Paper Processing for Package Purposes

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PRODUCTS may be put up in many ways; for example,

1. One wrapper.
2. Double wrapper.
3. Wrapped and put in a carton.
4. Put in a carton unwrapped.
5. Put in a carton, and a wrapper placed around the carton.

The range of possible complexities is wide.

A stainless steel cigarette case is a fairly simple wrapping proposition.

A stick of chewing gum is not.

Things wrapped by hand will tolerate a wider range of material than things wrapped by machine. Hence a need, not readily satisfied, for standard specifications and methods of test.

Surfaces must be suitable for printing or pasting, and stand exposture to light. Texture must be suitable for folding or twisting. Components must be proof to moisture, to alkaline or acid contacts. They have to keep some things dry and other things moist. They must not get mouldy; they must not be poisonous.

It is remarkable that even the simpler types of paper can fill so many specifications.

This is the more notable when it is considered that for only a few products sold in large volume, is the paper or board speciallly made. In many cases paper is bought by the printer, who does not use it, from the jobber, who does not make it.

From this kind of arrangement come misconceptions, such as the common adjective "alkali-proof" for all kinds of soap wrap paper, whereas in only the lowest grades of soap is there even a measureable amount of free alkali, and in some cases there may even be an excess of fatty acids. Alkali has been saddled with all the responsibility, which it should share with several other possible causes of damage to soap wrappers.

At times we find waxed paper used for oil substances, which gently ooze out, and greaseproof paper used for moist substances that become ossified, or wander out of bounds.

Probably the general principles of paper making are known to many of you, but it might serve our purpose to review them briefly and note wherein the process modifies the product.

In its simplest conception, paper is an aggregate of tubular fibres, and fragments of fibres, resisting disruption by mutual friction, and by an adhesion due to a not-well-understood reaction with water. For its various uses this aggregate is modified both by physical treatment of the fibre, type of fibre used, and by the addition of various agents.

Raw Materials

Wood provides the chief source of fibres for paper in America. Other sources are: Rags, for the highest types of paper such as fine writing, bank note and ledger stock; straw, used in Europe for book papers and in America chiefly for corrugated board; esparto (a grass found in Spain and North America), used for book papers, especially the fine, thin, opaque types known as bible papers.

Rag fibres include both linen and cotton. The fibres are long, and under treatment for paper making become fibrillized, that is, split or fritted into fine strips that materially assist in felting quality. On account of cost, rag papers are used for packages in special cases only.

Wood fibres are shorter and broader, coniferous woods (spruce, pine and balsam) averaging tbout 2.5 to 3 millimeters in length, while deciduous woods (poplar, beech, birch) average about 1.5 to 2 millimeters. Straw fibres and other grasses average about 1 millimeter, but the grass fibres are very narrow, and so behave like long fibres.

Old papers, from book and magazine stocks, can be regarded as a distinct type of fibre, being short and fragmentary from much treatment.

Bolt Drier

The character of paper depends largely upon the preparation, treatment and blending of these varied types of fibre. As wood fibre constitutes the great bulk of papers used in packaging, I shall confine my remarks on fibre preparation to that source.

Preparation of Pulp

Pulp is the term used for the prepared wood fibre. Four classes of pulp are used: Ground wood, sulphite (bleached or unbleached), soda, kraft.

1. *Ground wood,* or mechanical pulp, is prepared by pressing wood blocks, two to four feet long, against the face of huge grindstones, in the presence of water, and at the temperature (about 160 F.) resulting from friction. The product is screened. Accepted stock contains a wide range of fibre character, and all the other constituents of the wood. Owing to the presence of much fine stuff, paper made largely from this pulp is a good printing medium, taking a fine finish and having little show-through. Hence, in addition to low cost, its prevailing use (80%) in newsprint paper.

Paper containing ground wood is very readily stained with alkali,—silicate, carbonate or caustic—hence should not be used in paper where exudation or sweating would bring it into contact with alkaline material. It also is rapidly yellowed by light. Hence packages for exposure on shelves or in windows should not be of paper containing ground wood.

Ground wood pulp is sometimes bleached to a whiter shade, but as the bleaching is done by hyposulphites it has a reducing character and upon exposure to the air, "goes back" by oxidation.

