

**INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH
TECHNOLOGY****VARIOUS ASPECTS OF PERFECT BINDING PROCESS FOR OPTIMUM
UTILIZATION OF ADHESIVES****Goyat Arohit^{*1}, Nishan Singh² & Madhvi Latha³**^{*1}Assistant Professor, Department of Printing Technology, GJUS&T, Hisar (Haryana)²Assistant Professor, Department of Printing Technology, SITM, Rewari (Haryana)³M. Tech. (Print & Graphics Communication), SITM, Rewari (Haryana)

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ABSTRACT

Each generation, going back to the early middle ages, has had master craftsmen capable of producing handsomely decorated bindings, whether gilded, painted or be jeweled. These fine bindings have adorned the shelves of wealthy collectors and subsequently found their way into exhibition cases or published catalogues. They are self-evidently beautiful objects, works of art in their own right, and looking after them needs little justification. Such bindings constitute only a tiny proportion of the total output of binders over the centuries, and we are increasingly coming to recognize that this purely visual approach to the subject is too narrow. Before the early nineteenth century, when mechanization began to be introduced, every book binding was an individually handmade object, whose creation reflected a series of choices which became part of a book's history. Bookbinders offered their customers a range of options on quality, both structurally and aesthetically. A book might be quickly stitched in paper or vellum wrappers, or it might be fully bound in decorated leather-covered boards. The covers might be decorated simply with a few blind lines, or extravagantly with lots of gold tooling. The choices exercised in each case may tell us something about the ways in which individual books were owned, circulated and regarded.

I. INTRODUCTION

The interest of book bindings has traditionally been thought to lie primarily in their external appearance. A fine binding may have been put on a book for a variety of reasons, including respect for the text, a wish to impress friends and visitors, a wish to influence a potential patron with a noteworthy gift, a wish to create a handsome presentation copy of an author's own work, or a pure and simple love of nice objects. A cheap and basic one may likewise signify various motivators: a perception of a text as ephemeral, to be read and discarded, an intention to rebind later, an attitude eschewing unnecessary luxury, or plain economic necessity. School books, student textbooks, books for everyday household use, children's books and books for non-conformists are often found in cheap bindings for one or more of these reasons.

Type of binding

Following are the four categories of binding operation in which all type of binding lies.

- 1) Cutting and Folding
- 2) Folded Sheet Binding
- 3) Loose leaf Binding
- 4) Adhesive Binding

First three binding type is mainly used for securing of sheets. And the Adhesive binding is used for book publishing and book binding.

Perfect Binding

Perfect Binding is a hot melt adhesive binding. The term itself was developed by the Sheridan Bookbinding machinery company in 1911 when it attempted to overcome the disadvantages of cold emulsion while retaining the desirable characteristics of pull strength and flexibility. The results achieved over the past 80 years have

permanently elevated perfect binding to its place of prominence. Advances in plastic hot melts have driven the marketplace to refer to all adhesive binding as perfect binding, rather than ranking it simply as part of the adhesive binding family.

Perfect binding with higher end EVA (hot melt) glues provide page pulls and flex characteristics equal to cold emulsion. The few disadvantages can all be overcome through proper planning at the design stage. The most important advantage of perfect binding is its high speed and relative low cost in publishing Book Binding.

Important factor to be considered before Perfect Binding:

- Allow a minimum 1/8" head, tail and face trim on inside text pages.
- Allow 1/16" to 1/8" for "grind" on spine edge of inside text pages.
- On the cover, leave an extra 1/8" at the head and an extra 1/4" at the tail of the untrimmed folded signatures. Very important!
- Make certain grain direction of cover is parallel to the spine for a more durable bind.

PUR Binding (Polyurethane Reactive Material)

PUR is relatively a new term as it refers to bookbinding. Actually, PUR is a hot melt adhesive similar to EVA hot melts, but the adhesive is manufactured with polyurethane reactive material (PUR). As the adhesive product dries a natural chemical reaction occurs after the glue is exposed to moisture in the air. The results of the chemical reaction create a superior bond within the fibers of the paper giving the book a greater pull and flex strength. In most but not all product situations the books are more durable and lay flatter when opened than a typical EVA adhesive product. The disadvantages of this adhesive are that the cure time requires that the books not be used for almost 24 hours after application and the cost is slightly higher. Care should be taken when selecting this type of binding because in many instances the finished product does not require the additional cost associated with the application process.

