Development and popularity of the modern supermarket depends to a great measure on the advances in food packaging technology

Trends In Food Packaging Technology

Cooperation Needed to Produce A Good Package

MANY notable individuals and companies are contributing earnestly and greatly to the advancement of food packaging technology. It is only fitting that we give a report of a magnificent multimillion dollar segment of the world's business. The authors selected are duly qualified to represent the hundreds of chemists, engineers, and craftsmen involved in the broad field.

It is often taken for granted that foods reach the market, and the kitchen tables, in a fresh, sanitary package, economically and without waste. We assume and expect that packages will be attractive on the store shelves. All this can be taken for granted only because the food technologist, the plastic chemist, and the paper chemist have joined hands with the artist, printer, machinery engineer, glass manufacturer, and metallurgist in their efforts to better serve the American public.

Transparent films, glass, tin cans, paper, and adhesives are constantly being improved through research. Material converters are devoting many man-hours of technical effort to place these materials into more convenient, useful, and attractive forms so that the wealth of the nation's food supply can be properly delivered to the consumer.

Future developments in food packaging will undoubtedly be geared to the supermarket type of merchandizing for which the American public shows a decided preference. During 1952 grocery store sales amounted to $33 billion; self-service stores received 79% of this trade. The number of stores selling meat 100% self-service has grown from 15 in 1945 to nearly 6000 today.

Such radical changes can hardly go by unnoticed. As a result, the modern food package must advertise itself. It must also preserve aroma, flavor, and other food qualities economically for extended periods on the store shelves. Ease of handling, opening, dispensing, and reuse of the container are becoming increasingly important.

How can I best package my product? Experts in the field expressed their opinions recently before the Division of Agricultural and Food Chemistry at the Chicago ACS meeting. Now the Staff of Ag and Food presents a summary of the Symposium on Technology of Food Packaging Materials to acquaint its readers with the most recent developments.

Trend Threatens Traditional Uses of Tin Cans, Glass Bottles

Food stores and supermarkets today depend on the availability of packaged retail units which makes possible improved efficiency and consumer service. More important than ever is the proper selection of packaging materials.

The tin can is the time honored container for practically all foods. For economic reasons its use has been largely restricted to "wet packs" such as fruits and vegetables. A wide variety of internal coatings is now available to protect many foods against the effects of direct contact with tinplate and to prevent corrosion. A program has been launched to develop a completely tinless, solderless can.

Glass bottles replace cans in many food packs where visibility of the contents enhances consumer appeal. The glass industry has gone far in overcoming two serious objections—low rate of heat transfer and breakage by mechanical or thermal shock. A special annealing process permitted reduction in the weight of glass used per jar without loss of strength. The traditional screw cap has been replaced to a large degree by the snap-on, side-sealing gasket type. Among new developments to be watched is the polyethylene "squeeze" bottle. Its utility will certainly be further exploited as volume production reduces costs.

The folded boxboard carton may be called the backbone of the packaged food industry. Recent statistics show that food packers consume 4.5 million tons of paper and paperboard annually; as compared with 2.5 million tons of tinplate and 38 million gross of glass bottles. More paper is used for packaging than for all printing papers, including newsprint.

A wide variety of coated liners, laminated liners, and overwraps are available from which to design the best structure for any given food package. Some recent developments include processes for direct coating without solvents by such resins as polyethylene and saran; and the use of light tissue paper as a laminant over a heat-sealing wax composition. New developments in the formulation of waxes for packaging papers should not be overlooked.

Bags, envelopes, and tubes appeal to food packers for many reasons, including substantial economies in many cases. Materials used for these packages include cellophane, glassine, aluminum foil, polyethylene, pliofilm, and saran. Combinations with paper in duplex and laminated structures are also employed. In comparing over-all cost of such packages with their protective performance, the food packer must recognize many factors in addition to cost per unit weight or area of packaging material.

Retail food packages are themselves further enclosed for shipment and handling through distribution channels. Although many commodities are shipped in metal and fibre drums, wooden boxes, crates, or barrels, by far the most common are corrugated cases and multiwall bags. Current developments of corrugated cases are concerned with specification tests and package arrangements to provide maximum mechanical strength with minimum weights of component plies. The "zipper tape" case promises to be a real help to the retailer. Multiwall bags offer the food packer an opportunity to combine different types of plies to achieve almost any kind of functional protection.

Although tin cans and glass bottles will continue to carry a large share of food products, their traditional uses are being threatened. Low cost modifications of paper will see increased use. The growth of polyethylene for packaging purposes from nothing in 1944 to more than 35 million pounds in 1951 has made deep inroads.

Converter Advises in All Packaging Operations

The converter, once occupied with forming of simple materials for simple requirements, has established a new concept in customer service—meeting the needs of specialized products with integrated packaging service. Approaching each product as a specific problem, the converter has fast become the packaging expert, advising on materials to be used, special requirements, form of the package, packaging machinery, shipping, and merchandising. In doing so he has made available to the consumer a superior product, more tasty, more appealing, more healthful.

It is the task of the user to select from a wide variety of films those which independently or in combination contribute something more than the physical properties of the individual materials of which they are comprised. In doing so, new materials are created, each with its own character, its own potentials, and its limitations. Aluminum foil supported by fibrous products, pliofilm, or acetate, gains flexural qualities or strength with the added component. Polyethylene coupled with cellophane assumes the qualities of the latter. The high percentage of elongation and gas transmission rate associated with polyethylene is replaced by low stretch, low gas transmission, high impact strength, and a resistance to tear that can be controlled by the nature of the lamination.

