DEVELOPMENT OF A NEW LAMINATION METHOD FOR MANUSCRIPT CONSERVATION

Abstract:

India has the largest collection of manuscripts in the world. The manuscripts are the repository of wisdom of great thinkers of the past and the present and they are priceless heritage of mankind as they preserve facts, ideas, thoughts and evidences of human development in multifarious areas, ages and directions. These valuable resources are indispensable to the present and the future generations. Any loss to such materials is simply irreplaceable. This rich manuscripts wealth of India today faces a threat of survival. They are deteriorating fast due to several climatic, physical, chemical and biological factors. Various government and non-government organizations have already started making conservation strategies to meet out these challenges. Therefore it is the moral responsibility of everyone to preserve these valuable manuscripts. In recent years, the awareness about conservation is created in India by Cultural Department, Govt.of India. The present paper deals with the chemistry of manuscripts, deterioration, various conservative methods available mainly in the curative method –with cleaning, deacidification, fumigation and Photolam System, a manually operated reversible type of lamination with specially processed polyester film and pressure sensitive adhesive.

Photolam System, a patented method for the conservation of manuscripts makes use of the specially processed polyester film coated with glue.This paper focuses on the patented system, its process, characterization and a comparative study with the conventional methods. The review summarizes scientific ideas and research pertaining to provide the context for evaluation of manuscript conservation's research information.

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Introduction

Old manuscripts, rare printed books, significant archival and alike material constitute our most precious national heritage, specially the manuscripts, written in several languages, scripts and in different materials. They are spread all over the country and also abroad in different libraries, museums, temples, monasteries and in private collections. Among the existing collection only a very small portion has been surveyed and documented. Thus it is very essential to adopt a technology that can make the collections more accessible.

Mostly all manuscripts are paper-based, so this review limits to conservation of paper. The important area of conservation of paper conservation can be divided into two parts: one is preventive method and another is curative method. In curative method, fumigation, washing, deacidification, mending and lamination can be placed under. The conservators are more concerned about long term physical properties of the all components of the paper composite including fiber and cellulose polymer chain. Regarding paper properties and the existing conservation methods are outlined first followed by synopsis of recent finding out paper conservation treatment by innovative Photolam System. The information in this is highly selective and condensed representing only a small portion of the research data with permission from the patent holder.

Paper Manufacture:

Before 1850 A.D, papers were manufactured from cotton and linen fibers. They show permanency in their property, stability and low degradation properties. Nowadays, since 1850, a high percentage of the papers used in publishing have been made out of wood pulp. This contains lignin, an ingredient, which makes the paper to the extent of discoloration and disintegrations. In addition, the paper is coated with alum which is used to create a water resistant surface to the paper. This alum is an acidic substance which also causes the paper to self-deterioration.

Parameters for Paper:

The parameters for paper are selected into following headings.

1. chemical properties
2. physical properties
3. optical properties

These properties are derived from the following:

1. Furnish variables: fiber type, pulp stock refining techniques such as bleaching, coloring, coating, etc.
2. Formation variables: basic weight (gsm) and calendaring.
3. Manufacturing variables: speed, drying and fiber bonding.

Chemical properties:

1. **Degree of polymerization of the cellulose chain**: decreases by hydrolysis and oxidation and leads to chain scission. Increases by cross linking that can be determined by viscosity measurements.
2. **Acid content:** measured by pH measurements and alkaline reserve titration.
3. **Moisture content:** measured by gravimetric titration.
4. **Alkali solubility**: includes measurements of carbonyl content by solubility test.
5. **Functional groups:** measured by Raman and Ultrasound Spectroscopy techniques

Physical properties:
The physical properties of paper are determined by density, thickness, basis weight, smoothness, two sidedness, rigidity, permeability, roughness, handling, softness, porosity, dimensional stability, curl, strength (edge tear, internal tear, tensile and burst strength), etc.

