 31, 360 in or 217.78 ft^2 of surface.

TIN COATING

This is applied by either hot dip or by electroplating. Today only about 6% of all tin cans are made by hot dip which produce non-uniform tin coating.

Electrolytic plating can be differentially applied so that the inside and outside surface have different thickness of tin coating.

Hot dip - (1.25 1b/Base box) of tin

Electrolytic - (0.52 1b/Base box) of tin

ENAMEL COATING

These are baked organic coating, normally applied by roller to the flat sheet and are baked at temperatures below the melting point of tin.

Their purpose

(1) Preserve attractiveness of food in CAN

(2) Improve interior (occasionally only) exterior of can

(3) Increase shelf life of can

(4) Coating may make it possible to use less expansive tin coating

5.5 GENERAL TYPES OF ENAMEL COATING

Coating	Typical Uses	Type
1. Fruit Enamel	Fruits requiring protection from metallic salts e.g cherries	Oleoresinous
2. C-Enamel	Corn, peas and other sulfur-bearing products, including some sea foods	Oleoresinous with suspended zinc oxide pigment
3. Citrus Enamel	Citrus products and concentrates	Modified Oleoresinous
4. Sea foods Enamel	Fish products and meat spreads	Phenolic
5. Meat Enamel	Meat and various specialty products	Modified epons with aluminium pigment
6. Milk Enamel	Milk, eggs and other dairy products	Epons

7. Beverage CAN enamel (non-carbonated)	Vegetable juices, fruit juice, highly corrosive fruits, non-carbonated beverages	Two-coat system with Oleoresinous type base coat and vinyl top coat
8. Beer Can Enamel	Beer and carbonated beverages	Two-coat system with Oleoresinous or polybutadiene type base coat and vinyl top coat.

5.6 CAN MANUFACTURING

Modern process is highly mechanized. Can bodies are formed at speeds as fast as 600 units per minutes

1. Interior Enamel and outside lithography if used are applied to flat sheets of plate
2. Coated sheets are cut into proper size for individual can bodies
3. “Body Blanks” are fed into bodymaker which notches, edges and curls the plate so that the opposite sides lock together
4. The four thicknesses of metal which meet at the side seam are “bumped” flat and soldered (tin solder) forming a cylindrical shell.
5. The flanger puts a flared rim on both ends of the can body
6. When needed, a second coat of enamel is sometimes sprayed into the formed can body
7. One end (bottom) is double-seamed into the can body and the can is tested under pressure.

CAN ENDS: Are stamped from enameled or uncoated sheets of plate which have been out into strips of proper size.

The edge of the end is curled to form a groove. Into the groove, a heavy liquid rubber sealant is flowed. This gasket-like material, when dried, provided an hermetic meal in the double seam between body and end.

One can end is double seamed at the factory. The second is double seamed by the packer.

5.7 CIRCUMFERENTIAL BEADS

Those are used on large cans to provide strength. It increases resistance to rough handling and improves can ability to withstand paneling pressure.

5.8 QUALITY CONTROL CANS

The can manufacturer assumes responsibility for quality of tin plate in finished product. Microscopic pores or flaws in the plate may expose base plate and accelerate corrosion. Micro examination is done. Tests have been devised for checking continuity of tin coating.

5.9 (a) Pickle Lag Test

Detinned sample in immersed in HCl. The rate at which H_2 is given off by corroding plate is recorded. Good plate is attached at a content rate throughout the test. Poor plate is attached critically.

(b) Iron Solution Value (ISV)

This simulates reaction with a filled tin can. It measures amt. of iron dissolved from a tin plate specimen immersed for several hrs. in acid solution

(c) Tin crystal size: test samples are etched for 10-15 seconds in acid solution, to bring out the pattern of crystals on the plate large crystals are desirable.

