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A PERSPECTIVE OF LABELS AND LABELING WITH AN EMPHASIS ON THE PRESSURE SENSITIVES

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ABSTRACT

A PERSPECTIVE OF LABELS AND LABELING WITH AN EMPHASIS ON THE PRESSURE SENSITIVES

By

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Many labels and labeling processes were found to be available to the labeler. Prior knowledge of the various characteristics and limitations of each before production is a necessity.

Popular labeling methods were evaluated and compared with each other in an attempt to familiarize oneself with the advantages and disadvantages of each.

An emphasis was placed upon the pressure sensitive labels and their processes. The various pressure sensitive adhesives were evaluated by testing them on the plastics primarily used for packaging. Pressure sensitive machinery and their applications are also described.

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INTRODUCTION

Even today labeling, a very important part of packaging, is still too often a last moment thought giving rise to last minute decisions in which too little consideration is given to label design, shape, size and type. The label is vital. Successful products in all trades are silent testimony to marketing success where something more than perfunctory recognition was preempted to the label's need and purpose. Today more and more companies recognize the importance of employing specialists in marketing to advise on and coordinate the various aspects of packaging and presentation.

It is not enough to just specify a certain kind of label and hope it will work for your product. A thorough understanding of the materials and processes involved is mandatory for proper label selection and product success.

CHAPTER I

AN OVERVIEW OF LABELING

New Importances and Uses

Government legislation has given a new importance to labels. In the presentation of manufactured and processed foods and in food packaging, labeling can no longer be thought of as just a place for a price. Now it has to reveal specified information and penalties with attendant publicity existing for intervention.

Thus, with the increasing range of packaging materials and surfaces available today, it's good sense for the user of labels to maintain close and early liaison with label printers and with manufacturers of labeling adhesives and pre-coated adhesive labeling papers. By so doing an essential understanding is established of the production conditions and of the marketing needs. Unnecessary labeling problems are virtually eliminated by ensuring the use of the most suitable adhesive or pre-coated adhesive paper and the frequently ignored, but so often most important matter of grain direction of the finished label.

The choice of methods available to the user of paper labels are as follows:

(a) plain paper attached by a separately applied adhesive

(b) pre-gummed paper which is activated by water

(c) pre-coated paper, the coating on which is activated by heat

(d) paper which is coated with a pressure sensitive adhesive requiring only pressure to make it adhere.

The application of a separate adhesive to paper is the oldest method of labeling. Adhesives have kept pace with demands of new product materials by careful research into new raw material areas, coupled with research into manufacturing methods. For example, even in the area of "conventional" labeling such as high volume glass bottle lines, changes have taken place in the formulation of adhesives to give faster through-put with instant high tack qualities which handle easily, give high yield, are colorless, resist condensation yet can be removed rapidly in bottle washing units.

Pre-coated Paper Field

Remoistenable gummed papers are the oldest labels in the pre-coated paper field, having been in existence for something like 100 years. Generally speaking the adhesive material which is coated onto paper is starch or dextrine based. Over the past fifteen years or so, technical developments have made available remoistenable synthetic adhesives in the form of polyvinyl alcohol. These have excellent non-blocking properties and improved flatness, which makes them very useful in conditions where temperature and humidity are liable to vary widely.

Particle gumming or "dry gum" is probably one of the more interesting recent developments in the manufacture of pre-gummed papers. It is not a continuous coating when applied but is a mixture of dextrine or glue particles with a resin binder which is coated in granular form. It can be used under extremes of humidity because of its excellent non-blocking properties and is completely flat. However, it is essential that the body paper is flat prior to the application of the coating because if not, the resultant coated paper will tend to curl. This is especially important with clay coated papers which have an inherent curl.

While there are one or two variations on the basic adhesives which

deal a little more effectively with some of the more difficult surfaces, the use of water remoistened pre-gummed papers is largely limited to use with paper and board surfaces and to glass.

Heat Sensitive Resins

The availability of heat sensitive synthetic resins, which can be manufactured consistently within close technical specifications, has enabled chemists to formulate a range of heat sensitive coatings for label papers which has made possible considerable strides in the field of automatic packaging over the last decade. They adhere to a wide range of surfaces including most films and metallics.

There are three main types of heat sensitive coated label papers:

(a) the instantaneous tack type

(b) resin based coating, whose reaction to heat lies between (a) and (c)

(c) the delayed action type

For food labeling applications, the instantaneous type works well on automatic machines for biscuit end seals but it is the delayed action type which is best suited to general food labeling applications. The product, the type of wrapping material employed and the ambient conditions before, during and after labeling determine the exact heat sensitive resin formulation that should be used.

Instantaneous heat seal coatings are applied with solvents or aqueous based adhesives or with hot melts. The solvent and aqueous coatings are based upon polyvinyl alcohol homopolymers and polyvinyl alcohol copolymers which can be externally or internally plasticized.

Hot Melts

Hot melts are based upon ethylene vinyl alcohol copolymers or on a mixture of these resins with waxes and tackifying resins. All are

formulated so that they are non-blocking under normal atmospheric conditions. For tropical conditions, special coatings are required with a higher melting point.

Adhesion can be said to be dependent upon the combined effects of three factors:

(a) temperature

(b) dwell time

(c) pressure

Hot melts provide satisfactory adhesion on a much wider range of surfaces including polyethylene and polypropylene, than do the other two types. This type of coating is activated by applying a heat source to the coated substrate while it is in contact with the surface to be bonded. Once the heat source is removed, the thermo-plastic coating cools and sets up. Heat activated delayed action in labeling is eminently suitable for high volume production on fast running, automated, computerized catch weight pricing machines.

Coatings of delayed action heat fix papers have, on occasion, shown a tendency to powder, creating a problem not so much for the user, but for the printer. The inevitable pick up of the powder by the inked printing plates not only "clog" the image, but also cause damage to the plate as powdering builds up, and produces an unsatisfactory printed image. This has now been solved by the introduction of a new non-powdering, heat activated, delayed action adhesive suitable for labeling applications in the food and drug industries.

Pressure Sensitive Materials

Pressure sensitive labeling is a major "convenience" product of the last twenty years. Considerable improvements have been made over this

period in product reliability with improved adhesives. These developments have produced an added impetus to a labeling system that can adhere to almost any surface that is smooth, clean, and dry.

Additional Label Materials

Today many other materials are being used for labels including aluminum foil and plastic films. Some manufacturers have used a foil-plastic laminate to label their products and to give them a luxurious look, as on a fancy wine bottle. These labels are affixed to the bottle by integral bands or straps which terminate in a tab-lock. This particular use could perhaps only be justified for wine or other luxury products such as cosmetics.

For general applications, the use of aluminum foil labels or plastic films as labels can now be regarded as the standard practice. From their original use for whiskies and wines, the aluminum foil label has become the "splash" image and their use for cosmetics has also become a standard practice.

In the garment trade, the former woven labels have in part been replaced by the textile or plastic label. These labels are printed with water resistant inks and coated on the rear with a heat sealing adhesive to enable it to be attached to the ready-made garment by the application of heat and pressure. The all plastic labels are pre-printed on a polyester film base which are able to withstand hot ironing temperatures. The reverse printing is coated with heat seal lacquer or laminated with a polyethylene film for the purpose of attachment. The introduction of synthetic based inks may make it possible to dispense with this coating or with the lamination since these inks are themselves heat sealable.

Labeling of Other Forms

There are innumerable applications for labels of other kinds. Swing tickets, trade marks, price tags, seals of quality and other indicia such as governmental or association approvals are usually designed to be removable after purchase.

Still very generally used in the clothing trade are pin tickets, the wire "ins" or staples being used to attach the labels to the goods at the retail level.

Swing tickets are another popular type of label since they can be applied to so many different types of goods by looping the twine or cord over a button, knob or other projection on the article.

Some types of goods are particularly difficult to label because of their shape. Automobile tires are an example. Some manufacturers use a band label over the tread of the tire, the band being of shrink type polyethylene film with the brand name, size and other details pre-printed at spaced intervals with transparent portions between each repeat so that the customer can identify the make and size instantly no matter how the tire is displayed.

Due to the popularity of cotton and plastic mesh bags, used in particular for fresh fruits and other produce, there has developed a demand for an appropriate method of labeling. The bags can be purchased with the base either heat sealed or sealed with a metal clip. After filling, the bags can be both closed and labeled by the use of plastic clip-on labels. These labels are made from thin but springy plastics with a shamrock shaped (tri-lobar) cut out.

Another method of labeling which also provides an effective closure is the use of pre-printed, paper covered wire tape. These are supplied either in cut lengths or in the form of a continuous coil. A refinement

of this idea is the "pennant type" strip. A single or a double wire runs the length of the strip but the paper covering is die cut at intervals to provide triangular "pennants" on which the price etc. can either be printed or written.

For labeling large units such as packing cases and crates, it is not unusual to staple paperboard labels directly into the wood. Such labels suffice for the home trade. For export, it is more satisfactory to use a metal backed label stapled or nailed into the wood. The thin metal backing is faced with a thin, but water resistant paperboard, and the edges are sometimes protected by curling the margins of the metal. Such labels are called "indestructible" and under ordinary circumstances they resist almost all hazards.

Stenciling can be regarded as a form of labeling. The more modern techniques provide much clearer indications than the older methods. Formerly, zinc stencils, when linked together, enabled single leters to be made into words or sentences. The use of a dabbing brush to apply the ink or paint usually gave a rather smeary impression. Airless spray guns now on the market are more effective than are brushes when used in conjunction with waxed board stencils, which do not lie as flat on the case surface as do zinc stencils.

Labeling by means of rocker markers or roller markers has partly supplemented the use of stencil marking, since they print the whole of each letter or figure and thus eliminate many of the possibilities of misreading, especially when used for chemical product identification. The rocker marker has a rubber stereo mounted on the curved undersurface of the unit which takes up ink from a pad and transfers it by a simple rocking motion.