Optical properties:
Optical properties of paper are the physical properties which often monitored as an indication of chemical changes. These include brightness, gloss, transmittance of light, opacity, reflectance, whiteness, transparency, color and fluorescence.

In general these properties of paper are **interdependent.** The properties are in turn affected individually and collectively by environmental parameters and also by conservation treatments.

Deterioration:
Deterioration is the change of original state of any material by interaction between the objects and the factor of destruction. The types of deterioration of paper material are reflected in usual wear and tear, shrinkage, cracks, brittleness, wrapping, infestations, discoloration, abrasion, hole dust and dirt accumulation.

Agents of deterioration and destruction:

- Environmental factors: like light, temperature and humidity, dust and dirt, pollution, water and fire.
- Biological factors: microorganisms like fungi, bacterial insects, silver fish, cockroaches, bookworms, book lice, termites, rodents, etc.
- Chemical factors: formation of acids in paper.
- Human factors: like handling and improper stacking, theft, etc.
- Natural Disasters: like floods, earthquakes, etc.,

Present Scenario:
Libraries have long been aware of the magnitude of the problem of acidic paper; sometimes referred as "**brittle paper"** and the effect this has no access to collections. Literally speaking, millions of books and documents are disintegrating on library shelves. **The paper is so fragile that the items can no longer be issued for consultation**. It is clear that if these threats remain unchecked, it has the potential to lead a massive loss not only on information but also on heritage material. It is essential to tackle the problem. In order to prevent this deterioration International Standard Organization (ISO) during 1994 arrived standard to use **"permanent paper"** for publishing **(ISO9706).** This will help to increase the life period of paper, published after incorporating these standards only.

It is to be noticed that this will not help to the issues already discussed above as '**brittle paper'** and those books and documents which are lying in the library shelves and are not issued for any consultation. In this context, we must think of conservation treatment to those documents, books and brittle paper. The conservation treatment should protect the '**brittle paper'** from further decaying and extent the life period.

Conservation:

In general paper conservation can be measured in two ways.

1. Preventive measure.(passive way)
2. Curative measure.(active way)

Preventive Measure:

Preventive measure is to take all the steps required to preserve the document by external ways. The preventive measure can be generalized under three headings:

1) Storage
2) Good Housekeeping
3) Pest control.

Some of the examples for preventive measures areas follow:

- To protect from light, heat, fire, etc. the library building architecture should be drawn and built accordingly.
- The control of dust, air, dirt and moisture inside the library room should be properly maintained and periodical housekeeping and cleaning is necessary
- To maintain relative humidity and temperature, air conditioning should be used.

These preventive actions will help to extent the life period of paper to some extent only. And due to improper care and natural properties of paper it automatically degrades and become '**brittle paper**'.

As already said, the properties of papers are interdependent due to environmental, ageing and other factors mentioned above, the paper substance structure collapsed and it becomes fragile and the need of curative conservation arises.

Curative Measure:

Curative measure consists of all forms of direct action aimed at the life expediency of damaged or undamaged elements of cultural property (paper document). It includes the following.

1. Washing and Cleaning
2. Deacidification
3. Fumigation
4. Mending
5. Encapsulation
6. Lamination

Washing and Cleaning:

Due to dust and dirt, the documents become brittle which are to be cleaned first. The washing can be done by the following methods.

1. For manuscripts, which are written by water-soluble inks, we can use rectified spirit (alcohol) for cleaning and washing.
2. The insoluble ink materials can be washed and cleaned with distilled water and steam water bath.

Deacidification:

Due to acid formation and acid content, paper documents get decayed, to test the life period of paper deacidification is necessary. Deacidification is explained here by three methods as follows:

a.) **Aqueous deacidification** in which affected paper is immersed in or brushed with an alkaline solution or suspension until the acidity neutralizes. In general, magnesium bicarbonate solution is recommended as most effective.
b.) **Vapour phase deacidification:** This employs chemicals in gaseous forms to neutralize the acid. This method is an easier to use and offers greater productivity either of the immersion process.
c.) **Mass deacidification:** methods are being developed in number of countries, but are still in the developmental stage-all require expensive plan**,** mostly these are likely cost effective only where a high volume of work can be foreseen.