Favored over monofilms by reason of cost, performance or appearance, the

TECHNOLOGY OF FOOD PACKAGING MATERIALS

A symposium presented by the Division of Agricultural & Food Chemistry at the 124th national meeting of the American Chemical Society, Chicago, Sept. 8, 1953.

Introductory statement, L. J. Hayhurst, Research Laboratories, Kraft Foods Co., Glenview, Ill.

A Food Packer's View of Packaging Materials, L. W. Elder, Research & Development Dept., General Foods Corp., Hoboken, N. J.

Package—From Polymer to Purchase, P. B. Reuman, Standard Packaging Corp., Jersey City, N. J.

The Converter's Side of the Packaging Story, G. P. Dillon, Shellmar-Betner Division, Continental Can Co., Inc., Mount Vernon, Ohio

Cellophane in Food Packaging, Nelson Allen, Film Dept., E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.

Vinyl Resins for Food Packaging, M. C. Reed, Bakelite Co., Bound Brook, N. J.

Food Packaging in Pliofilm, P. J. Vaughan, Chemical Products Development Div., The Goodyear Tire & Rubber Co., Inc., Akron, Ohio

Polyethylene Film for Food Packaging, C. J. B. Thor and Meyer Goldman, The Visking Corp., Chicago, Ill.

Saran Film, Its History and Development for Food Packaging, F. C. Dulmage, Plastics Technical Service, The Dow Chemical Co., Midland, Mich.

Cryovac Packaging of Foods, R. D. Lowry & E. A Nebesky, Dewey & Almy Chemical Co., Cambridge, Mass.

A Method for Measuring Gas Permeability of Packaging Films, B. E. Ellickson, V. Hasenzahl & R. V. Hussong, Research Laboratories, Kraft Foods Co., Glenview, Ill.

Packaging of Foods in Metal and Composite Cans, R. V. Wilson, Continental Can Co. Inc., Chicago, Ill.

Aluminum Foil for Food Packaging, A. I. Totten, Jr., Light Metals Div., Reynolds Metals Co. Development Laboratory, Richmond, Va.

Vegetable Parchment Paper, Marshall Rutz, Kalamazoo Vegetable Parchment Co., Parchment, Mich.

The Magic Box, C. E. Lindgren, Cornell Paperboard Products Co., Milwaukee, Wis.

Development of the Shipping Container Industry, E. T. Hayes, Container Corp. of America, Chicago, Ill.

Adhesives in Food Packaging, Sam Schuller, Paisley Products, Inc., Chicago, Ill.

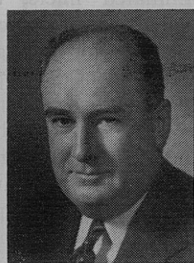
Current Trends in Meat Packaging, J. M. Ramsbottom, Research Labs, Swift & Co., Chicago, Ill.


L. J. Hayhurst


L. W. Elder


P. B. Reuman


G. P.Dillon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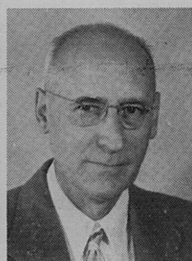
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Meyer Goldman


F. C. Dulmage


R. D. Lowry


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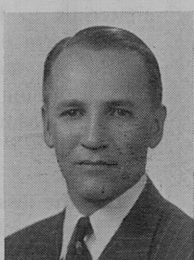
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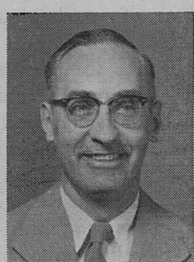

Marshall Rutz


C. E. Lindgren

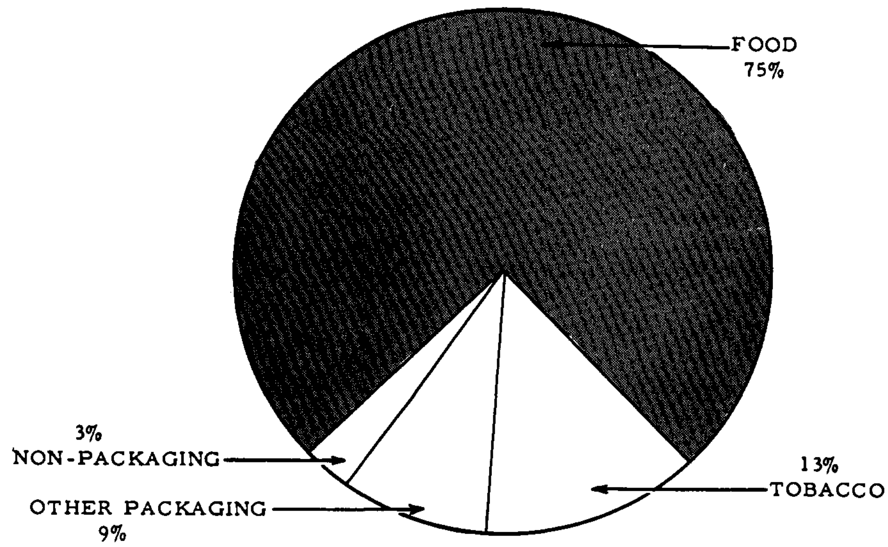

E. T. Hayes


Sam Schuller

multifilm is used today to package nuts, milk powder, and meat in a protective atmosphere of gas. Multifilms also provide an oxygen free atmosphere for packaging meats, cheese, sauerkraut, and pickles.