LECTURE 6

6.0 FLEXIBLE PACKAGING MATERIAL

These generally fall into two broad categories

1. Paper and 2. Films

6.1 PAPER – Consist of bonds, tissues, litho, krafts, glassiness parchment and greaseproof.

PAPER TYPE	MATERIAL	WTS/3000ft^2	USES AND FINISHES
(i) Bands	Uncoated sheets made of bleached chemical pulp	20-70 1bs/3000 ft^2	Wide variety of finishers for printing. May have high degrees of wet strength etc.
(ii) Tissues	Light wt paper made of semi-fully bleached chem. pulp	8-20 1bs/3000 ft^2	Wide variety of strength and porosity. They may be glazed etc. use as wraps
(iii) Litho	Coated on one or both side	29-60 1bs	Used in publication advertising Excellent printing properties used in beer labels

(iv) Krafts	Very strong paper, made in bleached or unbleached form	25-80 1bs	Wide variety of strength available they are porolls and roughly finished. They are sheap. Used in making cannister labels
(v) Glassines	Super calendered chemical pulp sheet	15-45 1bs	Have high resistance to air and grease. Very strong, have smooth surface and glossy. Used for candy wraps
(vi) Parchment	Bleached chemical pulp stipped in H_2SO_4	15-27 1bs	Good grace resistance, good wet strength used for butter and magarine wraps
(vii) Greese Proof			Very much like parchment paper.

6.2 FILM

Definition: Thin flexble plastic sheeting having a thickness of 0.0100 inchor less. They are flexible as a result of manufacturing processes.

6.3 PLASTIC FILMS

(i) Cellophane

Originated as a brand name for a regenerated cellulose film. Transparent, somewhat elastic heat-resistant, water and oil insoluble film.

Produced by precipitating viscose solution with ammonium salts. When dry, cellophane film is relatively GAS TIGHT, when wet it loans much of its imperviousness to gas. Its lowest rated property is lack of flexibility. It therefore breaks easily when used with dry products. Cellophane is often used with other plastic films in laminates.

Cellophane to cellophane is not heat sealabl but it easily accepts heat sealable coating. Cellophane should be used immediately after exposure to high PV or immediately after exposure to low temperature.

(ii) CELLULOSE ACETATES

Closely resembles cellophane as far as most properties go except in two respects

1. Gas Transfer 2. Water Transfer

Cellulose acetate is better in water transfer resistance than in GAS TRANSFER resistance.

Because of its permeability to GAS it is suited for packaging certain fresh products such as fruits and vegetables.

It is not used for meat because its transmission rate of water is high and shrinkage and surface drying of fresh meat will result.

Cellulose acetate is derived from cellulose treated with acetic acid anhydride. The cellulose triacetate is partially hydrolyzed. Additives include plasticizers, antiblocking agents U.V absorbers. Used where stiffness, gloss and dimensional stability are required.

Cellulose acetate is sealed commercially with solvent adhesives. It have a wide use in laminates. Used extensively with polyethylene.

(iii) Polystyrene: A polymer of styrene. Its tensile properties are good as a film only at temperature above 176^0F.

It has attracted considerable attention in recent times because of its remarkable resistance to RADIATION include CHANGE. It is three times as resistant to radiation as polyethylene.

(iv) Polyethylene: the largest volume single film produced. Its primary selling point is its high functional properties as well as low cost.

In 1960 consumption of polyethylene in U.S.A was 280 million pounds.

In 1970 U.K. consumption 315,000 tons.

It is a polymer of ethylene and it obatned by two processes.

(a) High Pressure polyethylene

Or

Low density film

Manufactured at temperature $302\text{-}392^0$F pressure of 1200 atmospheres traces of O_2 present

(b) Low Pressure or high Density Film

Temperature $140\text{-}320^0$F, Pressure 40 atmosphere with Alkylmetal catalysts.

Low density polyethylene is lower cost of the two.

Has moderate tensile strength and clarity. It is a good moisture barrier and poor O_2 barrier. Not affected by mineral oils. Easily fused for closure. Density manges are 0.926-0.940 medium 0.910-0.926 low.

High density film offers better moisture protection and increased heat stability. Density ranges are 0.941-0.965 polythene bonds with cellophane to make good laminates. Printability is a problem it will not take printing ink, but by crafting polyacrylamide, a hydrophilic polymer on polyethylene, a polyethylene hybrid is produced whose surface will take ink. Extensive use of polyethylene is made in the retail market.

(v) Polyamides - Nylons

Various grades are available

Nylon 6 – Ease in handling and good abrasion resistance

Nylon 11 and Nylon 12: Superior barriers to O_2 and water and have low heat seal temperature.