2. *Sulphite pulp* is prepared by cooking wood, usually conifers, in bisulphite of lime, with excess of sulphur dioxide. The object is to hydrolize and dissolve the non-fibrous material, chiefly lignin, with some resins and polysaccharides. After cooking it is washed to remove these materials. The degree of completeness of removal varies with different mill conditions. Sulphite pulp as cooked, is sensitive to light for a reason similar to ground wood. Its white appearance when freshly cooked is due in a measure to reduction. The non-fibrous material in the waste liquor is never completely removed by washing, and becomes brown on exposure to the air. It is also sensitive to alkalies. Therefore unbleached sulphite is unsatisfactory for wrapping or shelf use where appearances count.

Sulphite is bleached for better types of paper. This is done by hypochlorite, an oxidizing agent, and is for this reason less susceptible to discoloration by exposure to the air. Incidentally a lot of the non-fibrous matter is rendered soluble and washed out, so that bleached sulphite is about the best fibre for package purposes.

3. *Soda pulp* is made by cooking wood, usually deciduous, in caustic soda. It is used in conjunction with other pulps and is always bleached. Its shortness of fibre gives it functions of filling and opacity. When well made it does not discolor markedly with alkalies, nor readily with light.

4. *Kraft pulp* is also cooked in alkaline liquor, but in this case both caustic soda and sodium sulphide are present. The latter does not apparently act on the wood, but as a reserve of alkali in a form not so destructive to the cullulose. Hence it increases the yield and produces a strong pulp because of less drastic action on the cell wall. Kraft pulp has a naturally light brown shade, and until recently has been used unbleached.

Paper made from kraft pulp is excellent for wrapping purposes where white is not essential, on account of its high tearing and bursting resistance.

Old papers are distintegrated and re-used. They constitute an important raw material. When not printed they are only subjected to the necessary disintegration. In most cases the paper has been printed, and the ink is removed by cooking in soda ash, or caustic soda. If not well washed, some of the organic non-fibrous residues render the paper sensitive to alkali and sunlight.

Having been subjected to much treatment, the fibres of old paper are more fragmentary and therefore help to render paper opaque.

Other raw materials are:
- Fillers,
- Size,
- Color,

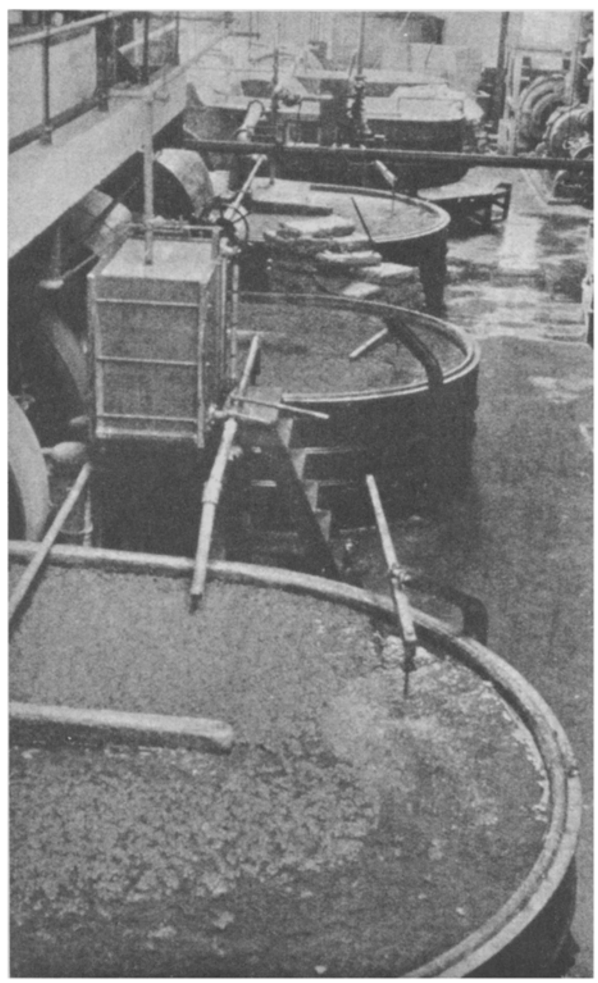
Fillers are usually inert and have little or no chemical effects. Their function is to improve printing surface, impede the passage of light and in special cases increase the whiteness. They tend to reduce strength, folding quality and resistance to fluids. China clay is used in largest volume, then talc, calcium sulphate (in various forms natural and artificial) and recently, zinc sulphide and titanium oxide.