Vacuum packaging of cheese, pickles, and fish is now an accepted commercial practice. Orange and lemon concentrates frozen rigid in an oxygen barrier provide a ready pack for institutional and home use. Frankfurters are available in a pouch that can be dunked in boiling water without dilution or dirtied pots. These and a multitude of new ideas are coming through the converter's laboratories.

The packaging industry is young, one step removed from the cracker and pickle barrel, but facing a Buck Rogers world. The use of self-conforming techniques and materials, the concept of the transparent tin can, the frozen cornucopia, high speed equipment for filling and forming, are but a few of the challenging problems still facing this industrial youngster.



Distribution of cellophane consumption in 1952

Converter Needs to Know Pros and Cons of Each Material

In the field of packaging the use of the term converter describes special functions in the production of flexible materials. Rigid containers such as glass jars and tin cans are used substantially as fabricated by the manufacturer. Some applications permit the use of plain films in original form. But the demand for a package to serve as an advertisement often requires a converter to perform such operations as printing and decorating, laminating or combining, and bag or pouch forming.

The converter frequently serves as package designer, engineer, and manufacturer. In the case of larger converters this has sometimes included the design and manufacture of packaging machinery. At the risk of over-simplification we list some considerations which guide a converter in developing adequate packaging structures. The package must contain the contents, display or describe, protect or preserve, facilitate later use, and cut costs. The definite way in which converters have been able to accomplish these functions explains in part the terrific increase in this field during the last 30 years.

The product manufacturer is making more complex demands as he buys packaging materials. He is offering the consumer products that were undreamed of in past years. Present-day citrus concentrates, two-component angel food mixes, and dry soup stocks illustrate the point. Often these demands are met by combining two or more well known films to produce a completely new structure with useful properties which neither film could offer alone.

As has been hinted above, the converter needs to know the disadvantages and potential pitfalls connected with each type of material just as thoroughly as he is aware of the advantages. The converter can be uncomfortably caught in the middle between the raw material producer and the package user. Variations that may seem minor or inconsequential to the raw material producer can cause great grief. When changes in raw materials are contemplated, the manufacturer has a responsibility to advise or even consult with the converter. Some progressive manufacturers go so far as to arrange joint tests with the converter before the changes are made effective.

The converter speaks for all packaging materials. He has the responsibility to survey all that offer promise and to select the best one or combination for the job to be done. It is obvious that with so much at stake, product manufacturers are inclined to select converters not on a price basis, but on a responsibility basis. Likewise responsible converters are forced to rely more and more on adequate research and development personnel and facilities.

Food Packaging Consumes 75% of Cellophane Production

Rapid development of self-service merchandizing is largely responsible for the increased use of cellophane. Today its manufacture is a $170 million business, with an annual output approaching 300 million pounds. Over one third of all production is sold to converters who print the film, fabricate it into bags, cartons, envelopes, and other items.

Cellophane's desirable properties make it particularly suited to self-service merchandizing. The film is transparent, greaseproof, odorless, tasteless, nontoxic, moisture protective, and has low permeability to odors and gases. It is sealable with heat, adhesives, or solvents and is mechanically efficient. The needs of particular foods have led to the development of many varieties. Du Pont alone has a total of about 130 different types.

What are the properties that are built into a type of cellophane to make it do a good job on food? Specific examples in the major food industries best illustrate the manifold requirements.

Baked goods require a material that will protect them from contamination and have adequate durability. Most breads and cakes must be prevented from drying out and a film with low water vapor permeability is used.

For adequate protection of hygroscopic candies, double wall bags or laminations must frequently be used. Low permeability of cellophane to odors and flavors in comparison to other films such as polyethylene make it preferred for these uses.

Crackers and biscuits are made with high moisture content and with low moisture content. A recent popular trend is fractional packaging. This packaging of multiple small units is spreading to other foods such as candy, cereals, and nuts. Highly grease-proof films are desirable for many cracker and biscuit items.

Frozen foods require films that are durable at low temperatures, with low water and oxygen permeability. They should be flexible to conform to the food and eliminate air pockets.

Laminations are used for dried milk and a specially coated film is manufactured for cheese. A water resistant, moisture-proof type of cellophane is given a heavy coating on one side with a special wax-resin blend. The tight cling of the wax coating eliminates air and prevents mold growth.

Types of cellophane with the needed oxygen permeability have been developed for fresh meat, and films and special laminations are available for the smoked and cured meats. The laminations can be used for vacuum or inert gas packaging.

Other foods packaged in cellophane include tea, coffee, dried vegetables, dried fruits, noodles, macaroni, and cereals. Dried fruits have a particular problem—sugars in the fruits produce a haze in the standard coatings of cellophane. However, a satisfactory film has been developed.

Vinyl Resins First Introduced as Can Liners

Vinyl chloride resins offer excellent resistance to most aqueous solutions, fats, oils, and alcohols. Inertness, as well as freedom from odor, taste, or toxicity, permit contact with all types of foods or beverages. These resins, in the unplasticized form, are less permeable to moisture than cellulose acetate, cellulose acetobutyrate, or regenerated cellulose; but are more permeable than vinylidene chloride or polyethylene. Vinyl resins are intermediate with respect to polyethylene and vinylidene chloride in oxygen, nitrogen, and carbon dioxide transmission. Vinyl films are moderately heat resistant. Being thermoplastic, they soften at sterilizing temperatures. Printed films are easily produced by a variety of printing processes; sealing is accomplished by heat or solvents.

Vinyl resins first attracted attention in the food packaging field as a lacquer for beer and food cans. A more recent resin-metal combination is aluminum foil with a vinyl coating. These packages provide a combination of heat sealability, moisture resistance, and light protection—properties that are especially suitable for food concentrates.