Nylon 66: Very high melting temperature, difficult to seal.

(vi) Polyvinylchloride: Used for dairy, meat, confectionery and beverage packaging as well as laminate component.

LECTURE 7

7.0 PLASTIC FILM CONTINUE

7.1 POLYVINYLIDENE CHLORIDE (SARAN FILMS)

Saran is a copolymer of POLYVINYLIDENE chloride and polyvinylchloride.

It is one of the best films for imperviousness to water vapour, gases and odour. This property together with its ability to shrink when treated by simple method has given it a wide scope for food package uses.

The form having the trade name of cryovac shrinks to the extent of 30% when immersed in water at 200 to 205^{0}F. The sarans are clear, have good mechanical resistance, low water vapoyr and gas transmission rates.

Uses for cheese, meats, sausages, dried fruits wrappers etc. saran films are highly resistant chemically and are varied in composition or given an appropriate coating to increases resistance to specific products. It takes printing and can be marked with a pen.

In heat sealing it tends to shrink away from sealing bars resulting in reduction of thickness and weakening of the film along the edge of the seal. In practice this effect is minimized by intensifying the application of heat and using very short heating period so as not to allow much time for shrinkage to take place. This produce is called impulses sealing. For heat sealing of sarans the heating bars are covered with TEFLON to prevent sticking on the bars.

STORAGE TEMPERATURE AFFECT THE PROPERTIES OF SARANS

1 year at 95^{0}F - lose 1/3 or shrinking ability

1 year at 115^{0}F - lose 1/2 or shrinking ability

At 40^{0}F - loss of shrinking ability

Stored below 40^0F SARAN loses pliability

The film is resistant to most solvent.

Saran was first produced in 1946. It was developed as a substitute for a natural rubber shrinkable film developed just before would War II when rubber had become scarce.

The Cryovac film is sxtruded by means of a special screw-type device.

A trapped gas bubble is employed to bring about the required orientation of molecules. Finely powered vinylidene-vinyl copolymer, mixed with plasticizers, stabilizers, dyes, pigments and other agents is fed in extruder is heated for the necessary time at accurately controlled temperature above the melting point.

The syrupy extrude passes through a circular die into COLD WATER, thus producing a super cooled tube of amorphous material using gas pressure, the tube is expanded to 4-times its super cooled diameter, causing the material to be strtched simultaneously in all directions. This orients the long chain lolecules bioxially to give the film its quality of uniform shrinkability.

(viii) Polyester

The ester polymer are films of unusual strength and of light weight they have various compositions, depending upon the identities of alcohols and acid from which they are formed. A popular type is polyethylene terephthalate, a polyester of ethylene glycol and TEREPHTHALIC ACID. This is called MYLAR. Mylar was first produced in 1954.

It has a geat tensile strength elasticity and STABILITY over a wide range of temperature (-80^0-300^0F).

Used in pouches for frozen food as well as other products which may be heated to boiling water temperature. For this application polyester is laminated with polyethylene. The laminate is used in most “heat in pouch” packaging of food.

Manufactured in thickness from 0.00025-0.0075 inches. They are much more expensive than polyethylene, cellophane or cellulose acetate.

Polyester films are made heat-sealable by treatment with certain subsrances. One of these substance is BENZYL ALCHHOL. Sealing Bars are covered with TEFLON.

POLYESTER comes nearer than any other film used today to having properties required of a film for packaging sterilized foods.

It has strength and stability but does not meet the requirements for imperviousness to gases and water vapour.

Its melting points is 482^{o}F and thus high temperature sterilization is possible.

It has clarity and has good printability.

It is used for vacuum packing of products.

POLYPROPYLENE

High potential use of this film is anticipated in the food industry. Presently used for bakery and confectionery goods. It has low density, excellent strength and stability with good shrinking properties. The film may develop into a real competitor of polyester film for “heat-in-the-pouch” packaging.

RUBBER HYDROCHLORIDE (Pliofilm)

Produced from Natural rubber by the addition of hydrochloric acid. It is stretchable, non toxic, good oil and greese resistance used for self service packages for meats, cheese. Bags lined with pliofilm are used for coffee, spices and cookie packaging.