China clay and talc are insoluble, and not chemically active unless the talc contains an excess of carbonate of lime as an impurity. Calcium sulphate is either ground gypsum or a preparation by reaction between calcium chloride and sodium sulphate. It makes a whiter sheet than one filled with china clay, but it is an expensive filler, being slightly soluble in water. For example, if ten pounds of calcium sulphate per hundred pounds of pulp were added to the batch, there would be practically none in the finished paper.

Zinc sulphide and titanium oxide are used for whiteness, opacity and permanence, but are only recent additions to the list of fillers, more expensive and not likely to be used for package papers except in special cases.

Size for our present purpose is a rosin soap prepared by cooking rosin with soda ash not sufficient to produce complete saponification. Usually there is a high percentage of free abietic acid. The manufacture includes emulsification except in recent forms where the rosin is treated with caustic soda in the cold. Of itself it does not size paper and is used in conjunction with alum (sulphite of alumina) as we shall see later.

Color. This is not too big a field for detailed attention here. Color enters into all types of paper. White papers are toned with red, blue, violet or yellow. The type of dyestuff should be chosen with the character of the packaged goods in mind. One yellow for example becomes red with acids and another red with alkalies. Ferro-cyanide colors are sensitive to alkalies. Ultramarine pigment is sensitive to acids and sunlight. It is sometimes used in white stock, which loses its white-



Bleaching Vats

ness when exposed to sunlight. Acid dyestuffs have no direct affinity for cellulose, hence are mordanted by the size and alum. If the sizing be destroyed the color will run. Excess of color, or color not well precipitated on the fibres, will bleed when wetted.

Process

Apart from the preparation of pulps, cooking of old papers, making of size and other adjuncts, the first stage of paper making is beating. The beater consists of a large oval trough, with a central divider or midrib. In one side of the trough a heavy roll is mounted. This roll has bars set in its periphery and parallel to its axis. Under this roll is a block into which are set similar bars, so that as the roll revolves the bars on its periphery pass with a shearing movement over the fixed bars in the block or bedplate. The roll may be raised or lowered while revolving.

The beater is filled with water and the various pulps added. The first action with a clearance of about an inch between the bedplate and roll, is merely a breaking up of the pulps. When the pulp is well broken, any filler called for is added. The order in which dye, size and alum are added varies in different mills, depending on character of dyes, hardness of water and experience of the operator. In the case of the acid dyestuffs, which have no affinity for cellulose, the color would be added first, next the size and, after time for thorough mixing, the alum. In this case the size and alum act as mordants and this kind of dye gives nice level shades. Direct dyes which combine directly with cellulose do so to a higher degree with the purer fibres such as rag or bleached sulphite.

The object of sizing is to reduce the capillarity. Just how far this is necessary when printing inks are used seems open to question. Further, just what gives a paper its water-resisting qualities when sized? The reaction is between the soda of the rosin soap and the sulphate iron of the alum, leaving the curdy precipitate of rosin accompanied by hydrate of alumina.

It has been variously claimed that rosin is the sole agent, but paper sized with rosin only, seems to lose its sizing on exposure to the air. The precipitation of hydrate of alum with the rosin curd appears to be the right combination, but just why that is so remains to be seen.

Sizing was developed for writing purposes where a water-vehicle ink was involved, hence for wrapping purposes would have no place except as it assists in finish. In a discussion of papers for soap wrapping, by members of the Technical Association of the Pulp and Paper Industry, very diverse views were given as to sizing. Some held that such papers should be well sized, and some that sizing was not important. The writer agrees with the latter.

Sizing may affect color, as we noted above in reference to acid dyestuffs. However, the direct dyes which give best results on the purest fibres, could be used where there was little or no sizing.

The fibre itself is the most important characteristic of packaging papers. Sizing may improve tear and bursting strength, but to an unimportant degree as compared with fibre and the fibre is put together.

The beater is a good mixing and reacting place for the various ingredients, but its main functions are mechanical. A paper's character as a fabric is determined by its treatment in the beater. Newsprint paper is a mere mixture of two kinds of fibre adequately prepared by methods of production and blended exactly by automatic devices. It requires no beating. In the case of other papers beating is necessary.

We have noted that the beater roll may be raised or lowered. This action may be used with profound results in the kind of paper produced. When the roll is up the stock is mixed by the paddle-like motion. When the roll is down the fibres are cut, split and crushed.