Fumigation:

Due to biological factors, the paper documents are deteriorated. To eliminate 100% the above said microorganisms, insect, etc., a fumigation treatment is necessary by appropriate chemicals.

Thymol is longer preferred chemical for fumigation. For this, we need a chamber. Nitrous oxide gas can also be used.

Mending:

1. **Chiffon cloth mending**: In this system, chiffon cloth and Maida paste are used. Since the paste is soluble in water we cannot recover the documents from floods. Eaten away by moths also unavoidable, this makes the documents more brittle. Woven material like chiffon cloth is used here. The thread will come out often and struck to each page is not avoidable.
2. **Tissue paper mending:** Here also, tissue paper of different variety is used. Cellulose acetate foil and acetones are used. This is also a kind of paper material and has the same properties of a paper and susceptible to deterioration as the above said method.

Encapsulation:

This is the method adopted and approved by International Organization for conservation of paper documents. In this system, only polyester film is approved. The system can be done by placing the document in between two bigger size polyester films, and their four sides are to be sealed either by double sided tape or by machinery methods. Encapsulation is not advised to be used for very fragile documents. The air in between the document and the polyester film will react with paper (hydrolysis/oxidation) and degrade the paper still further.

Lamination:

1. Most of the lamination processes are **irreversible.**
2. PVC and BOPP materials were used for lamination. These materials have high air permeable capacity. The air passes through this will create oxidation, which will degrade the paper composition.
3. Struck to each page in ageing will occurs.
4. The color change to the subject will occur easily.
5. These materials are laminated by heat process. The heat will affect the paper structure.

Due to the above reasons, conservators decided to reject the lamination process for conservation purpose.

PHOTOLAM SYSTEM:

Going through the paper manufacture, its structure, physical, chemical and optical properties and its deterioration nature due to environmental, ageing and its conservation methods to extend life period. Now we can discuss about the conservation method namely '**Photolam System'** a reversible type manually operated lamination system and how it will protect the paper document.

This system consists of three main products:

1. Photolam liquid 101 for cleaning and deacidification.
2. Photolam sheets for protecting documents.
3. Photolam liquid 102 for reversing.

Requirements for the complete protection of paper:

To safeguard a paper material it should be covered by a **Non-Destructive Type** (NDT) material. The NDT material should protect the paper from the following:

- direct air and dust
- light, heat
- water simultenancy, moisture and biological ingredients like bookworms, termites, etc;
- disasters like earthquakes, floods
- acidic conditions
- Usual wear and tear. (Tear resistance)

After protection from the above factors, the NDT material should satisfy the following needs:

- Possible to reverse and get back the original as and when required. (**Reversibility**).
- Give high optical resolution.
- Special coating so as not to stick to each page on ageing.
- Help in reformatting.

To keep in mind the existing methods and its drawbacks and also the above mentioned points, a manual lamination system with specially processed polyester film as protective cover and special glue coated on its one side has been evolved. The system named as '**Photolam System**'.

Photolam liquid 101 (cleaning-deacidification):

This is a special liquid to clean the surface of paper without damaging to the printed ink or any ink written matters of the manuscripts. This will act as a deacidifying agent. It is fully alkaline and the test result indicates.

a.) Its pH is ……. 13.29
b.) Its chloride content….. 2.91%
c.) Its sulphate content…… 0.016%

Polyester film and its properties:

Photolam film is a biaxially oriented, thermoplastic film made from ethylene glycol and dimethyl terephthalate (DMT). It is one of the most environmentally safe polymer products made today.