Vinyl coated paper has been widely used as cap liners. A combination of vinyl resin and nitrile provides a very effective oleomargarine package. The color capsule can be broken and the oleomargarine uniformly colored by kneading—before opening the package. A vinyl film is used as a liner for fiber drums containing condensed milk. Individual food portions are now being packaged in small cups made by drawing rigid vinyl sheet. Polyvinyl acetate while somewhat tacky and deficient in water resistance, makes an excellent adhesive for milk bottle hoods.

Rigid vinyl resins have excellent dimensional stability when exposed to a large number of liquids. These resins are ideal for injection molded parts of dispensers. Rodent repellant materials have been incorporated in vinyl film which is used as an outer wrap for food packages. Vinyl resins have also been quite successful in food handling equipment such as milking machine tubing and beer tubing. A banana crate lining is a recent development. It consists of a heat sealed bag made from a laminate of felt with plasticized vinyl sheeting on both sides. This liner protects the bananas against bruising in shipment and is easily washed for reuse. Much research effort is being directed to the expanding use of vinyl-based lacquers for metal cans. The number of foods which can be packaged in vinyl lacquered cans is expected to increase.

Novel machine designs permit pliofilm to be heated and stretched up to 800% to conform to contour of the product

Trend Is Toward Lighter Gages of Pliofilm

Pliofilm's acceptance in the food packaging industry is due to superior properties of dimensional stability, toughness, and the wide temperature range over which positive seals can be made on automatic packaging equipment.

Pliofilm is a homogeneous, transparent, plastic film composed of plasticized and stabilized rubber hydrochloride. By the addition of plasticizers and other agents, films of gradually increasing water vapor transmission rates, gas diffusion values, and flexibility are manufactured in thicknesses ranging from 0.00020 to 0.00250 inch. These films are strongly heat sealing, and may also be sealed by solvents, and by either lacquer or emulsion type adhesives. Standard converting techniques permit printing by gravure, flexographic, and letter press processes. Laminating and bag making are performed on standard equipment to produce constructions for specialized uses.

In recent years, development efforts have been concentrated on the adaptation of standard packaging equipment to the use of low-gage pliofilm at high speeds. Special efforts were necessary because pliofilm behaves differently on machines and in some converting operations than ordinary coated cellulosic films. Pliofilm becomes amorphous and plastic at sealing temperatures; heated, free-turning roller sealers are required to prevent scuffing. Sealing parts must be redesigned on discontinuous-motion sealing machines and bag-making machines where the film or package is arrested in motion. These parts are now available on most new machines, or can be installed by the manufacturer on existing equipment. Some novel designs have been produced to utilize the plastic properties of pliofilm when heated; pliofilm stretched up to 800% will conform to the contour of the product.

Only the design of specialized, high speed equipment can solve some of the really difficult packaging problems. We stand ready to cooperate and to participate in the design of equipment where necessary. As far as film development is concerned, we feel that the swing is toward lighter gages which still do the packaging job adequately. There are a number of packaging applications which no single film can do alone. In these cases we are constantly investigating combinations and laminations of pliofilm to other transparent film, and to papers and foil. We have in the pilot plant stage for demonstration a process for the simultaneous tensilization and lamination of pliofilm and foil. This product will be a 20-gage pliofilm, 35-gage foil combination which will enable converters to solve some packaging problems which require the ultimate in protection at low cost.

Polyethylene Film Stored for Years Without Deterioration

In the short period of eight years, polyethylene film has become a major and still rapidly growing factor in the packaging industry. At the present time polyethylene resin is being produced at a rate of more than 150 million pounds per year in the U. S. A substantial proportion of this production is being marketed as unsupported film.

Polyethylene film is thermoplastic and readily heat sealable. Most current applications of polyethylene film for food packaging involve the use of plain or gusseted bags made from film ranging in thickness from about 1.5 to 4 mils. These are usually fabricated by heat sealing methods which employ the common heated bar, hot wire, impulse, rotating band, rotating heated roller, flame, and electronic techniques. Manual and automatic devices are available, but most work is done on automatic high speed machines.

As yet, no adhesive satisfactory for bag fabrication has been developed. Adhesives are available which are satisfactory for lamination or spot gluing the film to other surfaces. These are usually latex types which require the escape of water and solvent for setting. Solvent sealing is not a feasible method of fabricating polyethylene film.

Bag closure may be accomplished in a number of ways: heat sealing, stapling, tying, twisting, taping, and banding. The method selected will depend on the demands of the product, the convenience of the filling operation, economics, and other factors. The reusable feature of a polyethylene bag is accomplished when a temporary closure is employed.