Important factor to be considered before PUR Binding:

- Allow a minimum 1/8" head, tail and face trim on inside text pages.
- Allow 1/16" to 1/8" for "grind" on spine edge of inside text pages.
- On the cover, leave an extra 1/8" at the head and an extra 1/4" at the tail of the untrimmed folded signatures. Very important

Double Shot Hot Melt Binding

Binders continually strive to produce a better book. Some authorities claim that improved construction of the book block can be accomplished by applying a double coat of glue to the spine of the book after spine preparation. The first coat is a primer coat of glue then the block passes over a second application roller and the final adhesive coat is applied over the primer coat. This process is known in the industry as double shot hot melt. At RGSC we feel that with proper planning of your book project any necessity of this process is eliminated by using either PUR adhesive or high end EVA products. Both styles will result in a significantly reduced purchase price.

Otabind

Otabind is a process of binding patented originally by Otavia Publishing in 1981 and now licensed by Gerard Hex poor. Basically, the books are gathered; glue is applied to the spine; then, the book block is capped covering only the glue. Next, the capping is side-glued and a cover is applied, adhering only to the side glue, detached from the spine. This process has been very successfully marketed as a "lay flat binding." By having the cover detached from the spine, the books have somewhat of a tendency to lay flatter, due to the lack of resistance of the cover glued to the spine of the book. The disadvantages of Otabind are that the binding equipment is very expensive, that the process requires the producer to purchase a license from the patent holder, and that generally it is compared to the pull and flex test of perfect binding. The greatest disadvantage is cost.

Adhesives

An adhesive is a material used for holding two surfaces together. An adhesive must wet the surfaces, adhere to the surfaces, develop strength after it has been applied, and remain stable. Adhesion is a specific interfacial phenomenon.

**Adhesion theory**

Several theories of adhesion exist which are based on surface-chemical phenomena. It is generally considered that there is no generalized, unified theory of adhesion since the phenomenon is known to exist between a great diversity of material types. In some special cases, either pure adsorption, or electrical or diffusion attractive forces are found at an adhesive-bound interface. More frequently, one finds adhesion to be a synergistic combination of all of these driving, attractive forces. This is especially true in the case of practically all adhesive bonding situations. Different types of theory are ;

(1) Electrical Theory (2) Diffusion Theory (3) Adsorption Theory

1) Electrical theory

This theory explains adhesive attraction forces in terms of electrostatic effects at an interface.

This is based on the phenomenon of a electrical double layer formed at the junction of two materials. At any boundary an electrical double layer is produced and the consequent columbic attraction might account for the adhesion and resistance to separation.

2) Diffusion theory

In this theory adhesion is attributed to intermolecular entanglements at the interface. This is applied to the union of high polymers the fundamental concept is that adhesion arises through the inter diffusion of the adherent and the adhesive. It is based upon the chain nature of the structure with the consequent flexibility and the ability of the chains to undergo Brownian movements on a sub-molecular scale. When the adhesive is applied in solution (most probably) and if the adhered is sensibly soluble in the solvent the substrate molecules will also diffuse to an appreciable extent into the adhesive layer. Overall the clean-cut boundary between the adhered and the adhesive disappears and is replaced by a layer representing a gradual transition from one polymer to the other. A major difference in this theory is that it implies a three dimensional volume process rather than a two dimensional surface process.

3) Adsorption theory

This theory regards adhesion as one particular property of a phase interface where in polar molecules or groupings will be orientated in an ordered way. The forces are initially involved in this mechanism are the van de Waals' forces - the orientation, induction and dispersion effects. If a molecule, which is large enough to contain a polar group and a non-polar part as separate and distinct entities, approaches an interface at which the dielectric constant changes it will orientate itself. It will move so that its non-polar part will be in the medium of lower dielectric constant and its polar part in the medium of high dielectric constant. This is the process that takes place in adsorption and must really take place if an adsorption theory is valid.