Acid etching is used as a means for the permanent labeling of glass ampuls. The acid is applied to the surface of the glass by rubber stereos and allowed to etch the glass for a definite period of time before being flushed away. The acid used is hydrofluoric, which requires the use of leaded containers since it cannot be contained in glassware.

Labeling of a sort can be provided by embossing or indenting. These methods are only applicable to metal cans during or after manufacture, or to plastic containers where the characters are embodied in the blowing molds. Lithographic printing directly onto the tinplate, from which metal cans are to be made, is perhaps the only other method of labeling which could be regarded as coming within the preview of this text. The use of hot foil printing to apply further markings onto already pre-printed plastic films used as wraps or overwraps, might also be included since this system provides a useful method of applying additional information such as price and date marking.

CHAPTER II

CHOICE OF A LABEL

Label Function

The choice of a label depends upon the type of container and the requirements for marketing and product use. The primary function of a label is to identify package contents. Equally important, in many instances, is the requirement that the label perform a sales function by stimulating interest, motivating purchase, and promoting satisfactory use. Increasingly, labels are required by law to carry certain information relating to fairness, safety, and similar elements of the overall area known today by the term consumerism.

Labels, as opposed to package printing and decoration, are generally printed paper or laminated paper combinations that are applied by means of an adhesive to a bottle, can, or box. The adhesive can be pre-applied to the stock with gummed, heat sealed or pressure sensitive labels or it can be put on the stock just before the label is attached to a container. An important factor in label selection is therefore the type of machine and the type of adhesive that will be used in affixing the label.

Label Types

Can labels. Many metal cans, especially cylindrical styles used for food items, use wrap around labels supplied to the user in cut form. Most of these labels have the characteristics of flexibility, adaptability, and relatively low cost. Paper for can labels is made with a hard smooth finish

on one side and a semi-absorbent backing to permit adhesion.

The length of a can label exceeds the circumference of a can by three-eights to five-eighths of an inch to provide for a glue lap. This lap, along with spots of glue or adhesive placed between the label and the can, holds the label securely in place. The bead of the can extends out over the label to prevent it from absorbing too much friction and lateral movement. Wrap around labels for cans that do not have a bead require scuff resistant inks or a coating to resist abrasion and scuffing.

Plastic and glass container labels. Either band wraps or spot labels are used on these containers. These may be supplemented, in the case of glass bottles, by neck bands or shoulder labels. Each of these labels occupies only a portion of the container surface, enabling contents to be viewed.

A band wrap usually occupies a center section of the vertical surface of a glass container. Spot labels are cut to shape and can be applied to the front or to both the front and back of a glass or plastic jar or bottle. A neck band fits around the neck of a glass bottle. A shoulder label is applied to a bottle shoulder.

Label Materials

Paper is the most widely used material for labeling. Special types of paper are available for labeling glass and other non porous materials. The direction of the grain of the paper is often critical. If the grain runs in the wrong direction, the label will spring away from the curvature of the container. Similar difficulties may also be encountered if the paper stock is too heavy or too dense.

A consideration for returnable bottles is their need for labels that will withstand water while in iced cabinets yet at the same time permit

easy removal when put into a cleaning solution prior to filling and re-labeling. Many returnable bottles employ labels made of a foil-paper lamination since the outer foil surface affords high resistance to water in use, but permits removal in the bottle soaker.

Adhesives

The adhesive used to affix labels to glass and plastic containers is critical because of the smoothness and lack of porosity of the surface. Surface treated glass jars and bottles present an even more difficult adhesion problem since a silicone treatment designed to permit easy flow and removal of contents also imparts strong water repellency to the glass surface. This can render regular glass adhesives ineffective. Special adhesives are made for silicone treated glass. The wrap around band label has a glue lap similar to that of the wrap around can label to help anchor it to the glass.

Printing of Labels

The printing of labels can be accomplished by any of the basic printing processes. The majority of paper labels are printed by offset. However letterpress, gravure and flexography are also used. Gravure is the most widely used method for printing foil labels because of its sharpness, uniformity, color fidelity and economy. Compatability of printing inks with the packaged product is also an important factor.

In addition to the basic can and bottle labels, a variety of specialized types exists. Saddle or header labels fold over the top of bags, forming a closure and are frequently die cut.

Insert labels are another type, often placed inside transparent packages for items ranging from soft goods and paper products to meats and toys. Attached extension labels or booklets sometimes accompany containers. These

are particularly useful for small drug and pharmaceutical containers and for cosmetic products that do not have sufficient label area to carry necessary use instructions and required legal information. Spot labels can be applied directly to a product and are also used as price labels.

These are items of packaging that serve the label's purpose, but which are not labels as such. One example is the wrap for folding cartons, which is essentially a wrap cup label that is formed into a cup shape with one end open. It is generally used for cigarette packs.

Label Forms

Labels are supplied to users in either of two forms, cut or in rolls. While cut labels have traditionally been the largest in volume of production and use, there have been considerable gains in the application of roll labels in recent years. This growing use has been due to new machinery developments which enable high speed application of roll labels to glass bottles, particularly beverage and beer bottles. Roll labels are also used by the pharmaceutical industry because they offer protection against product mislabeling and label mix ups, as well as the opportunity for inventory and batch control.

Straight cut (guillotined) labels are produced as a sheet and subsequently are cut and stacked by the converter into individual units.

Die cut labels are specified when a shape other than a ninety degree angle is desired. Die cutting is performed with a closed steel die and labels are produced which vary only slightly in size. They can be produced in almost any size or shape, depending upon the effect desired by the design and by the limitations of the container shape. Should the design for a die cut label involve narrow borders, specifications should allow an additional tolerance in registration between printing and cutting. Die cut labels are

shipped to the user in wrapped bundles.

Roll labels are supplied to the user in a continuous strip or web and are applied by machine directly from the roll. The speed and efficiency with which they are applied, sometimes at rates of over 400 per minute, and the elimination of bindery costs associated with cut labels are cited as advantages. Some packagers imprint and cut their own roll labels to circumvent converting costs and impose in-plant inventory control. The primary appeal of roll labels to the pharmaceutical industry is their assurance of accurate labels being applied to containers and their aid in product control. Often elaborate electronic verification systems that read pre-printed or notched codes on roll labels are used with the newer high speed labeling machines.

Label Constructions

There are two basic label constructions:

A. Laid on labels are precisely positioned on backing paper with space between each label. They are available in sheets, rolls, or fan fold packs. The roll form is especially suited to high speed manual or machine application because rolls lend themselves to fast label dispensing.

B. Butt cut labels are butted next to each other yet are separated by a fine rule cut. They usually come in rolls, however sheets are available.

Coatings

Label coatings, as differentiated from paper coatings, are applied to labels after they have been printed. Varnish, lacquer or synthetic coatings protect the surface of labels from abrasion, soiling and scuffing and can also impart to a label such qualities as moisture and frost

resistance. Special attention in the choice of a coating is required for certain products where odor transmission might create a problem. While coatings are necessary to minimize wear and environmental influences, they also enhance a label's appearance by highlighting color and art.

Special coating machines are used to apply coatings to labels after they have been printed. Coatings also may be applied directly on the printing press. A special printing plate may be made that applies spot varnishing to specific label areas.

Particular care must be exercised in selecting varnishes or overcoatings for foil labels to assure that they do not disturb the inks or the adhesion of inks to the foil's primer coat.

Special effects are achieved with gold and silver inks. Powdered metallic pigments can be dusted over wet inks to simulate gold or silver leaf. Metallic powders such as gold, silver, bronze and copper can also be mixed with these coatings. The process of metalizing is called vacuum metal vapor deposition. Labels carrying seals or crests use these processes and methods for quality appearance. Cosmetic and distilled spirit containers are the large users.

Embossing, or the raising of part of the design above the level of the rest of the label, gives an appearance of depth or a three dimensional effect. Embossing is used on labels primarily to achieve a luxury appearance, but it is also a proven means of enhancing display appeal.

Added Impetus

The form of label supply will largely depend upon the type of printed label. There has been considerable progress in ticket and label overprinting machinery. However, some consideration should still be given to both the label design for the purpose of registration in overprinting, and

to the ultimate form of label application to the product.

Labels printed on plain paper are invariably "put up" in 250's or 500's, such labels being applied by hand or by semiautomatic methods. Rotary forms of label supply can be styled to suit the fully automatic or flow line processes of merchandise labeling.

Water remoistenable and heat fix coated label papers may be supplied in packaged units in specified widths and diameters to suit mechanical means of label application. Labels may be perforated at suitable intervals for tear off, or sufficient blank space may be left for some form of label cut off.

Users of various types of self-adhesive label papers will be familiar with the latest forms of label supply. They are currently presented in two main types. In one, the labels are mounted on sheets or reels of specially treated release coated backing material which provides an easy "peel off" facility for the label. The number of labels per sheet or reel will depend upon the size of the label itself, the smaller the unit the larger the number of mounted labels. Labels are set out in such a form that they are capable of being printed to accurate register on the press.

The printer may obtain an alternate form of self-adhesive label supply where large brand and merchandise labels are individualized. In such cases, the labels are supplied individually with a backing release sheet attached, as may be convenient for the size of the label and its application. In this form the backing incorporates a slit or special removing aid thus enabling the use of the ultimate printed label to strip off the backing and apply the label. Most of these labels are applied to the package or product manually but there are suitable hand and semiautomatic appliances which assit in the speedy application of the pressure sensitive label.

White Versus Colored

There is a tendency to "pull" away from the almost firmly established "white" label and to use a tinted variety which can harmonize with the product and assist in creating sales appeal. Colored labels also assist in the ready identification of similar products such as reams or packages of tinted or toned papers and board. In the past there have been far too many labels which may now be classified as nondescript, where just plain white paper has been printed in black, serving only as a means of product marking. The new function of the label is to mark and brand, assisting in selling the goods.