Thinking of paper as a aggregate of tiny tubes, we can conceive of blotting paper as retaining as many tubes as possible, while at the other extreme we have glassine, where there has been so much comminution that few complete fibres remain. For blotting paper, beating is done as quickly as possible. Fly bars and bed plate bars are sharp, and the roll is set down quickly. The object is to cut the fibres rather than to crush them, to preserve their capillarity. Such papers are not strong, lacking the felting action of innumerable fibrillae. The fibres used in paper are tubular vegetable cells having intricate internal structure, and the structural members are pulled apart in beating; very little in blotting paper, very much in bond papers or glassine. The degree of this breaking down of structure determines largely the kind of paper that will be produced.

Cellulose is transparent, but like glass, when finely divided refracts light in all directions and appears opaque. If it is treated so as to lose its structural character and pressed together in a sheet it becomes transparent. Blotting paper, an aggregate of tubular fragments, is opaque. Glassine, an almost structureless mass, is transparent. Between these extremes are wrapping, book, writing, and bond papers. Package papers are found in all degrees, depending on use requirements, strength, appearance, absorption and feel. Beating is the foundation of most of these qualities.

After beating, the stock is put through a machine called the Jordan, a hollow cone having a cone-shaped plug revolving in it. Both the cone and plug have bars similar to the beater. The plug may be moved horizontally a short distance. Stock from the beater passes in at the small end of the cone and out the large end. If the plug is well in, the stock gets a drastic refining and cutting. If eased out a little, the stock is cleared of knots and lumps without much crushing of fibres. The Jordan supplements the beater.

To get rid of splinters and dirt, various forms of screen are used. They do not otherwise affect the character of paper.

The Paper Machine

There remain now the combined operations of removing water and forming a sheet. This is done on two types of machine, paper being usually made on a Fourdrinier machine, and board on a cylinder machine.

To the Fourdrinier, the stock, containing about 99½% of water, is pumped through a mixing box extending the full width of the machine. From this it flows on to the wire. This is a wide endless belt of fine wire cloth supported on rolls. Water passes out through the wire. The formed sheet remains and is taken off the wire at the couch roll end. Details are (1) the *shake,* which is imparted by a reciprocal motion of one end of the wire. The object is to add to the felting by changing the set of the fibres. A majority of the fibres tends to lie along the direction of movement, making the sheet definitely stronger one way than the other. Shaking does not eliminate this. Paper and board always have a grain, which must be taken into account in all types of packages and in printing. (2) The *slices.* These are bars set across the machine to regulate the thickness and weight of the sheet. Incidentally they prevent bubbles and foam from passing into the paper. (3) *Suction* boxes are set under the wire. Some inches of vacuum withdraw water from the forming sheet and give it the final set. Too much suction tends to draw fine fibres and filler to the underside of the sheet, making it two-sided. Also it increases the defect known as *wire mark,* the impression of the wire on the underside of the sheet. (4) The *dandy roll* runs on top of the sheet between the suction boxes. It is hollow and covered with fine wire cloth. It compacts the surface and gives better finish. Any pattern woven into the surface of this roll is imparted to the paper, and constitutes a water mark, the paper being a shade thinner along the lines of the pattern.

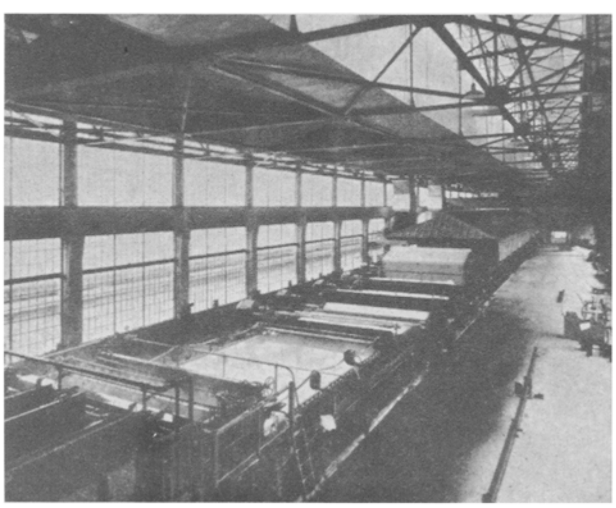
At the end of the wire is the couch roll, which is equipped to provide suction at the part of its periphery over which the paper runs. This roll drives the wire. The paper at this point still holds about 85% of water, and is carried between two or three sets of press rolls by woollen felts. Care is needed here not to overpress, which "crushes" the sheet, greatly weakening it, spoiling its appearance and reducing its sizing. This is more likely to happen on heavy sheets such as tag and cover paper.