Balance of Properties:

The polyester film has a unique combination of **physical**, **chemical**, **thermal**, and **optical** properties:

Film thickness: 15-22 micron
Tensile strength: 39.2N/10mm width (ASTM D882)
Percentage Elongation: 175.00 (ASTM D882)

It has very low air permeability, rich in elongation, good heat barring property, water resistant, tear resistant, non absorbent to dust and NDT material. It has high bonding molecules and has low degradation property than paper. Special coating like waterproof, antiglare, reflective, heat retardant, non sticky coating is done on one side of the film. **Research is on the way to produce fire proof polyesters films**.

Adhesive:

It is copolymer of acrylic and cellulose along with vinyl acetate monomer (VAM). It has high viscosity and low crystallinity property, so it has nondrying capacity (high ageing character).
The specifications are:

1. PH - 7.80 ± 1
2. Viscosity RVT/5/20/30˚C - 40-60
3. Film Clarity - Clear glossy and bit free
4. Solid at 105˚C for 3 hrs - 55±1%
5. Appearance - Milky white emulsion
6. Flammability - Nonflammable
7. Toxic - Nontoxic, non hazardous under normal condition.

Photolam Liquid 102 (Reversing):

This liquid is used to reverse the Photolam System process. The liquid consists of acetone, kerosene, hydrocarbon and ammonia in a calculated percentage. This helps in deactivating the adhesive bonding with the paper and releases the original document. It is a volatile alkaline liquid so that the released Photolam film can be reused again.

Process:

1. The glue coated polyester film (Photolam system film) is released from the pouch.
2. The document is placed on the table.
3. Then the film is slowly left from one side so that the adhesive coated side gets laminated to the paper. (no need of heat or any external factor to bond)
4. The other side of the paper is then placed and the same procedure is followed.

Justification:

Damaged or undamaged paper is cleaned, deacidified, fumigated, is protected by '**Photolam System'**. Now we justify the Photolam protection by the following:

1. Since it is a manual process, it'll be suitable for most brittle documents.
2. Since it is a reversible process, we can delaminate and get back the document as and when required.
3. The special coating, heat retardant will protect the document from heat.
4. The water resistance coating will protect the document from water simultaneously from moisture and microorganisms and also aid to recover document from natural disaster like flood.
5. Since it is a NDT material, it'll protect the document even if buried or while collapsing of library building occurring due to disaster like earthquake, bomb-blast.
6. Its antireflective coating protects the document from light, especially UV rays.
7. Polyester film's low air permeability protects the document from oxidation, hydrolysis and other chemical factors.
8. Polyester film's smooth surface protects the document from direct action of dust and dirt.
9. Also polyester film's high strength protect the document from Handling (wear & tear)

10. Any microorganism or bacteria formed will be on the top of the film only that can be swept off easily.
11. The admixtures like neem, camphor, are added with selected proportion with glue, which will kill the biological factors.
12. The glue's pH is 7.08 which show its neutrality.
13. The glue's strength is reduced by reversing liquid, so reversibility is possible.

Scientific Justification:

As already mentioned, the properties of paper are inter-dependent, the **Photolam System** is tested by optical testing method – (Light fastness test as per **IS 101(part4 sec-3)-1988**- with **Atlas Weatherometer-Xenon lamp**. Test certificates of **National Test House** No: CM/01-02/80, CM/01-02/80A & CM/01-02/80B dated 21-08-2001) which correlates the physical and chemical properties. And the test result reveals the fact that the Photolam laminated documents will extent the life period of paper documents.

Conclusion:

India is very rich in its age old, rare and valuable manuscripts collection. The most important and precious information is stored in these resources. Preservation of these resources is really a very difficult task, in tropical and sub-tropical countries like India. The emerging technology like Photolam System becomes cost effective and planned efforts in preserving the knowledge embodied in the manuscripts and rare collections may help to a considerable extent for the preservation of ancient thoughts and use them as and when required.

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