Color itself is not only a physical phenomenon. Color fully and often exotically vibrates life and the viatlity of the product where it is used in a labeling scheme. Color may be obtained by the simple application of a printing ink on white paper, if such is chosen. There are many tinted inks which may be used in printing labels by the various processes which add appeal to the printed label.

Color may also be obtained by using a tinted paper, the color being chosen for product harmony or for some degree of contrast where it is desired. Every color has a value. Red for example, compells attention. Color applied in the paper and printing industry can be just as vital a factor in marketing the goods as in so many other trades where color has long been accepted as an important factor in selling.

Where economy in label production is important, although it should not be in view of the very low percentage cost of the end product, it may be remembered that a tinted paper printed in a harmonious color can produce a two color effect at the cost of a single printing.

Label Design

Paper makers, converters, and printers will always have their own ideas relative to their own labels. They certainly know a lot about paper and printing, and sometimes design itself. It is a fact that many labels used in the paper trade have long become recognized as the hallmark for that product. However simple in presentation they assist in establishing the product both in the home and in overseas markets.

However, there are a considerable volume of labels used by important undertakings that are just plain "tickets" which serve only to mark the goods. Since the new aspect of labeling embraces marking, selling, identification of the product, impact, and sales appeal, perhaps some attention may be paid to label design. The fact that so many first class designers and artists have joined the ranks of the label printer specialists serves to emphasize the true importance of label design or the more limited form of restyling.

Many paper makers use an illustration in their label design and this conforms to the well known and accepted principle that "a picture is worth a thousand words". This should never be changed unless the brand name or trade emblem is varied. Some progress could, however, be made in label redesigning by the use of new typefaces which have appeal and current application. This process has been carried out with good effect in many trades where labels have been restyled by using modern typefaces, label shape, color and sometimes larger sizes.

The size of the label will always have some relationship to the size of the packaged product.

Label Protection

Outside labels are applied to the faces of all forms of corrugated fibreboard packing cases, cartons, containers, and drums. Kraft wrapped bales and bulk packed merchandise are subject to the varied conditions of weather and rough handling. Such labels may be suitably protected by the simple application of strips of cellulose self-adhesive tape applied over the label's area, covering any added matters which may suffer from adverse conditions of weather while the goods are in transit or stored.

This form of label protection permits the printed label to remain fully visible, becoming scuff proof and resistant to wear and tear and similar hazards encountered in the shipping environment. Processes of high gloss varnish treatment carried out by the printer in the process of label printing can be similarly effective and, at a small extra cost, provide additional labeling protection.

Label Shape and Other Considerations

The conventional paper makers and allied trades label, is either square or rectangular in shape. Since these sizes conform to the shape of the average ream or bale of paper. Shape may be restyled to suit the shape or contour of round or other shaped packages so that there is some conformity of package labeling and general presentation. Shape also may help to identify the goods where they are stored away in the warehouse.

The trade cutter is now able to produce some unusual shapes from stock dies and punches. The specialist label printer can also undertake special designs and shapes in the label in conjunction with printing.

Manufacturers exporting their goods overseas may well consider the importance of employing some form of bilingual printed label, particularly where instructions and usage are involved in label type. The brand name

will always remain constant. But where additional instructional labels are used, such may be considered from the standpoint of bilingual and where they may apply, multilingual printings. Such labels serve to assist all those handling and using supplies. Competing export countries have long introduced this form of labeling to advantage.

In conclusion, all the skill of the label designer, the paper maker and converter, the printer and label specialist, are now available where new label ideas are contemplated. Whatever the label shape, color or method of presentation, the right adhesive label must be chosen for the appropriate surface of the wrapping or packing case on which it has to stick. It may therefore be stressed that the full facilities of the label producer be utilized so that the label choice gives complete adhesion and firm contact with a surface.

CHAPTER III

PRESSURE SENSITIVES

History of Pressure Sensitives

Pressure sensitive stocks are not new to in-plant printing departments. They have been used for over twenty years to fill a wide variety of applications requiring a "built-in" adhesive backing. Like any product that has progressed through multiple stages of design refinement and improvement, there are certain negative carry over misconceptions that remain even though the product has been improved. In order to fully appreciate the advanced pressure sensitive products on the market today, we should identify some of the early problems connected with pressure sensitive printing.

It is a known fact that early pressure sensitive sheet stock materials were difficult to print. The adhesive would ooze from the edges of the material causing sheets to stick together and jam while feeding, forcing the printer to dust the edges of the material with powder to reduce sticking. This was a tedious task. Before production the printer spent a considerable amount of time calculating the registration of the split in the stock. The printer had to match the proper spacing and number of liner splits with the size of the printing design to guarantee a split on the back of each finished piece. The split on the finished piece was necessary to facilitate easy removal of the liner. There was no way to avoid the split planning maze. Because one could never lay out the design

using the full sheet, material waste was unavoidable. When the job was finally on the press, one still wasn't free of possible problems.

The nonadhesive coated areas under each liner split presented potential problems. The uneven nonadhesive areas caused ghosting of the printed image and overlapping of the splits as the sheet passed through the printing cylinder. Even worse, the liner splits had a tendency to tear open during printing, jamming up the press with paper and adhesive.

In many ways, printing the old conventional split back pressure sensitive label was a tedious process. It required a printer who was fully experienced with the product and one who had the patience to put up with the problems. Many printers suffered trying experiences with the old conventional split back pressure sensitives. Some still remember these frustrations and avoid pressure sensitive jobs whenever possible.

With the introduction of the first "splitless" pressure sensitive sheet stock, most of the problems connected with pressure sensitive printing were eliminated. The product design was based on the simple fact that if you eliminate physical liner splits, you also eliminate the major cause of production problems associated with pressure sensitive printing. The construction, which utilized diagonal crack lines chemically processed into the release liner instead of the conventional physical splits, resulted in a totally solid liner construction that served the function of a liner split without the inherent production problems of physical cuts in the liners.

With the introduction of the splitless liner design, the printer could run a pressure sensitive sheet with the same convenience as any quality paper stock without an adhesive coating. No longer were special press attachments, inks or make ready necessary to print a quality pressure sensitive job. If the printer possessed the equipment to print on quality paper stocks, one could use the same equipment, with minor press

adjustments, for any pressure sensitive job using the splitless construction. Excellent in-house printing is achieved using splitless constructions on equipment as simple as the A.B. Dick, Multilith or Chief printing presses.

Constructions

The splitless pressure sensitive construction offers the in-plant printer numerous advantages that result in trouble free production. To illustrate these advantages, let's take a look at some of the traditional problems of printing pressure sensitives and see how the elimination of splits also eliminates the major problems.

With splitless constructions, one can forget about planning for a split on each finished piece. The liner design does the planning for you. Every finished piece will have a crack line to facilitate liner removal by the user. The elimination of split planning means that you can get the job on the press faster and complete it sooner.

With the elimination of the need to select jigs to fit specific printing designs, the in-plant printer can stock one or two standard splitless stocks to fit most job requirements. This also enables one to keep a supply of pressure sensitive stock in inventory to handle those "needed yesterday" jobs that always seem to pop up.

Production Problems

The old problem of splits opening on the press exposing the adhesive and jamming the press is completely eliminated with splitless constructions. Splitless liner constructions are solid and can not split apart during printing. Some stocks have further safeguarded against splitting open on the press by designing chemically processed crack lines in a diagonal direction on the liner. Diagonal positioning of the crack lines reduces

the chance for cylinder pressure to grab and tear the liner apart.

Another important feature of splitless constructions is the flatness of the sheet stock. The elimination of nonadhesive coated areas under the splits achieves a smoother liner. Smoother sheets mean faster press speeds, up to 20% faster than conventional split back constructions. In addition, the smooth liner on splitless constructions eliminates the ghosting effect that occurred in nonadhesive coated split areas.

The use of splitless constructions allows the printer to achieve maximum yield of a given design from each sheet. With conventional split back constructions, no matter what split plan the printer selected, one could never fully utilize the sheet and maintain a split on each finished piece. In additon, with splitless constructions, the printer may gang run various designed sizes and shapes on the same sheet to further maximize printing efficiency and reduce waste. In the event that the printing lay-out does produce unprinted off cuts, these may be saved and used at a later time for odd sized jobs providing a splitless construction is used.

Uses of Pressure Sensitive Stock

The uses for pressure sensitive materials are practically unlimited once you have started to apply the convenience incorporated into the concept of a built-in adhesive system. Since all of us need ideas from time to time, the following is a sampling of pressure sensitive jobs being printed and their uses:

A. Address the labels for envelopes, mailing tubes and packages. There is no need to moisten to apply since it won't dry out or fall off.
B. Correction labels are used to update the product's information. A special opaque construction preventing show through is used here.
C. Bright, appealing point-of-purchase labels are a natural application

for pressure sensitives. Many pressure sensitives resist weather and abrasion.

D. Pressure sensitive labels used as container labels can economically identify boxes, barrels, crates or other shipping containers.

E. Pressure sensitive product labels adhere to practically any clean, dry surface. They are also economical and easy to apply.

Adhesives

Just as a pressure sensitive can fill a wide variety of requirements, the adhesives incorporated into the material are designed to be equally flexible. The adhesive part of the three ply sandwich may be specified as removable or permanent, depending on the requirements.

Removable adhesives are designed to be removable from most surfaces without permanently damaging or staining the surface. Removable stocks should be used when removability is desired or not objectionable. Removable stocks are ideal for use on rough, smooth, curved, or flat surfaces.

Permanent adhesives should be specified when removability is not required. In most cases, attempted removal of permanent adhesive will result in tearing of the face stock or adhesive residue on the application surface. The degree of permanence depends on the application surface and the strength of the face stock.

Although most modern pressure sensitive materials are designed to fill a wide variety of applications, there are some tests that should be incorporated before printing any self-adhesive job.