After the presses the sheet still carries over 60% of water, which is driven off, down to about 7½, by leading it over and partly around a number of revolving steam-heated drums. Occasionally it is overdried, which is undesirable, both from the maker's point of view, who sells by weight, and from the buyer's, whose paper is injured internally in sizing and strength.

From the driers, paper goes directly to the calenders, unless it is to be antique or eggshell finish, which does not call for calendering. Calenders are steel rolls superimposed, and driven by the bottom roll, which is much larger in diameter. They are referred to as the "stack." If the paper is too wet coming to the calenders there is "blackening," a mottled appearance caused by increased translucency at the more compact spots, which have to take excessive pressure. Some popular forms of wrapping paper are produced in this way.

The paper is now ready for finishing operations. It is reeled off the calenders, and when one reel is filled another is put in its place, while the first is rewound to improve its appearance and to trim and slit it to required roll widths. It is now ready for finishing operations.

If it is to be supercalendered, it goes to a special stack, whose rolls are alternately steel and paper. The paper rolls are built up of discs of parchmentized paper very closely packed. Super-calendered paper (called S.C.) has a higher finish, is more translucent and prints better than similar paper machine finished (called M.F.).



Collender Machine

Special Types of Paper

Greaseproof paper is made in two ways. One is to carry the beater action to its extreme, using neither filler nor size as noted before. Owing to its highly comminuted condition—approaching the gel stage—this stock parts with water very slowly and production is not rapid. This type is characterized by transparency and glossy appearance.

The other method is to make a paper of high grade rag or sulphite and pass it through concentrated sulphuric acid, followed immediately by passage through water. The final traces of acid are neutralized by passing through weak ammonia. This treatment breaks down the fibre structure on the surfaces, but the action is arrested before it penetrates the sheet. It will readily be noted that uniformity of treatment conditions is imperative. This form, known generally as vegetable parchment, has a dull finish, is not so transparent as that produced by extreme beating, and is tougher.

Antitarnish paper, which is used for wrapping metals such as silver, copper, is not made by any special process, but is made with special care. Well washed and bleached pulp must be used. The cause of the tarnish is the presence of sulphide in the paper, partly associated with moisture, temperature and stagnant air.

Paper for lining of radio cabinets, laminated coils, wire insulation or other electrical purposes must be free from conducting particles. Fragments off the edges of beater bars, or minute particles of Fourdrinier wire, at times run right through the sheet, making short circuits. Iron particles may be removed in process by electromagnets, and others by traps or riffles.

Asphalt paper is prepared by flowing an emulsion of asphalt and bentonite between two running sheets of dry paper just at the nip of a pair of press rolls. Strength and continuity of the asphalt sandwich are important points. It is to be kept in mind that what keeps moisture out will also keep moisture in, and may merely aggravate internal sweating. Good circulation of air is sometimes a better protection than a waterproof cover.

Board

Modern packaging depends so largely on paperboard that some note should be made of the special equipment on which board is made, and its composition.

Board stock is broken, beaten and sized in just the same way as paper, but is made on a different type of paper machine. Instead of flowing on to a flat wire in one stream, the stock is divided into several streams to several vats standing in line. Each of these vats contains a revolving cylinder covered with wire cloth. The cylinder is about half submerged in the pulp stock and as it revolves, water passes through the wire and out at the trunnion. The pulp adhering to the cylinder face proceeds around the periphery until it passes under a roll riding on the cylinder, called a "couch" roll. And endless felt passes under the couch roll and carries away the pulp layer from it and to the next cylinder, where a second layer of pulp is added, and so forth. Usually the first and last vats contain the highest grade material and form the "liners," or surfaces. After the felt has passed all cylinders, it runs back over the top of the vats with the composite sheet, which it carries through a set of light rolls, called "baby presses," and then over three sets of heavy presses, steam drum driers, and a calender stack, as in the case of paper.

Specifications

As to requirements of paper and board, much could be said and but little of it is based on complete observations.

Greaseproof papers are used to a large extent for packinghouse and dairy products and a recent writer in Ireland suggests the following specifications for dairy products:

Moisture (maximum)	10%
Water-Soluble Extract	1.3%
Ash	0.45%

Bursting Strength, 1 lb. per sq. in. per lb. per ream.

High water-soluble extract is said to indicate possible mould development later in butter packages.