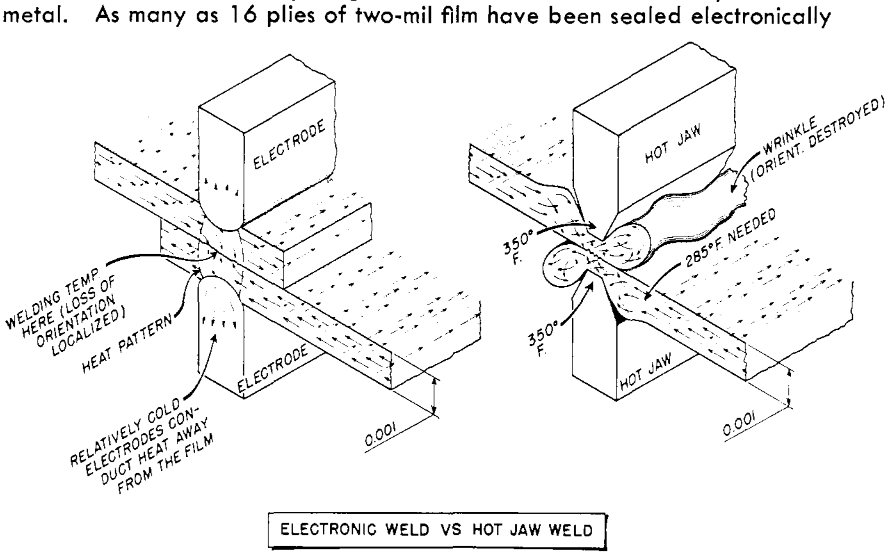
Polyethylene films are often printed with identifying marks, illustrations, directions, and recipes. The adhesion and durability requirements are sometimes exceedingly high, as for example, in produce packages which may have to endure long freight hauls in refrigerated cars in contact with crushed ice. Printable polyethylene films are now available which offer permanent bonding of flexographic, letter press, and rotogravure inks. Such printing is done continuously on rolls of tubing or single thickness film prior to fabrication into bags.

Polyethylene film has adequate tensile and elongation properties which are retained to a remarkable degree at subfreezing temperatures. High tear strength permits the use of perforated bags. The film can be stored for years without loss of its prime physical properties. It is further characterized by a relatively low water vapor transmission rate and a relatively high gas transmission rate. Generally speaking, polyethylene is quite permeable to organic vapors, essential oils, and related materials. It is also nontoxic, odorless, and tasteless.

Electronics Solve Saran Heat Sealing Problems

Saran, a copolymer of vinylidene chloride and vinyl chloride, is crystal clear, tough, and has many outstanding physical properties. Low gas permeability makes it suitable for the preservation of full flavor and freshness of many food products. The functional properties of saran make it ideal for packaging cheese, meat, dried fruits, and confectionary products. Its chemical resistance and low water vapor transmission are utilized in the manufacture of cap liner materials. A lined drum is fabricated from sheet metal which has a laminated coating of saran film. Many frozen food processors and shippers are using it as a replacement for more expensive stainless steel drums.

Electronic sealing is necessary for saran film. Maximum heat must be developed at the interface of the adjoining films since saran has a tendency to stick to hot metal. As many as 16 plies of two-mil film have been sealed electronically



Printability is a big advantage of polyethylene film. Printing is done continuously, before fabrication of bag

Saran film is sometimes referred to as being an unusual or unorthodox material because of its physical properties. For example, it cannot be heat sealed in the same manner as cellophane or pliofilm. This is due in part to the very small difference between its sharp melting point and softening point, as well as its tendency to shrink under heat. We have, however, found a solution to this problem by using electronic sealing.

Saran film is available in many types which vary in clarity and slip. Sometimes a less clingy film is used to facilitate handling on automatic machines; this usually means a more opaque film. For luncheon meats or hand-wrapped packs, another type is preferred which practically seals itself. Gauges from 0.0005 to 0.002 inches are commercially available in single thickness. Some users prefer a double wound film. This type provides added toughness, more scuff resistance, and less danger of leaks and tears.

Printed double wound film demonstrates printing which is locked in between the plies. This not only eliminates possible contamination of the product from the ink, but it also defeats the smear problem which is sometimes encountered. It also adds considerably to the gloss or depth of printing and overall appearance of the package.

Saran film could possibly replace metal cans and glass jars in many applications, since it can withstand processing temperatures under proper conditions. As a container, it could be lighter to ship, easier to dispose of, and more convenient to open. The latter property would certainly add to its appeal for picnic foods and the like.

Cryovac Provides "Skin-Tight" Covering

Cryovac film is made from a vinylidene chloride base copolymer. It has many outstanding properties, the most important being uniform shrink, low water vapor transmission, and low oxygen permeability. This film is well adapted to the packaging of both refrigerated and frozen foods since it is essentially odorless, tasteless, nontoxic, transparent, tough, and flexible at low temperatures.

In the Cryovac process, the food is inserted into a loose-fitting bag, air is removed by vacuum, the bag is sealed, and then shrunk by momentary immersion in hot water at 200° to 205° F. This method is readily adaptable to automatic, high speed packaging, and it provides a wrap which clings to the contour of the product. It makes an attractive package which commands consumer appeal.

One of the many advantages offered is that of longer shelf life with preservation of flavor, aroma, and color. Crovac film reduces bacterial growth with packages of fresh cut-up chicken, because of the limited oxygen present. Mold growth on smoked meats is retarded for more than 6 weeks. Frozen pork does not become rancid after a period of more than a year.

One serious problem with the long time storage (over three months) of frozen poultry is freezer burn. Moisture loss, combined with oxidation of the fat, produces white areas that look bad, are tough, and poorly flavored. The imperviousness of Cryovac to oxygen and moisture, and its "second skin" contour fit prevent freezer burn, maintaining the quality of frozen poultry for well over a year.

With the present trend toward self-service stores having brightly lighted display cases, the preservation of good color for sales appeal is of utmost importance to many products. There is no appreciable color change in the cut face of half hams packaged in Cryovac and stored under 70–80 foot candles intensity at 38° to 40° F. for five days. Another important advantage is its prevention of weight loss due to the low water vapor transmission rate.

Effects of Creasing, Folding, Sealing on Gas Permeability

A number of methods have been developed for measuring the gas permeability of packaging films. They are usually one of two kinds: continuous gas flow across a film, or two different gases on opposite sides of the film at a pressure difference of about one atmosphere. None of these account for the effects of creasing, folding, and sealing of the film.