First, test the product you plan to use. Simply check to see if the adhesive will stick to the surface you have in mind. Apply a sample of the construction to the surface on which the label will be used. A pressure sensitive adhesive has low tack when its initial grab is low, high

tack when it grabs tightly. Many adhesives will have higher tack on smooth surfaces, and lower tack on rough surfaces. Most adhesives will stick more readily when warm, less readily when cold. Full adhesion usually develops about twenty-four hours after application.

Second, test for removability of the adhesive. You can ordinarily check this twenty-four hours after the sample has been applied. Before deciding whether to use a permanent or removable adhesive, determine whether removability of the finished item is desirable.

Third, test the ability of the face stock to conform to the surface on which the pressure sensitive will be used. Experiment with several constructions to determine the best for your particular application.

Storing, Handling, Cutting, and Printing Pressure Sensitives

With the perfection of pressure sensitive sheet stock, many of the headaches of printing pressure sensitives have been eliminated. Most self-adhesive constructions can be taken directly from the carton and put on the press, but here are a few steps to follow to insure fast, easy, trouble free printing under nearly all conditions:

A. Sudden humidity changes can often cause edge ripple. To alleviate this problem, stack the sheets on a flat surface and inter-weave every two inches of the stack with chip board. Place a flat, rigid sheet of fiberboard or other material on top of the sheets. The time required for acclimation depends on the severity of humidity change and the amount of stock involved. Normally, only forty-eight to seventy-two hours are required.

B. Clean the stops on the press and wipe them with silicone to help prevent adhesive build-up. Do not set grinders too tightly, use the same tension you normally use for the correct setting on ordinary printing

paper.

C. Don't overload the feeder, especially in hot or humid weather. Use no more than four inches of stock at one time.

D. If one is faced with runny, wavy letterpress or offset stock, the trailing edge of the sheet may wrinkle as the edge is ironed out by the press rolls. To work effectively with rippled stock, one can remedy this wrinkle problem by utilizing one of the methods below:

   1. The press cylinder circumference should, if possible, be one and one half times the length of the sheet. This reduces sharpness of roll pressure on the sheet making the plate flatter at printing surface and trailing edge. Wrinkles are less likely to occur with this method.

   2. Spacing and pressure on press nip rolls. There should be as little roll pressure as possible. The adhesive mass on pressure sensitive stock will conform to roll pressure more easily than paper of the same caliper. Too much roll pressure causes wrinkling of the stock.

E. Pressure sensitive constructions have resiliency paper stocks don't have, and ghosting usually isn't encountered if the packing cuts are carefully removed. If it is a problem, it can generally be shimmed up.

Finishing Pressure Sensitive Stock

Use a clean, sharp knife. One will get less resistance, cleaner cutting, and less damage to the construction. When cutting a large order, change to a newly ground knife.

Keep the cutter bed clean. Use a new stick and be sure the bed is clean. It may be wiped with silicone for easier handling.

Wipe silicone or soap on the cutter blade. Be sure the knife is

clean. Spray silicone on the cloth and wipe on the cutter blade. Rub it on blade after every three or four cuts. This makes cutting easier and prevents pick up of adhesive on the blade (Adhesive won't stick to silicone).

Cut in short lifts, face down. A one inch to two inch lift provides best results. Cut using a clamp pressure of twenty-five to thirty-five pounds per square inch. If you can't adjust the pressure, place three or four pieces of chipboard on the lift to absorb shock.

Avoid high stacking. Between colors, stack the job not over 4" high in separate piles. One may want to weight each stack lightly to prevent any tendency to curl.

Edge ripple on larger sheet sizes may cause printing problems during hot, humid weather. This problem, potentially present with all paper stock, is caused by an imbalance of moisture in the sheet. High humidity causes growth in the paper. Problems occur when the edges of the sheet grow faster than the center. As a result, ripples appear on the edges because those edges become longer than the center of the sheet.

CHAPTER IV

ADHESION

Label performance will partly depend upon the adhesive and also upon the influence of the individual characteristics of the substrate on which it is coated.

Adhesion is the state in which two surfaces are held together by interfacial forces.

Bonding Theory

An important assumption in explaining adhesive bonding theory is, all important adhesive forces are electrical in nature. An adhesive attracts a solid surface by polar forces. Electrically positive and negative sites on the surface of the adhesive and the substrate exert unlike charge attractions for each other and thus adhere. The unlike charges may result from either permanent or temporary dipoles.

The presence of dipoles is not the only consideration in adhesion. Lubrication grease is a rather sticky material just because of its temporary dipoles. But, it is a poor adhesive not because it will not adhere, but because it is internally weak and fails cohesively. Thus, if an adhesive joint is to be strong, the adhesive must be internally strong.

Adhesives form internally strong films only when they are polymers. This is because only polymer molecules are large enough to have the great number of electrically positive and negative sites discussed earlier which are required for high self-attraction (cohesion). The adhesive polymers

may be linear as in most hot melts and solvent adhesives (thermoplastic adhesives) or they may be cross linked as in most epoxy, phenolic and polyester adhesives (thermosetting adhesives). In either case, the solid film should be as free as possible of internal stresses.

Internal stresses may result from excessive shrinkage during solvent loss or from uneven cross link density (cross links per some given volume).

Probably the most critical step in the production of good bonds is to ensure good contact of the adhesive with the substrate surface. It is for this reason that adhesives are applied as liquids, or at least pass through a liquid state during their cure.

Wetting

The process of having the liquid adhesive intimately contacting the solid surface is referred to as wetting. Good wetting results when there are strong attractions between the adhesive's molecules and the substrate, poor wetting when these attractions are low.

Surface Considerations

It is important to examine the nature of surfaces in order to understand why they sometimes attract, and sometimes repel adhesives. Modern concepts of ordinary surface structures include the following:

A. They have some particular surface energy
B. They are never clean, i.e., free from contamination
C. They are never smooth, i.e., never really flat

Surface energy is a complex concept not easily expressed in non-mathematical terms. Surface energy relates whether the surface electrons are highly stressed, whether they are being attracted in several directions by several neighboring atoms or whether they are not. Surfaces of high energy are generally polar, those of low energy generally are

non-polar. The concept of surface energy is useful because of the following fact: "Liquids will wet only solid surfaces of higher surface energy than their own". Thus, water will wet metals, but not polyethylene. There are no commonly available liquids, including melted solids, with surface energies lower than that of polyethylene. This is why there are really no good adhesives for polyethylene.

The solution to this problem of nonwettable surfaces is to modify the surface, converting it to a surface of higher energy. This can be done by flaming, acid etching, or by treatment with ultraviolet radiation. All these processes are capable of bringing about a reaction between the low energy polymeric surface and oxygen in the air. The result is that the oxygen becomes part of the chemical structure of the surface. This increases the polarity and the surface energy to the point where wetting by adhesives is possible.

Contamination of the adhered surface is a much encountered problem. Silicones are a common contaminate having a very low surface energy. Thus they will be able to wet nearly any surface they contact. The contaminated surface thus obtains a very low energy silicone coating which is not wet by adhesives or by cleaning agents. Silicones are extremely heat stable, they become virtually impossible to remove by any ordinary cleaning process. Since no ordinary surface is free of contamination and, if the cleaning has not been truly effective, traces of oil or grease may be present. Other contaminants such as water vapor, CO_2, and other atmospheric gases may also be present. Plastics may absorb all these contaminants.

Adhesives are generally able to absorb a certain amount of these surfaces contaminants and either transmit them to the adhesive atmoshpere or retain them without undue loss of film strength.

Adhesives must be fluid enough to flow over and conform to the shape

of the substrate surface if strong joints are to be formed. Only liquids can penetrate into the valleys and crevices of a solid surface. The adhesives must flow over a series of hills and into the bottom of valleys if good contact is to be made. The spreading adhesives must also displace or absorb the weakly held surface contaminants for maximum adhesion. This can happen only when the adhesive wets the surface well.

It is important that the polymer in a solvent cement have greater attraction for the substrate than for the solvent. The solvent could otherwise be preferentially absorbed and the adhesive polymer left floating on a tightly bound but internally weak solvent layer.

Bond Types

Most adhesive bonds can be thought of as being electrical in nature. Electrically positive and negative sites on the surfaces of the adhesive and the substrate exert unlike charge attraction for each other and thus they adhere. Bonds can be further distinguished by being either mechanical or specifiec (chemical).

Mechanical adhesion is the state in which the two surfaces are held together by an interlocking action and actual physical penetration of the adhesive occurs. The adhesive is interlocked or wedged between and around the fibers, crevices, and pores of the board surface.

Specific adhesion is the state in which the two surfaces are held together by various chemical valence forces between the molecules of the adhesive and the surface. It must rely on these valence forces in order to bond the two together.

When an adhesive is applied between two surfaces and the surfaces are brought into contact, the adhesive begins to set. The manner in which the final bond is achieved can be termed either thermoplastic or

thermosetting. Thermoplastic bonds are a result of the lowering of the temperature of hot melts to return them to a solid state.

Thermosetting bonds are a result of a chemical reaction. Epoxy is a good example of this type of bond.

Consideration in Adhesive Selection

Consideration in selecting a label and adhesive begins with taking a total view of the expected package environment, including the end use.

It is not possible to select one basic type of adhesive and restrict it to a single industry or application. Each application must be considered seperately. The starting point is the surface. This will determine the type of adhesive bond (dipole, mechanical or universal tack). Condition of the surface should be known i.e. smooth, rough, indented, granulated, etc. Working conditions of label application offer other important considerations as they may be involved in a high humidity application, extreme dryness, heat or cold conditions. At the same time, the product may have to undergo an additional process after the label has been applied. The end use of the label should be considered. Often some form of removable or temporary label is required. Machining requirements should be considered. Application by hand or by automatic processes will provide some limiting factors.