Factors that influence adhesion

Following factor is relevant for both permanent and removable adhesives. Humidity & Moisture, Surface Tension, Temperature storage and service conditions influence adhesion in a big way.

1. Roughness

A substrate's roughness or smoothness affects the contact area of the adhesive. If the substrate is very rough, contact can take place only on top of the 'hills' and the 'valleys' will not be in contact with the adhesive. The total contact area will be small and the resultant adhesion low. Accordingly, a permanent adhesive for rough substrates must properly wet the 'valleys'. This can be achieved either by raw material selection or by using a higher adhesive coat weight. For removable adhesives, rough substrates are undemanding. Removability is not a problem – it is very rare that the adhesion would be too high for a rough substrate. It is much more likely that the adhesion is too low, which results in labels that come loose from the substrate. It follows that the level of adhesion provided by a removable adhesive must be tested before its commercial application.

2. Humidity and moisture

Substrates are sometimes moist. This is a real challenge for the adhesive. Water based adhesives are able to absorb and therefore tolerate a certain amount of moisture they should not be abandoned without due consideration. When moisture levels prohibit their use, possible alternatives are hot melts and solvent-based adhesives. They are not affected by moisture because they don't contain water-absorbing substances.

3. Surface tension

Surface tension is the property that causes the surface of a liquid to behave as if it were covered with a weak elastic skin. This is why a needle can float on water, for example. The phenomenon is caused by the tendency of

exposed surfaces to contract to the smallest possible area. For the adhesive to wet the substrate there is a basic rule: the surface tension of the adhesive must be lower than or equal to the surface tension of the substrate to be labeled.

In other words, wetting occurs if the adhesive has a stronger attraction to the substrate than to itself. If this is the case, the adhesive flows onto the surface without difficulty, and it is easier for the adhesive to bond to the substrate. The surface tension of a substrate is also very important in the case of removable adhesives. The development of a removable adhesive that exhibits excellent long-term removability from substrates with a high surface tension is especially demanding. Problems may occur some weeks after labeling. This is because the surface tension of the adhesive is lower than the surface tension of the substrate, which leads to good wetting and increased adhesion with time, i.e. reduced removability.

4. Temperature

The properties of adhesives are affected by temperature. With various modifications, some adjustment can be made to an adhesive's application temperature range. At low temperatures, adhesives become harder. This decreases adhesion – particularly immediate adhesion. In higher temperatures, adhesives soften. This is the result of decreased internal strength. Softening may increase adhesion to a certain extent because it helps the adhesive to flow and the contact area with the substrate increases. However, if an adhesive gets very soft it begins to lose its adhesive properties. Also, an adhesive has a greater tendency to bleed as it softens.

Advantages of adhesive bonding

- Ability to join dissimilar materials like Paper-Paper, Paper-Board, Board-Board
- Fast and cheap joining technique
- Provides design convenience and flexibility
- Sealing properties (adhesive fills gaps and voids)
- Provides thin and invisible joint
- Joints may be electrically/thermally conductive or insulating
- Eliminates Galvanic corrosion
- Good vibration damping properties
- Uniform distribution of mechanical stress over the joint
- Good Fatigue resistance.

Disadvantages of adhesive bonding

- Requires careful substrate (adherent) surface preparation
- Long mixing and curing time may be required
- Importance of right joint design
- Difficult disassembly of joined parts
- Necessity to fixture (hold together) the joined parts during curing
- Service temperature and environment limitation
- Low creep strength
- Changing properties during service.

Stages of adhesive bonding

1. Assembly and joint design - Proper design provides minimal peel and cleavage stresses. Tension, compression and shear stresses may be increased.
2. Adhesive selection- Selection of a proper adhesive is based on the substrate material, service temperature and environment, requirements to the bonding strength, flexibility and durability.
3. Surface preparation- The substrate surfaces should be cleaned from dirt and oils, and then abraded. Clean and roughened surfaces provide good wetting of the adhesive, which results in strong adhesion.
4. Applying and spreading - A proper amount of the selected adhesive over the substrate surface. The operation is performed either manually or by means of dispensing devices.
5. Assembly - Of the parts to be joined.
6. Clamping - The parts in a fixture at a controlled pressure.
7. Curing - In the curing process the adhesive molecules are cross-linked forming a strong adhesive joint. Curing method depends on the adhesive type.