The film has fairly good imperviousness to water vapour. But it is coated with other plastics to give it differing degrees of permeability. Has good film-to-film heat sealing properties. It is used in identical circumstances as polyethylene. It makes good laminates with a variety of other materials.

ALUMINUM FOIL

Advantages

1. Large covering area per pound of material
2. Opacity
3. Almost absolute imperviousness to water vapour and gas in higher gages and good imperviousness in low gages.

However, in thickness less than, 0015 in aluminum foil contains small perforations which makes it pervious to gases and vapours.

Aluminum foil is unaffected by sunlight, does not burn. It is non absorptive of water and thus does not exhibit dimensional change with variations in humidity. Intermetent contact with water has very little effect. But hygroscopic products packaged in thin foil may cause some reactions particularly if product contains salts and organic acids as do mayonnaise and cheese.

Use: candies, milk, unsalted meats, butter and Oleomargarine. Can be used safely with oils and greases. Commercially aluminium foils are not used with strong mineral acids which will cause severe corrosion but weak acids found in food products do not, have appreciable effects.

The only safe rule with new products is to make suitable tests. To protect aluminum foils against corrosive materials, protective coating may sometimes be applied.

Mechanical Properties of aluminum foil

Tensile strength of annealed foil = 8.5 Ibs/in of width/mil of thickness. Strain hardening increase tensile strength for bursting and tearing while the tensile strength is relatively high, advantage cannot always be taken of it in foil packages. Economic considerations may dictate the use of thinner gages with reliance on laminations with other materials e.g. plastic films or paper to increase strength.

One important property of aluminum foils is that they do not become brittle at low temperatures. Infact aluminum foil increases in strength and ductility as temperature is lowered down to 320^oF.

TESTS OF MEASURE CHEMICAL AND PHYSICAL PROPERTIES OF FLEXIBLE PACKAGING MATERIALS

BURSTING STRENGTH: (Mullen Burst Tester)

Increasing pressure of a rubber hydraulic bubble against sample of sheet or film, clamped between two jaws having coincident circular openings, bursts the sample which ahs closed the circular opening. Unit : (psi)

TENSILE STRENGTH AND ELONGATION (Baldwin Static – Weighing machine; Pendulum – Weighing machine)

Each end of a sample strip 1” wide is clamped between a pair of jaws. A load applied to one set of jaws, tending to stretch the sample is increased gradually until sample breaks in two.

Units: (enlongation (%)

Tensile strength (Ib/in-width/thickness)

GAS TRANSMISSION

Sample of sheet of film, sealed across an opening in wall of a vacuum chamber, transmits gas from outside to inside the chamber, causing pressure in chamber to increase

Unit: (cc/100 in^2/24 hours).

WATER VAPOUR TRANSMISSION

Sample of sheet or film, sealed across mouth of a cup containing a substance that absorbs water readily, transmits water vapour from atmosphere at 90% R.H. at 100^oF outside cup causing dessicant to increase in wt.

Unit: (grams/100 in^2/24 hours).

GREASE RESISTANCE

Sample of sheet or film of specified size (4" x 4") intimate contact with white paper is treated on the other surface with test reagent (grease or oil).

Unit: time (minutes or hours) required for first appearance of stain on the paper.

AGING

Sample of packaged product is alternately exposed to different aging conditions, such as wet and dry heat at 160^0F. extreme variations of temperature.

Extreme variations of R.H.

Various types of rays or extreme variations of free oz-concentration.

At proper intervals, sample is examined for product deterioration, changes in wt and dimensions, dulling, crazing (i.e. collapsing), warping and discoloration.

OTHER INSTRUMENTS

OTHER INSTRUMENTS ARE LISTED AS FOLLOWS

S/N	Instruments	Property Tested by Instrument
1	Tear Test (Elmendorf)	Tear resistance (gram/mil)
2	Folding Endurance or stiffness Tester (MIT)	Pliability or resistance to bending
3	HEAT SEALER	Temp. Required to seal (^oF)
4	Size Tester	Moisture absorptiveness (% increase in wt)
5	Climatizer or Testing Cabinet	Holds controlled conditions of R.H. and Temperature
6	SPI TESTER	Flammability