However, the setting of specifications for any paper type is not an easy thing. Common sense and practical results are important factors. Each user of paper should endeavor to develop as much reliable history as possible as a basis for specification, being careful to avoid special qualities often of no value and of greater cost.

Multiplication of variables, sizes, weights and fibre composition is to be deprecated. One reason for multiplicity is that in many cases the ultimate user does not buy his paper direct, and the paper maker is unaware of the product to be packaged. Where a large number of small users are packaging similar products, a very small contribution per unit would take care of a central laboratory, which would not affect competitive matters but would be able to carry on investigations and act in liaison between the paper mills, the printers, and the users.

Moisture in paper and board is not given the attention it merits. Board in places of high humidity may contain as much as 14% of moisture. Goods may be packed in boxes made from that board, warm, and apparently dry, then shipped to a cooler, drier point and stacked in a cold warehouse, where the contents may be much damaged by condensed moisture. Later with rising temperature these contents may develop mould growths and other unsightlinesses.

In conclusion I would say that specifications should be prepared mutually, should be confined to qualities whose conformity to standards can be definitely controlled, and should be as few as possible.

For instance, *moisture* content is needlessly specified if the plant using the product has no control over its own atmosphere. *Strength* is often specified, where printing surface is the chief consideration. *Resistance* to folding is specified, but it varies greatly with humidity and may become a mere factor in increased cost if not essential to the package. Unnecessary variety in weight, composition and quality merely add to costs, as far as basic paper or board is concerned, and study should be made to avoid them.

Apology.

The January, 1934, issue contained a paper by Dr. Arthur D. Holmes entitled "Some Results That Have Been Obtained by Supplementing the Dietary With Cod Liver Oil." This paper should have been continued on page 6, however, the paper was concluded on page 13, and Mr. A. P. Lee's paper on "Refining Losses on Edible Vegetable Oils" was concluded on page 6 and should have been concluded on page 13.

We sincerely apologize to Messrs. Holmes and Lee for this serious and regrettable error.

OIL AND SOAP.

REMARKABLE NEW CHEMICAL WILL KILL INSECTS BUT IS HARMLESS TO HUMAN BEINGS

Scientists of Michigan Alkali Co. Perfect Fumigant for Grains, Food and Homes—Hailed as an Outstanding Chemical Achievement During the Depression

A new chemical substance, known as malium, which will kill insects and their eggs, but which in ordinary concentrations is entirely harmless to human beings, has been perfected by the Michigan Alkali Co., New York City, the largest manufacturer of dry ice in the world and one of the leading chemical manufacturing companies in this country. The substance is expected to find wide use in the fumigation of grain elevators, cereal mills, candy factories and other food establishments where destructive insect pests cause millions of dollars of damage annually. Malium will also be used, it is said, in the fumigation of ships, hotels, restaurants and homes for both food eating insects and household pests. Being non-toxic to human beings, it can be used safely for insect fumigation under any conditions. It is used without heating or the addition of other chemicals.

Malium is a colorless, volatile liquid, with scarcely any odor, thus differing from most fumigating substances at the present time, which have undesirable odors. The new fumigant is made from a combination of carbon dioxide with newly developed synthetic chemicals, and is the result of four years of research by the experts of the Michigan Alkali Co. Besides being odorless, tasteless and colorless to human beings, it leaves no residual odor or taste in foodstuffs. Previously many food establishments could not be fumigated to prevent the development of worms and insects. In candy factories, for example, it will now be possible to keep fruits, nuts, chocolate, etc., free from worms. The fruit or nuts may come into the factory clean, but somewhere in the journey from nature to the factory insects may deposit eggs on the foodstuffs. The eggs, invisible to the human eye, may quickly develop into worms.

Grain elevators and flour and cereal mills at the present time experience great difficulty in controlling insects. It is all too frequent an experience that packages of breakfast food become wormy if left to stand any length of time. These worms, or larvae, do not just happen. They come from the eggs of insects on the grain. Up to now it has been difficult to destroy these tiny eggs without affecting the palatability of the food.

"Malium is one of the big chemical achievements of the depression," Lewis C. Chamberlin, manager of the solid carbon dioxide division of the Michigan Alkali Co., said in announcing the new fumigant. "It is a distinct step in progress in the prevention of waste. According to estimates of the U. S. Department of Agriculture, more than $200,000,000 of damage annually is done by insects which eat food and clothing, to say nothing of the discomfort caused by household insect pests and the loss of good will of customers. Because of its unique properties, malium can be used without danger or discomfort to human beings in the war against insect pests."