Applications of adhesive bonding

- Binding of books, cartoons, diary, magazine etc.
- Construction
- Electronics
- Telecommunications
- Automotive industry
- Furniture manufacture and other woodworks
- Medical devices
- Surgery (Bonding of tissues and bones)
- Textile industry
- Package materials (stickers, stick tapes).\

Perfect binding

A popular method of binding books printed with conventional & digital technology is perfect binding. It is one of the most automated of the binding processes, which makes it inexpensive. The low cost makes it an extremely popular choice for binding a variety of books. Perfect binding is used to bind many types of publications including Magazines, Catalogs, Paperback Books, and Telephone Directories.

Perfect binding can be divided into three categories according to the specific process that is used: Hot Adhesive, Cold Adhesive, and Thermal Binding.

1. Hot Adhesive Perfect Binding

Hot glue is the most widely used of the perfect binding adhesives. Books are usually 1/4" up to 2 & 1/4" thick depending on the thickness of the substrate. A major disadvantage with hot adhesive is that the book cannot lie flat when it is open. The binding will break if too much pressure is applied in attempting to make the book lie flat when it is open.

2. Cold Adhesive Perfect Binding

Cold glue is not used as often as hot glue because it is more expensive and requires more time to cure than hot glue, but it is stronger and more flexible. When the cold adhesive is used in conjunction with a scored and hinged cover, the book is able to lie flat when it is open and the binding will not crack. Books with cold adhesive perfect bindings range in thickness from 1/8" to 2 & 1/4".

1. Thermal Binding

Thermal binding is similar to the hot adhesive method of perfect binding in that adhesive and heat are used to form the binding, however, rather than using hot glue, an adhesive strip is used as the material for binding. Pages are fed into a machine where the adhesive strip and a wraparound cover are applied to the binding edge of the pages. Heat is used to secure the adhesive strip and cover to the page.

II. RESEARCH OBJECTIVE

The objective of this study is to reduce the consumption of adhesive along with the optimum utilization of adhesives and explore the possible ways of optimum utilization of the adhesives used in different binding processes in "Caxton offset private limited, of Hyderabad.

III. RESEARCH METHODOLOGY

The whole study has been divided in 3 sub parts to utilization of adhesives improve different binding works along with the cost, efficiency, coverage area & drying time, influence of binding process and influence of utilization of adhesive used in perfect binding.

The following methodology will be adopted during the study.

1. Study of different binding processes used in printing industries.
2. Study of the adhesives used in different binding works along with the cost, efficiency, coverage area & drying time.
3. Different jobs of the " Caxton offset private limited, of Hyderabad" during project work consuming moderate amount of adhesives will be selected and the study will be conducted on each selected job.

Data collection will be done during the study.

IV. FUTURE SCOPE

This research focuses on optimum consumption of adhesive and explores the possible ways of optimum consumption of the adhesive used in perfect binding processes in “Caxton offset private limited, Hyderabad”. In all three cases when check list get adopted number of wastage depending up on the job and machine availability. These preliminary results can be used in future. Check point suggestion incorporated in printing section on perfect binding machine after consultation with various press authorities may be indicative for other presses. They may modify, increase or decrease the factors to be considered.

To implement the suggestions properly we generate a check list in form of table to check the different factors before all jobs to be handled on particular Machine on daily printing. And the check point helps to reduce the consumption of adhesive along with optimum utilization of adhesive. The study may be concluded in a manner that, if all suggestion were implemented in matter of practice on perfect binding presses Machine, consumption of adhesive will go done along with controlled / minimized wastage.

However researcher feels that limited facilities or infrastructure was available in city like Hyderabad. The result may vary depending upon type of Machine/Technology, and skill man power.

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