We have developed a new method where test films are wrapped around a lucite form and heat sealed in the same manner that retail packages are handled. All sides of these forms have four to eight holes $^{7}/_{16}$ inch in diameter to permit gas passage to the film. The wrapped forms are placed in gas-tight containers fitted with petcocks, so that an atmosphere of oxygen, carbon dioxide, or nitrogen can be admitted for testing purposes. A gas sample may be removed at any time for analysis.

Both the volume inside and outside of the lucite form is known. Analysis of the gas inside the form at the beginning of the test, combined with an analysis inside and outside the form at the end of the test, permits calculation of the percentage transferred.

Under these test conditions we found that three films were impermeable to both oxygen and carbon dioxide: cellophane laminated to aluminum foil laminated wax coated cellophane; 150-gage saran with a wax coating; and 75 gage saran wax coated. Those films which showed permeability included cellophane laminated to wax coated cellophane; pliofilm laminated to wax coated cellophane; and heat-sealing cellophane. Gases which permeated these films were able to pass in both directions.

More Cans Produced With Less Tin Consumption

Almost every type of food is packaged in a metal or composite can: fruit juices, meats, dairy products, coffee, fats, oils, vegetables, beer, and carbonated beverages. The best way of illustrating the industry's aggressive approach is to follow a few fairly recent developments. Some fruit and vegetable juices, beer, and carbonated beverages are quite sensitive to iron pick-up which is reflected in their taste and appearance. For this reason, enamel lined cans have gradually replaced plain ones. Over one and a half times as many cans were produced in 1951 as in 1940 using only four fifths the amount of tin.

The development of suitable organic coatings presented a large scale program. These coatings must possess an almost impossible combination of characteristics which include flexibility and resistance to abrasion and fabrication, as well as the proper physical properties to allow application at high speed by either spray or roller coating. The final baked enamel must be nontoxic, reasonably impervious to moisture, and must not impart flavor to the food product.

Another major step was the development of means for spraying a coat of enamel over the severely worked seam side after fabrication. Preventing metal exposure on the ends of the cans was solved by new assembly methods and the use of specially developed double coats of enamel applied on the flat plate prior to fabrication. Closing machines were developed which operate at production speeds as high as 500 to 600 cans per minute. Several billion cans are produced every year with as little as 0.02 to 0.04 square inch of exposed metal per can.

Development of the coffee can involved a reclosure container which could be either vacuum or pressure packed. The greatest problem was the mechanical equipment required to close cans under 29.7 inches of vacuum at speeds of 125 to 200 cans per minute. Elimination of oxygen in containers for shortening was accomplished by developing mechanical means for displacing air in the headspace with a jet of inert gas prior to sealing. Research on propellant gases and dispensing nozzles made it possible to pack whipping cream and other food products in a pressurized container similar to that used for carbonated beverages and beer.

Aluminum Foil Production to Reach 200 Million Pounds

There has been a phenomenal increase since World War II in the use of aluminum foil for packaging purposes. This trend actually started in the late 30's, but because of wartime restrictions it was not until 1946 that it gained real impetus.

Its negligible moisture vapor transmission rate, lightproofing, and complete nontoxicity have been responsible for aluminum foil's use in packaging sugar-coated cereals, cheese, dehydrated soup, cookies, oleomargarine, and butter. The eye appeal imparted by a foil wrap is naturally important, and in many instances is responsible for the housewife making that most important purchase, the initial one.

By 1949 when a wrap of this kind was beginning to gain acceptance throughout the dairy industry, the Federal tax law on oleomargarine was repealed. One large concern recognized immediately its possibilities and adopted the aluminum wrap 100%; his product quickly rose to first place in the industry and other producers were quick to follow suit. Today you really have to look hard in a supermarket to find a margarine package without foil. This new wrapper offers the advantage of moisture-loss protection, moldability, and odorproofness. The last factor is very important in the refrigerator. In regard to moisture protection alone, one producer estimated that with the entire industry using foil, 10 million pounds of oleo would be saved annually at the consumer level. A Department of Commerce survey indicated that the attractiveness of printed foil has been largely responsible for this package being preferred 3 to 1 over other types of margarine packages.

The future of aluminum foil for food packaging is undoubtedly assured. A large percentage of the 100 million pounds that will be produced this year, as well as the estimated 200 million pounds to be produced in 1954, will be used for this purpose.

The aluminum industry and its foil converters do not claim that aluminum foil is the panacea to all food packaging problems, but they do feel that it is the rare case where it should not be evaluated thoroughly.

Vegetable Parchment Paper In Use for Over 100 Years

Vegetable parchment is considered an ideal material for packaging lard, poultry, fish, meat, vegetable shortening, oleomargarine, cheese, and ice cream. By far the largest use is as butter wrappers, either in printed form, waxed, or laminated to foil. In almost every grocery store you will see broccoli, celery, onions, and other fresh vegetables which have been wrapped or banded with this material. Specialized applications include box liners for greasy products such as doughnuts and cookies, printed inserts in ready-mixed cake packages and coffee cans, and both tamale and corn-on-the-cob wrappers.

Types of vegetable parchment can be identified as three major classes: regular grade to provide wet strength where extreme grease resistance is of minor importance; lard liner grade for applications requiring high grease resistance; and kraft grade where high wet and dry strength is needed. Each type can be modified to impart particular properties; several hundred distinct varieties are produced.