Supply continuity, along with cost, are of prime importance. The higher the solids, the better the bond, the higher the price. There are exceptions, of course. While an adhesive may contain a substantial amount of filler, the resulting high solids are not actually "adhesive solids", and an inferior product results. On the other hand, an adhesive may have a high solvent content, thus reducing solids, but without the solvent the adhesive would lack the "bite" necessary to bond. As a general premise,

the higher the solids the better the bonding capability. It is best to strive for a balance between quality, price, coverage, the range of adhesion afforded, labor and equipment costs, the service supplied by the adhesive company, speed of operation, carton and adhesive waste, etc.

It is not uncommon to find the higher priced adhesive often providing the more economical operation in the long run.

CHAPTER V

ADHESIVE TEST PROCEDURES

Innumerable procedures have been developed during the past two decades to inspect and determine the quality of adhesives and bonded joints. Inspection and testing are conducted for two major reasons: (1) to evaluate the quality or performance of an adhesive or bonded joint under specified loading and environmental conditions, and (2) to establish quality control procedures on the basis of the test results. However, the multiplicity of inspection and testing procedures can produce considerable confusion when the results are analyzed. For example, the lap shear joint is probably the most widely accepted design to be used in evaluating adhesives, adherend surface preparation, bonding procedures, etc. This joint design frequently bears little resemblance to the joint that will be used in a structural application. In addition, other tests may be used to evaluate joint quality, and a specific joint may pass one test but not the other. In such cases, caution must be exercised in comparing the quality of a number of joints. Usually, the tests are weighted and an average quality level is obtained.

The selection of methods for inspection and evaluation of adhesive or joint quality depends on factors such as: (1) the nature of the adherends or substrates, (2) the type of adhesive, (3) the joint design, and (4) the service conditions. Methods that are suitable for use with adhesive-bonded metallic substrates are not necessarily useful when nonmetallic substrates are joined. The usefulness and limitations of

inspection and testing methods must be clearly understood before they can be successfully employed. Fortunately, the industry has progressed to the stage that inspection and test requirements are quite well detailed for specific joint systems.

The provisions of inspection and test methods for adhesive-bonded joints are detailed in specifications issued by Government agencies, by technical societies, and by the industrial firms engaged in joining materials with adhesives. These procedures evolved over a period of time and reflect the thinking of many individuals; they are subject to change as new and improved techniques are developed for evaluating adhesive-bonded joints. It is beyond the scope of this chapter to review all of the available inspection and test methods. Instead, the most widely used methods for pressure sensitive adhesives are emphasized.

Nondestructive Testing of the Bond

Visual inspection can be used to a limited degree to determine the quality of adhesive-bonded joints. The usefulness of visual inspection is limited by the joint design, the type of adhesive, and the nature of substrates. Considerable information can be obtained if the substrates are transparent or translucent. In such cases a dye can be introduced into the adhesive and the bonded area can be illuminated by a strong light. Defects such as unfilled areas, voids, bubbles, cracks, etc. can be detected by the transmitted light. The exterior appearance of the adhesive-bonded joint can yield a limited amount of information on bond quality.

Destructive Testing of the Bond

Numerous test procedures have been developed to evaluate the properties of adhesive-bonded joints and structures; most of these methods have

been developed under the auspices of Committee D-14 of the American Society for Testing and Materials and appear in the ASTM Book of Standards, Part 16 (3). This publication is revised on a yearly basis, and the latest edition should be consulted for up-to-date information.

Tensile Tests. The relative tensile strength of adhesives can be determined with bar- and rod-shaped specimens in accordance with the provisions of ASTM D2095-62T.

Peel Tests. The peel test (ASTM D903-49) is designed to determine the relative peel resistance of adhesive bonds.

Environmental Temperature and Humidity Test. The effect of temperature and humidity on the properties of adhesive-bonded joints can be determined in accordance with the provisions of ASTM D1151-61. This test specifies conditions for determining the performance of adhesive bonds when subjected to continuous exposure at specified conditions of moisture and temperature. This standard method of testing is to be used in conjunction with ASTM D903 (Test for Peel or Stripping Strength of Adhesives).

Additional Tests

There are a number of additional tests that are used in determining the performance of a pressure sensitive adhesive.

Some of these tests are simple and require little technical knowledge. Although simple, they can provide valuable information used in selection and quality control of a pressure sensitive adhesive.

Listed below are the more popular tests used for pressure sensitives. The procedures for performing these tests are contained in the Appendix.

1. Ball Tack Test
2. Loop Method For Determining Tack
3. Thumb Tack Test

4. Shrink Test
5. Effects of Accelerated Aging On Peel Strength
6. Wettability Test
7. Creep Test

CHAPTER VI

THE USE OF PRESSURE SENSITIVES ON PLASTICS

General Problems

Each potential application should be tested to uncover possible problem areas so that they can be anticipated and avoided. This section will evaluate the application of pressure sensitives on various plastic surfaces. Pressure sensitives are probably the most interesting and most versitile of the labels available today, hence their emphasis in this thesis and the choice for label performance testing. Although they frequently cost more than water or heat activated labels or direct printing, pressure sensitive labels are being used more and more on plastic surfaces because of their ease of application, their ability to be made either permanent or removable, and important among other reasons, their ability to adhere to surfaces not easily labeled by other methods.

Today's pressure sensitive label may consist simply of paper with a rubber resin pressure sensitive adhesive, carried on a release coated backing paper or liner, or it may be a multi layered, multi coating product. By the time the stock, adhesive, primer, printing, topcoating, backing, release coating, etc., are included, it may contain scores of different materials.

It is easily understood that with a product consisting of such combinations of ingredients, it is virtually impossible to make absolute predictions as to performance in combination with a plastic surface under a given condition until it is field tested.

Specific Problems

Specific problems which are most often encountered when using pressure sensitive labels on plastics include:

A. Plasticizer migration: 1) from the plastic into the label adhesive, causing excessive softening of the latter, or if the plasticizer is incompatible with the adhesive, a surface contamination will result in loss of adhesion; 2) from the plastic completely through the adhesive into the primer, causing failure of the adhesive on the label stock side, or causing bleed through; 3) from the adhesive formulation into the plastic, where it may cause etching or crazing.

B. Migration of contents completely through the walls of the container into the adhesive, producing much the same effects as in A, plasticizer migration.

C. High specific adhesion for a particular plastic by an adhesive which is supposed to be removable and the converse, poor specific adhesion of an adhesive which is designed to be permanent.

D. Contamination of a plastic surface by a mold release agent or other contaminant which may cause poor adhesion of a label, with possible lifting of the edges or even fall off, particularly on curved surfaces and/or with a stiff label stock.

E. Exposure of a label after application onto a plastic surface to a condition for which that particular label was not designed to withstand, e.g., excessive water or ultraviolet exposure, extreme or continued flexing, temperature changes, etc.

Solutions are available for most of the problems mentioned above. Data presented in Figures 1 and 2 illustrate the effects of plasticizer migration and specific adhesion, which are the two most important considerations involved in the selection of the proper label to use on a

particular plastic. The selection of the label stock, printing, topcoating, etc., is usually determined by the customer as required by the application and will be based upon cost, the desired appearance, the need for resistance to abrasion, heat, and other environmental conditions.

Plasticizer Migration and Specific Adhesion

To illustrate the effects of plasticizer migration and specific adhesion to plastic surfaces, four representative types of adhesives were tested on seven types of plastics. One additional adhesive was tested on three of the surfaces to illustrate specific adhesion. A metal surface was used as a control for comparative purposes.

Procedure Used

The plastics were bonded to rigid metal plates to eliminate any effect that stretching or other deformation of the plastics might have on the test results. To relate the tests to actual labeling operations, the test surfaces of the plastic were not cleaned prior to testing, although contact with bare fingers was avoided. All tests were run at ambient conditions (about 24 degrees centigrade, 55 percent relative humidity). Initial tests were run immediately after application of the label to the test surface (with two passes of a five pound rubber roller). Label samples using the same adhesive coating were applied simultaneously to identical test surfaces and then placed in an air circulating oven for 24 hours at 72 degrees centigrade, cooled to room temperature, and then tested in the same manner as those with no dwell period. The accelerated conditions were used to speed up the plasticizer migration and the ultimate adhesion.

The adhesives were all coated on the same release paper backing, at a thickness of 1.5 mils, and dried under identical conditions. After

cooling, they were laminated to two mil polyester film. For two of the adhesives, it was necessary to prime the polyester film to obtain adequate anchorage, but it was assumed this would not appreciably affect the results.

The results of the peel adhesion tests which were run on a Scott tester at a constant speed of twenty inches per minute and at a 180 degree angle of removal are shown in Figure 1. Strips one inch wide by five inches long of the adhesive polyester label construction were run, as described above. The cold flow or cohesive strength tests (Figure 2) were run with a one-half inch square sample of the label constructions applied to the test surface by the same procedure used on the peel adhesion test specimens. 500 gram weights were hung from the vertically appended test strip, and the time to failure recorded. The metal surface used as a control for the cold flow tests was a highly polished stainless steel surface. Pre-cleaned with a solvent wash and a hot water detergent solution wash, then carefully dried to be spot free. The metal surface used for the peel adhesion control test was aluminum, cleaned in the same manner as the steel.

Adhesives Used

Except for "E", the adhesives tested were a representative cross section of the types used for plastics:

A. Adhesive "A": An adhesive based on cured synthetic rubber (polyisobutylene) designed for removability from most surfaces.
B. Adhesive "B": Also a synthetic rubber based adhesive, but with a different type of rubber (butadiene styrene copolymer), designed for permanence on most surfaces.
C. Adhesive "C": An adhesive based on a compounded acrylic polymer, formulated for permanence in most applications, and outstanding

resistance to degraduation by heat or ultraviolet light.

D. Adhesive "D": A pure inherrently pressure sensitive acrylic polymer with no additives. This self cross-lining polymer is highly resistant to the effects of plasticizer migration.

