Aging of paper

The necessary material requirement for protective packagings to prevent paper decay

Description:

The main reasons for the premature decay of historical collections of paper and board documents are well known. The hydrolytic division of the basic content of paper „cellulose" is the key cause for its premature decay. The influence of acidic compounds on the material during production causes a catalytic reaction that activates the hydrolytic decomposition (degradation) of cellulose. During the process the cellulose molecules get depolymerised, and at an advanced stage the cellulose fibres lose their tensile strength. Since the introduction of acidic resin sizing in 1850, which was used as a substitute for aluminium sulphate $Al_2(SO_4)^3$ based sizing, a vast amount of paper documents have been affected by cellulose degradation.

In this case one talks about the G. Dessauer (1980) endogenous causes. In addition to the acidic catalysis of cellulose, the material is simultaneously entirely exposed to an oxidation process, which due to the low concentration of transitional metallic ions (such as Cu^2+, Fe^2+, Fe^3+) produced during the production process, gets accelerated. A critical point during the paper and cellulose manufacturing processes are the restricted or totally closed water cycle chains, which increase the organic and inorganic reactions in water, and therefore are able to penetrate stronger into the produced paper or cellulose pulp.

Reactive and harmful impurities can also occur and act as atmospheric pollutants. They get absorbed by either paper or board and depending upon their composition they can induce hydrolytic and/or oxidative degradation processes. These so-called exogenous controlled degradation processes are basically caused due to external atmospheric conditions, mainly due to sulphur dioxide (SO_2) and nitrogen oxide (NO_x) prevalent in the atmosphere, but also due to damages caused by dust.

The technological development in the paper industry has made it possible to produce permanent, age-resistant paper and board quality products. This refers specifically to the chemical aspect and the physical durability of paper and board.
In the case of uncoated papers special norms and standards have been developed (ANSI Z 39.48, 1984, ISO 9706, 1995), in which not only basic requirements for the mechanical strength (tensile) of the paper but also the material composition for durable paper used in the print industry has also been defined. Accordingly, permanent and durable age-resistant papers must meet the following criteria:

- The paper must be free of unbleached cellulose pulp or wooden fibres. Thus pulp or semi-pulp fibre materials can be excluded.
- The paper must possess a low content of oxidisable material, which is indicated by the kappa number.
- The paper must have an alkaline buffer – an alkaline reserve – of at least 2 % natural calcium carbonate.
- The pH value in the cold water extract must lie between 7.5 and 10.

These material standards enable consumers, at least in a limited way, to check and review the permanency and durability of paper. In terms of a cost reduction of future conservation measures, private collectors are expected to choose preventive materials for their wrappings and packaging of the collection items which are in accordance to the respective norms and standards, so that the usage of non-age-resisting materials, for example recycling paper possibly does not get used to wrap or cover collection items. Interestingly the controlled concentration limits set for the existing transitional metallic ions in the paper are not due to the norms, even though they are considered highly oxidative catalysts that are significantly responsible for the degradation of cellulose and aging of paper and board materials. This factor is currently the main aspect being surveyed in the overall assessment of permanent and age-resisting uncoated printed paper.

Presently the permanency and age-resistance of coated papers is not covered by national and international standards (norms). Even though in the case of coated paper production most of the raw materials used are in accordance with the norms and standards for paper permanency, but however, the actual carrier and cause for the decay of paper/cellulose degradation are found in the pigment layer base of the paper and in the binding/adhesive material used. At the moment there is no reliable data source regarding the age durability/permanency of this pigment layer and the binding material used. Relevant research in this field is hardly known. Considering the fact that today more and more coated papers are being used for archive documentation and in terms of cost reduction of preservation and conservation measures for archival objects, it would be advisable to undertake more research in this field.

Besides the material composition, the most crucial factor responsible for the aging behaviour of paper is the consistency of the climatic condition, which the paper or board material is exposed to while being stored in magazine spaces. Technological research has shown that even pulpy paper with a high acidic content, definitely if stored climatically correctly – under constant temperature and relative humidity in accordance with the norm standards – were highly durable and age-resistant.

On the other hand, J. Hofenk de Graaff (1994) proved that paper and board qualities with material compositions that fulfilled the standards for paper permanency, if not stored correctly, especially if they were exposed to periodic climatic conditions, they would not meet the set norm regulations.

Accordingly, it should be noted that the crucial prerequisite for the durability of paper and board material are stable and consistent climatic conditions.

Principally one can affirm the question of whether protective wrappings or coverings offer active protection for collections items. The prerequisite is that the covering material used for archiving or storage in chemical terms is inert and compatible with the material of the object being protected.

Ms. A. Haberditzl (1992) has summarized the main points for protective packaging of stored or archived objects:

- Any library or archive object without a cover requires a protective packaging that encloses the complete object.
- Proper packaging of archival and library objects offers excellent conservation protection and can extend the durability tremendously.
- Improper protective packaging, even under ideal storage conditions, leads to the decay and degradation of the stored object.

Protective wrappings and coverings not only protect the collection items against atmospheric pollutants but also help regulate the room climatic fluctuations which also influence the preservation of the stored item. While protecting archival objects, primary importance should not be laid on the wrapping or covering making sure that it is durable, but more significant is the fact that the material of the wrapping or covering absorbs the transferable atmospheric pollutants and humidity and makes them inactive, like for example sulphur dioxide ($SO_{2)}$), nitrogen oxides (NO_x), chlorine compounds, hydrocarbons, infact even fine dust particles can through the atmosphere surroundings harm the stored object. But all these scenarios can only take place if the harmful pollutants penetrate through the protective packaging.

A protective packaging must be designed in such a way that the necessary mechanical protection of the stored items is ensured and that penetration of the finest and partly catalytic dust particles is prevented. In addition, due to thier chemical composition they also, at least for a certain period, ensure that intruding gas pollutants are also absorbed.

Currently, hardly any discussions are being held concerning the possibilities for further development of protective packagings. The requirement for further research in this field, particularly in the development of economical protective packagings that provide the necessary protection of the stored objects, is very necessary. Additional research opportunities are also possible, for example by trying to introduce materials which absorb and bind less contaminants. Upgrading paper or trying to produce a more refined paper with additional protection features, for example against mold infestation, is technically also possible.

Literature:

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