Vegetable parchment is treated in many ways; most familiar is the glycerine treatment which causes the paper to take on a rag-like softness. Other types of processing impart mold-inhibiting, antirancidity, anticreep, and antitarnish properties and permit release against sticky substances such as crude rubber and adhesive masses. Vegetable parchment waxed on one or both sides provides resistance to water vapor; a semi-parchmentized, lightly waxed paper is also manufactured. Creping treatment is performed either in the parchment machines or in a secondary operation. This paper has remarkable strength wet or dry. Opaque parchment is produced by adding titanium dioxide filler to the pulp before formation into the waterleaf stock.

All methods of printing can be applied with parchment, although letterpress is the most popular. Printing inks must pass vigorous laboratory and use tests—oleomargarine and butter wrappers are soaked for days in tap and distilled water, salt water, lactic acid, chloramine, and other chemicals. Some of these tests specify boiling for several hours. The ink, after the above treatment, must not bleed, rub, nor have changed color. Actual packaging tests are also conducted.

Industry is turning more and more to tailor made types of vegetable parchment. It is the natural sheet upon which to apply special treatments because of its extreme density and imperviousness toward most chemicals. The treatment remains on the surface where it is most beneficial. Parchment paper is completely odorless, tasteless, and free of loose fibers.

Increased Sales Predicted For the Magic Box Industry

The manufacture of folding cartons has proved, over a period of many years, to be a "service" industry. Our industry provides an agency for creative work, both structural and artistic, which is constantly seeking to develop improved grades of boxboard, equipment, inks, and related products. The Folding Paper Box Association has a strong technical committee and full-time technicans on their staff to assist in developing projects of national interest. We further have assistance from other technical groups such as the Packaging Institute and the Technical Association of Pulp and Paper Industry.

Growth of the folding carton industry has followed very closely the per capita production of paperboard. Consumption of paperboard has risen from about 14 pounds per person in 1904 to approximately 168 pounds per person in 1951. This growth shows a slope factor of about 0.85; forecasts indicate that this trend will continue for years to come.

Methods for studying package requirements of a product are now generally fully understood and used. Provisions for maintenance of protection against such things as rancidity, flowability, undesirable chemical activity, and related matters, can be made by careful study of the product. Shelf-life and accelerated storage tests are common. Pretesting of package design is used effectively, and should be standard procedure.

In selecting paperboard for folding cartons, we are generally concerned with weight, thickness, stiffness, and tearing strength. Other equally important considerations are porosity and transmission of moisture and gases; oil, grease, and water resistance; and resistance to chemical activity and the development of odors. These properties become a matter of specifications, and the paperboard industry has recognized the need for controlling their product to meet the demands for packaging.

New and improved lining materials are becoming available. Today we have polyethylene applied as a continuous film to paperboard. We feel that this development is destined to become most valuable in food packaging. We are finding new waxes for protective treatments, and these can be applied with standard equipment. Some of these treatments are particularly effective in retarding rancidity and other chemical activities leading to the production of off-taste and odor conditions.

Advances in printing and die-cutting equipment have been accomplished. New and improved machines are creating opportunities for further reducing packaging costs, obtaining better graphic illustrations, and better mechanical handling. This constant change has further increased the need for closer cooperation between carton user and carton producer, if full utilization of improvements is to be obtained.

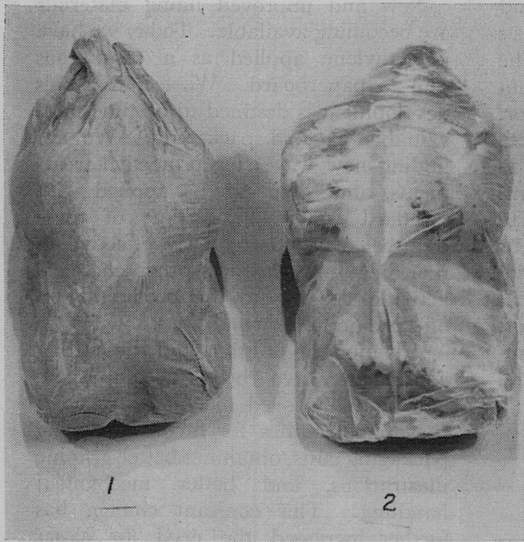
5 Million Tons Paperboard Used In 1952 in Containers

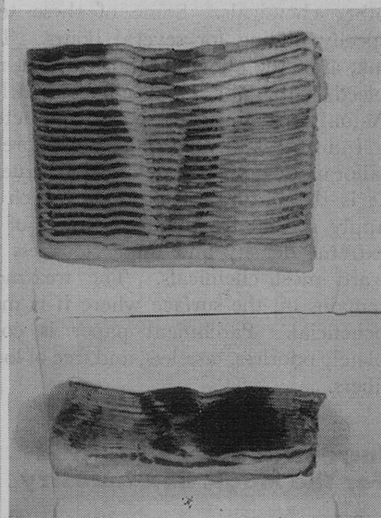
In 1910 there were 50 companies manufacturing corrugated and solid fiber containers, consuming 150,000 tons of paperboard per year. By 1920 the number had increased to 100; annual paperboard consumption was 970,000 tons. Last year 296 companies operated 568 box plants which used 5.66 million tons of paperboard.

The basic raw material for paperboard is cellulose in the form of fibers. Wood provides the most common source, partly because of economics and also because of its superior physical properties. Equal in importance to wood pulp is waste paper, which is collected in all places where sufficient quantities make it economically feasible. The collecting organizations themselves form a rather sizeable industry. Another raw material is straw, one of the few wood substitutes that has been successfully employed on a commercial scale.