E. Adhesive "E": Also a pure acrylic, virtually non pressure sensitive, but having exceptionally good specific adhesion to vinyl.

Results

The data in Figures 1 and 2 illustrate how migration of plasticizer from the plasticized vinyl degraded adhesives A, B, and C. Whereas adhesive D was relatively unaffected. The peel adhesion value for adhesive D would have been higher than that recorded, except for primer failure, after the 24 hour swell period at 72 degrees centigrade. This illustrates that the primer was attacked by the plasticizer, although the adhesive was little affected. On the cold flow tests, the cohesive strength of adhesives A, B, and C is shown to have decreased drastically to near zero, while the migration resistant adhesive D actually improved its resistance to flow while on a highly plasticized PVC surface for 24 hours at 72 degrees centigrade.

Adhesive E, which is practically tack free and could hardly be called pressure sensitive, gives practically no peel adhesion reading initially, but after the 24 hour dwell period at 72 degrees centigrade, its adhesion to the plasticized and unplasticized vinyl surfaces is by far the highest of any of the adhesives tested. This dramatic evidence of specific adhesion is shown by the fact that its adhesion to polyethylene was nil before and after the accelerated aging period.

Adhesive D, with excellent performance on vinyls, and good permanence on most of the other surfaces, showed a lack of affinity for polyethylene

with a lower adhesion to that surface than adhesive A, which is designed to be a removable adhesive. Adhesive B shows a notable specific adhesion to polymethyl methacrylate which would not be predicted from any known edge of its composition nor from any of the well known theories of adhesion.

Tests similar to these are referenced in Cagle's Handbook of Adhesive Bonding, 1973. Procedures for these tests are further outlined in ASTM D903-49 for the 180 degree peel adhesion and the cold flow test in Federal Test Method 175.

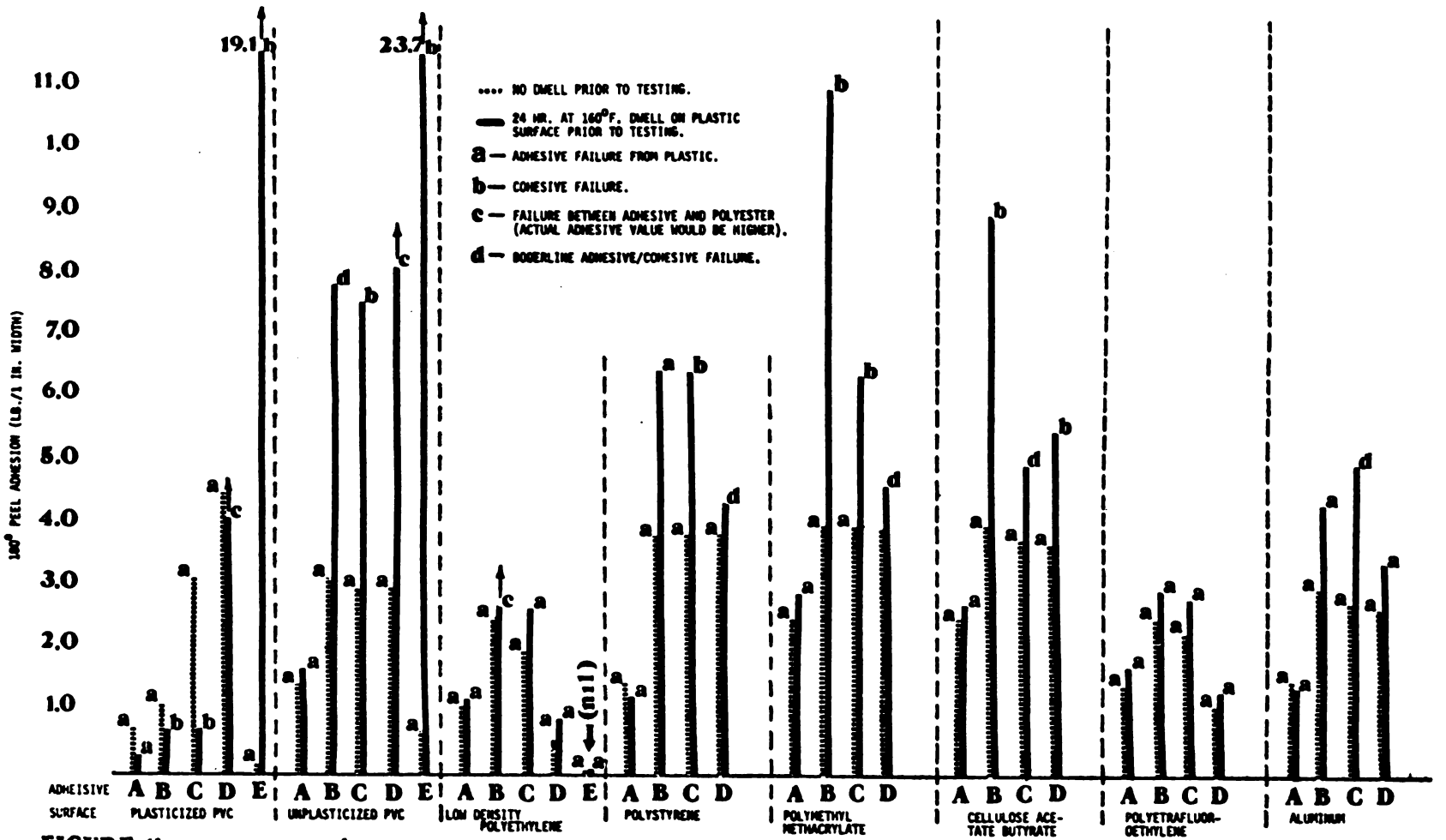

FIGURE 1: COMPARATIVE STUDY OF 180° PEEL ADHESION (20 IN/MIN) OF PRESSURE SENSITIVE ADHESIVES ON PLASTIC SURFACES.

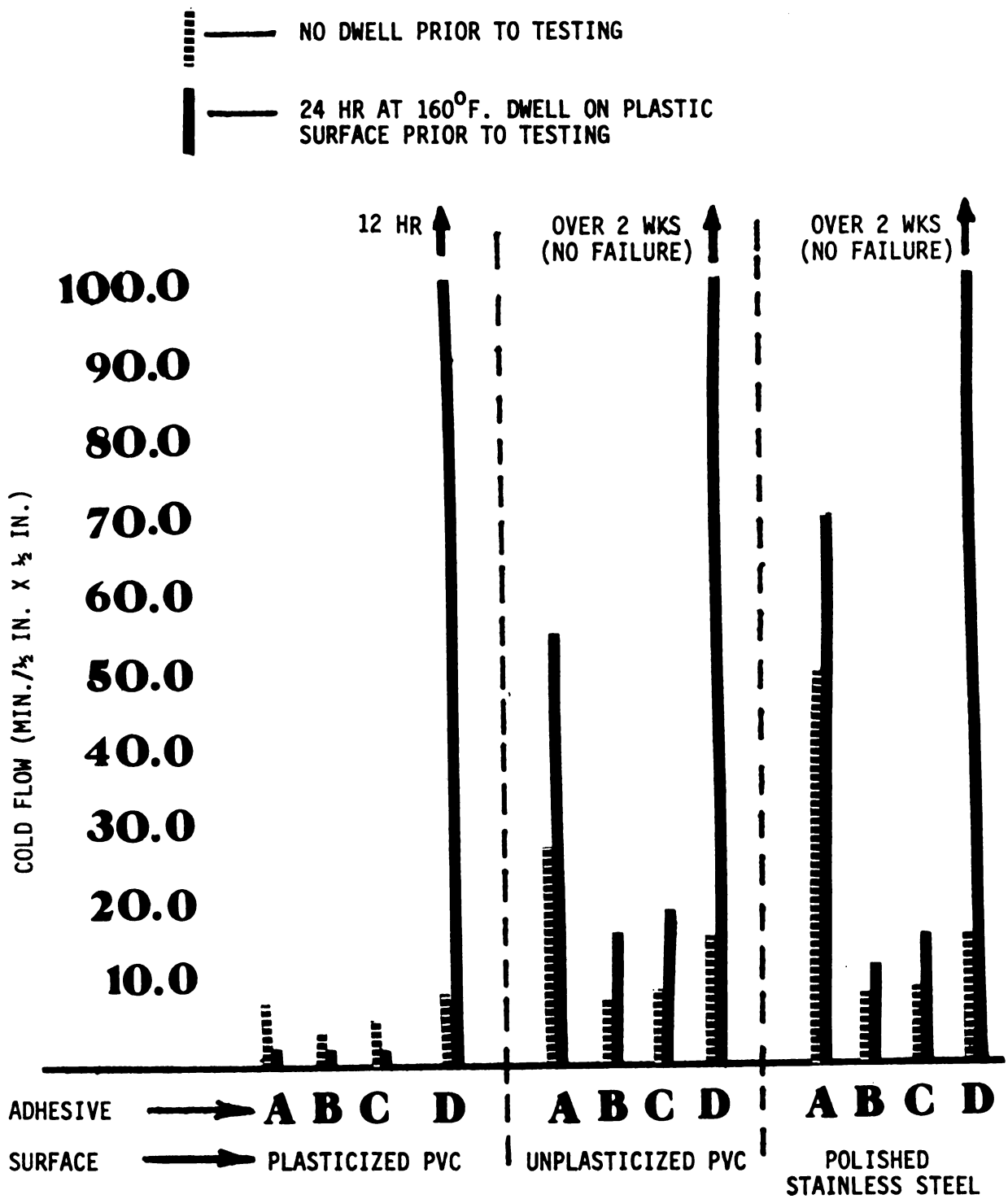

FIGURE 2: COMPARATIVE STUDY OF COLD FLOW IN VARIOUS PRESSURE SENSITIVE ADHESIVES ON PLASTICIZED AND UNPLASTICIZED POLYVINYL CHLORIDE SURFACES. STAINLESS STEEL SURFACE WAS USED AS CONTROL.

CHAPTER VII

PRESSURE SENSITIVE LABELING EQUIPMENT

Advantages

There has been continued growth in the demand for the pressure sensitive label. Paralleling this growth is the demand for its corollary, the pressure sensitive labeler.

One of the largest factors in this rapid growth has been the relatively low cost and numerous advantages of pressure sensitive labeling as compared to other forms of product identification. There has always been a wide variety of labels, papers, foils, films, and laminates, but it was the advent of high speed, efficient machinery available at a reasonable cost that has promoted the growth of the pressure sensitive labeling system.

The pressure sensitive label is in many cases the only answer to one's labeling problems. Bringing together dissimilar materials; containers, adhesives, and label stocks, in addition to a wide range of shapes and sizes of labels makes the pressure sensitive label the only practical method of labeling.

Considerations in Equipment

Many important factors must be taken into consideration before one can select the label best suited for the job. Thorough knowledge of the various types of equipment available today is needed to judge the compatibility of pressure sensitive labeling to each individual application.

The more knowledgeable one is about the kinds of equipment available along with their advantages and disadvantages, the more likely one is to make a wise choice. What is a pressure sensitive labeling system? The generally accepted definition of a labeler is a "machine which removes a pressure sensitive label from its backing paper and automatically applies it to the end product". This equipment ranges from simple dispensers, operated by hand, through the semiautomatic and standard automatic, up through the high speed machinery capable of providing over 1000 applications per minute. Whether you can justify a labeler for use over your established line or a complete system, will depend largely on your requirements for product control and your ability to provide this control. Speed and accuracy will be prime considerations in your selection of equipment.

Other factors to consider may include:

A. Versatility: Sizes, shapes, and quantities of labels applied to each container.

B. Product material: Metals, plastics, and papers are all a little different to label and this must be considered if the label is to work well with its product from production to consumer.

C. Flexibility: A machine should be flexible if one's products and lines change very frequently.

D. Maintenance: The machine's operating environment, down time for change over, cleaning, and machine longevity are all very important considerations.

Also one should consider the standard and optional features of each machine, warranty, spare parts availability, lubrication systems, safety features, ease of operation, power requirements and container feed and handling systems. As one can see, some research should be made before the sound machine investment can be made.

Mechanics of a Pressure Sensitive System

The pressure sensitive labeling machine is broken down into various mechanical sections. All labeling systems start out with a dispenser. The dispenser is the means by which the label is removed from its backing. This is usually accomplished through the use of a sharp edge commonly referred to as the "peeling blade". The peeling blade bends back the release paper, thereby allowing the label to separate from its backing and run off in a straight direction. One can illustrate this by hand and it is interesting to see that the release paper must be bent from the label, for if it isn't and the label is bent, a curl is induced in the label making it more difficult to handle and to apply.

Sequence of Operations

The normal sequence of the labeler is as follows:
A label stock supply is first. There are the hopper types for individual labels and the reel types for roll stock. The majority of labels are supplied in reel form. Recently, a label supply used in the computer oriented labeling field is making its way into the packaging market. As labeling systems increase their speeds, this "fan folded label" as it is called, will surely be seen more and more. Continuous running is accomplished with this system as a splice can be made at any time during the process. This is the main advantage as automatic splicing for present reel systems has not been perfected as yet.

Label Sensing

Label sensing will vary with the type of label used. Photoelectric sensing types are used in high speed applicators where there is sufficient contrast between the label and its backing paper. Electromechanical types

such as microswitches equipped with "cat wisker" sensors are used for transparent films or materials too similar to their backings in color value to be read by the photoelectric equipment. Other product variables such as the lack of weight, stability or opacity may dictate the use of a specific sensor. Generally speaking though, either may be used. One will find the photoelectrics are more expensive, but a much longer life is obtained from them as opposed to the mechanical types.

Drive Systems

The heart of the label dispensing unit is the drive system. Its function is to accelerate and decelerate with precision and accuracy. This is where pressure sensitive equipment varies in sophistication and cost.

Stepping motors are employed for the less expensive slow speed equipment. These are directly coupled to pull rolls for label feed. Much of the high speed equipment available today employs low voltage micro circuits rendering greater machine reliability and longevity. Electric clutch brake systems are a result of this use in systems applying labels at speeds of over 1000 per minute. A big advantage with these designs is their elimination of down time, a board can be replaced in a very short time.

Label Application

The label applicator will be dictated by the type of labeling project. There are two main categories: 1) the continuous motion of the labeling process and 2) the product being stationary at the time of labeling. Production line products are normally in continuous motion and generally if high speeds are to be attained, there should be no stopping of the product to apply the label. Where labeling accuracy is of prime importance or if other unique properties such as product configuration

or area registration is a problem, then the stationary type is recommended. For slow speed application on stationary products, the impressor methods using air cylinders or solenoids to move the labels to the products are recommended. A vacuum pad mounted to the air cylinder pod is used to dispense the label. By actuating the cylinder, the label is placed on the product. For placing labels in depressions in the product, this method works very well. Extremely accurate placement of the label can be obtained through the use of secondary devices using stop pins on the vacuum pads or additional label positioning cylinders for label alignment after it is dispensed. Tolerances of less than .0050 inch in label placement are obtained with this equipment. The speed of this operation is limited by the physical characteristics of the air cylinder and the stopping of the product for application of the label. Higher speeds are obtained utilizing the motor drive, linear motion type of applicator as it moves with the product.

Two methods are used to label products in motion:

Roll on applicators are generally used for larger labels in a synchronous dispensing of the label to the product with the label being rolled onto the product as it is moving past. Synchronous dispensing has become a very practical method of label application. Its precise control of acceleration and label feed lends itself very well to high speed application as the label is applied as it is being dispensed.

A fixed roller is the simplest of the applicators and also the least expensive. It is used for labeling smooth, flat surfaces. The floating tip roller is used when the product has a curve or contour to its surface. It is also used when various sizes of products are labeled on the same machine. Solenoid actuated rollers are recommended for the flat packs of soft products such as clothing. These products are stable

enough to be transferred between a fixed or floating tip roller but too soft to drive the roller up before being labeled.

The blow on is the second type. This method utilizes a vacuum grid to which the label is dispensed. The label is then positioned on the grid and air pressure applied which actually blows the label onto the product. Products that are easily marred or of a fragile nature are labeled utilizing this method. This applicator is not recommended for use with labels larger than two by three inches or for use on films, as there is a possibility of trapping air bubbles between the label and product and the tendency for larger labels to wrinkle when subjected to the secondary wipe down.

An air blast applicator is utilized for large labels being dispensed over or along a moving product. The label is blown against the product for initial contact and a secondary roller is used to insure positive contact. The placement accuracy inherent to roller applications is not offered with this method.

Product Sensors

The product sensor's function is to initiate the labeling cycle as it senses the presence of the product. Most all of these sensors are photoelectric. Microswitches are also employed but to a lesser degree.

Product Handling

Product handling systems can range from the very simple types of fixtures used to position a product for hand labeling to very sophisticated equipment that not only is extremely fast but accurate too. Labeling accuracy will depend on two variables. First the ability of the dispenser to position the label and secondly, the ability of the product handling

system to position the product consistently in the same position each cycle.

Many established lines will already have good product handling capabilities. This will allow the label dispenser to be mounted utilizing these capabilities, thus saving considerably on the cost of labeling equipment.

A lot of this type of equipment available today is modular in its design. This has the advantages of lower costs, flexibility and availability as it is stocked by the equipment manufacturers and can be delivered in a short time at a lower cost.

Conclusion

Pressure sensitive labeling equipment is perhaps the most versatile available to the labeler. It is easily adapted to existing lines. Speeds can vary from ten applications per minute on hand operated equipment to over 1000 per minute. Label materials are of a great selection; foils, films, laminates, etc. There are many other advantages such as maintenance, versatility of product, etc., but perhaps the largest advantage a pressure sensitive system can provide is a lower capital cost. A pressure sensitive system is one-third to one-half the cost of other labeling equipment doing a comparable service.

CHAPTER VIII

SUMMARY

Pressure sensitive label has been compared with and evaluated against other labels and labeling mediums. The merits of most forms of labeling have been discussed. However, it may be repeated that the pressure sensitive label is now generally accepted as the most advanced form of labeling in view of its complete convenience and wide variety of surfaces to which it will immediately and firmly make contact.

Advantages Reemphasized

Pressure sensitive labels are used today for sales promotion, price marking, identification, nameplates, service guarantees, and many other purposes. These labels excel in their ability to label fragile or difficult surfaced items. They are supplied ready for application and adhere to a variety of surfaces. The adhesive can be formulated to provide a removable or permanent label as desired. Also, the label can be designed for special shapes; cylindrical, elliptoid, and other non flat surfaces.

The primary characteristic of the pressure sensitive label is its ability to adhere to most any surface by simple press on contact. Both consumer and industrial operations have accepted the pressure sensitive concept for its versatility in fast, effective, and efficient product labeling and identification.

Atmospheric conditions affect the pressure sensitive label very slightly. Perhaps the only real problem area is where surfaces to be

labeled are hygroscopic. Both the permanent and removable labels remain firmly affixed at the lower temperatures (-6 degrees centigrade to -20 degrees centigrade). Above 72 degrees centigrade, the removable type adhesives start to break down. Special adhesives have been developed for the abnormally high as well as low temperature applications. The permanent type adhesives are capable of withstanding temperatures in excess of 205 degrees centigrade. It should be noted here that special materials should be utilized in these temperature ranges as over 150 degrees centigrade normal paper will tend to char and break down.

Some plastic bottles have such an extremely high plasticizer content that labels tend to look greasy and ink smudges and starts to lift. Special adhesives that resist plasticizers should be specified here. There are formulations developed especially for this.