Three types of paperboard are used in the manufacture of corrugated and solid fiber shipping containers. The container liner, which is the facing for both corrugated and solid containers, is made from jute (a mixture of waste paper and kraft pulp) or from kraft (100% kraft pulp). The corrugating medium, formed into a serpentine shape, holds the two plies of liner board in their proper position. This material can be made from straw, semichemical, chestnut, Fourdrinier Kraft, or bogus pulp. Chipboard is used for the inner plies of solid fiber containers.

The majority of all fiber shipping containers are manufactured as a regular slotted container, although center special, overlap, and telescope containers are available. People who package their articles in fiber boxes are permitted





Voids between frozen product and package should be kept at a minimum, otherwise dehydration and frosting occur, impairing visibility. Right. Consumers prefer shingle-type packaging of bacon, which is not the best method, since exposed surface area is increased 103% and amount of packaging materials is increased 100%

three methods of closure: taped, stitched, or glued. Many types of interior packing made of corrugated board are used to hold articles firmly within the containers.

From a start of packaging cereals in the early days, the field in which a fiber shipping container may now be used seems endless. Practically all articles of food are packaged in fiber shipping containers. Great progress has been made in packaging fresh vegetables and fruits, such as lettuce and citrus.

Consumption of Starch Adhesives to Remain Large

It has been estimated that more than 400 different raw materials and chemicals are used in adhesive formulations. If we wish to consider the widespread use of adhesives, we have only to walk into a grocery store and examine practically any article on the shelves.

By far the largest class of adhesives consists of those using starch or starch derivatives as a base. Although synthetic resins have made significant inroads, the consumption of starch adhesives will always remain large. There are many uses for adhesives where water resistance is not required and where quick tack and retack characteristics are necessary. The fact that starch adhesives are less costly than resins and are odorless, nontoxic, and flexible in application assures them of wide acceptance for a long time to come. The starches of commercial importance are principally tapioca, corn, potato, and, to a lesser degree, wheat, sago, and sweet potato.

Adhesives made from starches are used in a great variety of ways; manufacture, sealing, and labeling of cases, bags, cartons, boxes, and fiber containers; tight wrapping of cereal boxes; and labeling of cans and bottles. This includes the use of so-called "iceproof" glues, that will keep beer and soft drink labels on the bottles when immersed in ice water.

Another important type is made from animal glue, processed from cattle and hog skins and bones. Animal glue produces a stronger and more flexible film than starch glues. It also provides a high rate of tack and allows the converter to run his machine at high speeds. These glues are more expensive and in many cases their use cannot be justified.

A large class of useful adhesives has been developed with casein as the base. One of their chief advantages is that they can be made irreversible in drying, thus producing a water resistant bonding film. Casein glues are used in the manufacture of drinking cups, straws, ice cream pails, and a great variety of containers.

Probably the greatest emphasis is being placed on the development of adhesives from polyvinyl acetate in the form of an emulsion. Emulsion-type adhesives are preferred to the solvent or hot type, in that they have no disagreeable odor and fire hazard, do not need any heated equipment, can be thinned and cleaned out with water, and in general are useable on regular gluing equipment.

Trend Swinging Away from Transparent Meat Packages

The selection of packaging materials for fresh meats is based in part upon the requirements which must permit free passage of air to the cut surface. Oxygen reacts with the myoglobin to produce oxymyoglobin which has a bright red color. This color must be developed and maintained. If a packaging material restricts the passage of oxygen, the fresh surface will darken within an hour.

Special wrapping papers and paperboard are recommended for separate slices or cuts where transparency is not a merchandizing requirement. These materials restrict the loss of moisture and prevent development of the dark color associated with drying. Materials for bone-in meats must be highly resistant to puncture and tear.

There is considerable difference in opinion as to the need for transparency or windows in frozen meat packages. The current trend seems to be away from transparent packages. Once a frozen meat has an established market the need for a transparent package to display the product is often overbalanced by the economy and protection from light provided by an opaque package.

If the packaging material is essentially moistureproof and in contact with the surface of the meat, dehydration of the superficial tissues, "freezer burn," is prevented. Shrinkage may become an economic factor if the desiccation is extensive. Voids between the meat and packaging material should be kept at a minimum, otherwise dehydration and frosting occurs, which impairs visibility.

An important factor in the storage life of frozen meats is the stability of the fat. Frozen meats may be essentially free of rancidity after storage periods up to one year at subzero temperatures, if tightly packed in ozygen impermeable materials.

In contrast to unfrozen fresh meats, cured meats retain their bright pink and red colors in an oxygen impermeable package. Vacuum packaging eliminates light discoloration and effectively prevents the development of rancidity. Packaging materials for cured, smoked, and table-ready meats must be greaseproof.

Casings made of regenerated cellulose and plastic materials are used extensively. They serve as molds and containers during the processing of some cured meats and sausages, and in many cases as consumer packages.

Materials for packaging fresh poultry include semimoistureproof and moistureproof cellophane, pliofilm, polyethylene, and modified saran. Poultry, both whole and cut in sections, is often placed in paperboard or molded pulp trays and overwrapped with transparent film. While the present films are fairly satisfactory, increased permeability to air is desirable. There is also need for improvement in the wet strength of trays, particularly molded pulp trays.

Summaries by the AG AND FOOD *staff of papers presented at the Symposium on Technology of Food Packaging Materials presented before the Division of Agricultural and Food Chemistry,* AMERICAN CHEMICAL SOCIETY, *Chicago, Sept. 8, 1953.*