A pressure sensitive system eliminates the need for glue pots, water moistening brushes and belts, chemical, solvent or heat activated materials and devices required to make other labels stick. These systems not only cost more initially, but require more labor and materials to run. Perhaps the biggest advantage of a pressure sensitive system is its requirement for very little maintenance. This is an area to which little consideration is given to until "something happens". Discounting normal maintenance, which all production equipment must have, lets look at "set-up", "down-time", and "clean-up".

These terms, common to the labeling industry, are all different phases of a labeling operation. A closer look at each will give one an idea of the problems to be expected of labeling equipment and also will reinforce the pressure sensitive labeling system.

Set-up is the actual preparation of the machine for production. All labelers have to be loaded with stock and fed into and through the machine.

Pressure sensitive labeling machines can be turned on at this point and labeling started. Heat activated labeling equipment will need to be warmed up to production temperatures and tested for its adhesion before actual production can begin. Water activated and solvent types, along with wet glues, will require from 10 minutes to 30 minutes for production to begin. Timers are added to this equipment along with other special mechanical devices in an effort to aid in the speed of set-up times. These generally work, but they do add to the total machine cost and they themselves are often the cause for "down-time".

Down-time is the term used to express in minutes, the non-productive time of a machine during a production day. This is an area which is probably the touchiest of all for a production manager. When a machine is not working, the product is not being made, and money is being lost. A machine down for as little as 2 minutes can cost hundreds of dollars in loss for a company. With that kind of money involved, one can easily see why down-time must be kept at a minimum. Generally speaking, a pressure sensitive system is far simpler to keep running as there are fewer parts and many of these are modular in design. This provides for quick and efficient replacement.

"Clean-up" is the time involved after the production run for the preparation of the machine for the next days run and for general good housekeeping. In this area, if one is using conventional labeling equipment, he or she must be willing to devote a certain amount of time to clean-up. Also, a worker must be employed who is conscientious enough to do a good job day in and day out. If this phase of the labeling operation is not done properly, all other labeling will be in vain. A messy machine produces an aesthetically poor product. Here the pressure sensitive labeling system is truly the leader as clean-up is minimal.

Conclusion

On occasion the pressure sensitive label may be higher in cost, but the packager must also consider the high cost of labor. Looking at both, one will often find that the pressure sensitive system can provide lower overall costs. Costs along with the advantages and disadvantages, availability, versatility, speed, and quality will all have to be evaluated before a good, sound decision can be made. The packager who bases his decision on his preplanning and constructive analysis performed before production and capital expense, will remain the leader in the competitive world of packaging.

APPENDIX

PRESSURE SENSITIVE ADHESIVE TEST PROCEDURES

Equipment and Conditioning

When using the standard 4.5 pound roller, the proper method requires that the protecting support be pointed upward with the handle lying across the film at a rate of twelve inches per minute.

When aging samples in the circulating air oven, cover exposed adhesives with a release paper.

The constant temperature and humidity room should be maintained at 22 degrees centigrade and 50% relative humidity.

1. Ball Tack Test

The purpose of the ball tack test is to determine tack and tack retention of pressure sensitive adhesive.

The procedure for the ball tack test is as follows:

A. Cast an appropriate adhesive film, suggested level 1 mil dry, on the appropriate release paper. Dry at room temperature for 15 minutes, 2 minutes at 90 degrees centigrade in oven, and 1 hour in constant temperature and humidity room.
B. Place on PVC film and roll with 4.5 pound roller in proper manner.
C. This vinyl film may be used after 24 hours in constant temperature and humidity room or after the appropriate length of time, in the air aging study. At the end of this period, remove vinyl film and place at bottom of chute in constant temperature and humidity room.
D. Place appropriate ball bearing, suggested ball bearing is two grams, at top of chute, three and three-fourths inches above table top.

Release ball bearing and measure distance rolled across adhesive surface.

E. This process is repeated six times and averaged to determine ball tack.

F. The sample is moved after each roll in order to test new adhesive surface. The ball bearing is cleaned after each roll in acetone and dried thoroughly with a lint free cheese cloth.

2. Loop Method For Determining Tack

The loop method is used for determining tack and tack retention of pressure sensitive adhesives.

The procedure for the loop method is as follows:

A. Cast an appropriate adhesive film, suggested level 1 mil dry, on a glass plate. Dry at room temperature for 15 minutes, 2 minutes at 90 degrees centigrade in oven and 1 hour in the constant temperature and humidity room.

B. Cut one-half inch wide strips, six inches long, of Type A Mylar or other suitable film.

C. Place the two ends of the one-half inch strip between the jaws of the Instron Testing Machine. Place the coated piece of glass on the cross head, raise the cross head to within one inch of the jaws in order that the one-half inch strip films make contact with the glass.

D. Lower the cross heat at the rate of five inches per minute and run the chart at one inch per minute.

E. Steps C and D, the raising and lowering of the cross head of the Instron, should be done automatically.

F. Six samples should be run and averaged for the tack index.

G. One glass plate may be used for six samples by using a new area of adhesive for each tack test.

3. Thumb Tack Test

The purpose of the thumb tack test is that it is a quick qualitative test for determining the tackiness of pressure sensitive adhesives.

The procedure for the thumb tack test is as follows:

A. Apply an appropriate film of adhesive solids, suggested level 1 mil dry, to a rigid substrate, e.g., glass, aluminum plate, etc.

B. Dry film for 15 minutes at room temperature, 2 minutes at 90 degrees centigrade, and one hour in the constant temperature and humidity room.

C. Exert pressure on film with thumb, note amount of tack. Vary pressure and length of time while noting variations in tack.

4. Shrink Test

The shrink test is used to determine the shrink resistant properties of pressure sensitive adhesives.

The procedure for the shrink test is as follows:

A. Cast appropriate adhesive film, suggested level 1 mil dry, to appropriate release paper.

B. Dry at room temperature 15 minutes, and 2 minutes at 90 degrees centigrade, allow sample to return to ambient temperature before placing on appropriate film, generally PVC.

C. Roll laminate with 4.5 pound roller. Allow this specimen, release paper, adhesive and film, to age 24 hours in the constant temperature and humidity room before proceeding. Cut a 4 inch by 8 inch sample from the laminate. The machine direction of vinyl film must be in the 4 inch direction. Make a light pencil mark on vinyl film in center of 8 inch edge.

D. Remove 4 inch by 8 inch release paper and place a 6 inch by 1 inch

strip of release paper across the center, in four inch direction, of the specimen.

E. Partially laminate film with strip of release paper to appropriate surface. Cut the vinyl film with a razor and ruler over the 1 inch strip of release paper without scoring the substrate.

F. Remove the strip of release paper and laminate the vinyl with 4.5 pound roller. Mark the six edges with a red wax pencil, then place the samples immediately in a 45 degree centigrade oven for ten days.

G. The shrinkage of the film is determined by measuring the gap opening in the waxed area at the edges and at the cut. Shrink resistance is expressed in mils.

5. Effects of Accelerated Aging On Peel Strength

The shelf life of a pressure sensitive resin is estimated from the effect of accelerated aging on the peel strength of the resin.

A. Preparation and aging of test specimens: Specimens are prepared on release paper in the fashion described from the peel test procedure. One set of specimens is placed on the vinyl film. A second set is placed on release paper applied with the 4.5 pound roller. The specimens are aged in a convection air oven at 70 degrees centigrade $\pm$ 2 degrees centigrade for seven days. The top layer of release paper is peeled from the second set of specimens which are then placed on vinyl in the standard way with the 4.5 pound roller. Strips of film one inch wide are cut from the two sets of specimens and the test of 180 degree peel adhesion is carried out.

B. Solubility of adhesive in acetone: After the peel test has been carried out, one inch squares of test specimens are cut and placed in acetone in an aluminum cup. The solubility and swelling behavior

of the pressure sensitive resin is observed and compared with the behavior of a sample which has not been subjected to the aging treatment.

C. Report: Raw data will include the minimum, maximum, and average peel adhesion values reported in pounds per inch width to the nearest tenth of a pound. The type of failure for not less than three specimens of adhesive aged in contact with the vinyl and not less than three specimens of adhesive aged within the release paper sandwich will also be recorded. The average peel adhesion value and the solubility or swelling behavior of the aged resin will be reported.

6. Wettability Test

The purpose of the wettability test is to determine the ability of the adhesive to wet a surface.

The procedure for the wettability test is as follows:

A. Apply a three inch wide film of adhesive of appropriate thickness, suggested level 1 mil dry, to a release paper.

B. Dry the film at room temperature for 15 minutes, 2 minutes at 90 degrees centigrade, and 1 hour in the constant temperature and humidity room.

C. Apply a 2.75 inch wide Type A Mylar film to the adhesive, using the standard 4.5 pound rubber roller. Cut this laminate into four separate samples.

D. Apply the adhesive coated Mylar to a black kraft paper and roll with a 4.5 pound standard rubber roller.

E. Estimate percent of adhesive film which has wet (adhered) the black kraft paper after standing at room temperature for five minutes.

F. Four replicates should be run and averaged for wetting index.

7. Creep Test

The purpose of the creep test is to determine the creep or cold flow performance of a pressure sensitive adhesive.

The procedure for the creep test is as follows:

A. Apply appropriate adhesive solids, suggested level 1 mil dry, to release paper.

B. Dry at room temperature for 15 minutes, 2 minutes at 90 degrees centigrade. Allow casting to return to ambient temperature before placing on Type A Mylar film. Cut 0.5 inch strip with the 0.5 inch precision sample cutter.

C. Bond 0.25 square inches of coated Mylar to vertical edge of chromium plated flat bar with the Standard Pinch Clamp, for 15 seconds in order to achieve a uniform degree of pressure.

D. Apply a one pound load to the Mylar film in order to exert uniform tension across the film and hold at 25 degrees centigrade until failure occurs. Note time to failure as an index of creep.

E. Three replicates should be run and averaged for creep index.

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