Simple anoxic storage for textile collections in Bhutan

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Abstract

In 2005, the first anoxic storage system was established at the Textile Museum in Bhutan. The goal was to create a cost effective and protective environment for the textile collection. This system isolates textiles into oxygen free microenvironments and protects from insects, aerobic biological threats, and dust. The system remains active on a long-term basis, and is being monitored with the oxygen indicators and observation. This small scale experiment has accomplished the goals of protective storage and expanding the program of preventative conservation at the Textile Museum. This sets a successful example for other museums in the country, as well as providing options for extensive pest eradication for a variety of cultural artifacts. The anoxic storage technique heralded the first time use a high tech system in Bhutan for cultural protection.

Résumé

En 2005, le premier système de stockage anoxique a été mis en place dans le Musée du Textile au Bhoutan. L'objectif fut de créer un environnement protecteur et rentable pour la collection de textiles. Ce système isole les textiles dans un microenvironnement sans oxygène, et les protège des insectes, des menaces biologiques aérobies et de la poussière. Le système reste actif à long terme et est surveillé à l'aide d'indicateurs d'oxygène et par l'observation. Cette expérience à petite échelle a atteint les objectifs du stockage protecteur et élargi le programme de la conservation préventive au Musée du Textile. C'est un exemple de réussite pour les autres musées du pays et fournit des options pour une éradication des insectes nuisibles applicable à divers biens culturels. La technique de stockage anoxique a annoncé la toute première utilisation d'un système de haute technologie au Bhoutan destiné à la sauvegarde culturelle.

Synopsis

En 2005 se inauguró el primer sistema de almacenaje anóxico en el Museo Textil de Bután. El objetivo era crear un ambiente de protección eficaz y a bajo costo para la colección textil. Este sistema aísla los tejidos en microambientes anaeróbicos y los

Keywords

textile storage, Bhutan, anoxic, micro-climates, low tech, pest eradication, barrier film, Ageless®, Escal®

Introduction

In 2005, Julia Brennan led a Textile Conservation Training program at the National Textile Museum, Thimphu, Bhutan. The project's primary goal was the augmentation of the storage facility into a protective environment by creating anoxic micro-climates for the long term preservation of textiles. This system isolates the textiles into anoxic (without oxygen) microenvironments, and protects from insects, aerobic biological threats and dust. It was a bold step, as anoxia has not been thoroughly tested for long term storage of textiles. But the low cost and minimal risks seemed to outweigh the ongoing damage sustained by textile collections due to environmental conditions. Its success is the adaptation of a highly developed yet low tech system into a very traditional culture where climate control and long term preservation is an enormous challenge. This is a major step towards protecting vulnerable national collections and a ground breaking effort in Bhutan.

Julia Brennan has conducted three preventative conservation training workshops in Bhutan since 2002. A major component of each project is upgrading the museums storage facilities and protecting religious textile relics. This is challenging in a country which has extreme outdoor climate changes, and consistently damp and cold interior conditions. Electricity is erratic or non existent in monasteries, windows and doors porous, and mold and mildew, endemic. In addition, much of the textile material is protein based, and extremely susceptible to infestation. Over a period of five years of training, little progress was made to effectively reduce continued damage from mold and insects. Freezing, fumigation, and trapping was done with limited success for entire collections. Use of desiccants was not practical for large damp spaces. Dehumidifiers and equipment to control temperature and relative humidity in overall rooms was out of project capabilities and budget. Until the implementation of the anoxic storage in 2005, many textiles stored on open shelves, and wrapped in local mulberry paper or plastic, had sustained mildew and pest damage.

Methodology

There had to be a cost effective, simple and safe solution for long term storage of textiles in this challenging climate! Research for the anoxic system was done through technical searches, and in consultation with other private and institutionally based American conservators as well as with suppliers Jerry Shiner of Microclimate Technologies International and Keepsafe Systems and Christoph Waller of Long Life for Art. Basic anoxic technology originates from the agricultural and pharmaceutical industries and has been adapted for museum use. Several published conservation studies from the 1990's explore the use of short term anoxia for pest management (Burke 1992, 3; Daniel *et al.* 1993a). These experiments were successful for pest eradication and functioned for a variety of historic materials (Daniel *et al.* 1993b). In fact, protege de insectos, amenazas biológicas aeróbicas y del polvo. El sistema se experimentó durante un largo periodo en el cual se controló periódicamente sus niveles de oxígeno y se hicieron observaciones de la reacción de los artefactos. Este experimento a pequeña escala resultó exitoso en la intención de crear un almacenaje con un adecuado nivel de protección y en extender el programa de conservación preventiva en el Museo Textil. Este resultado genera un exitoso ejemplo para otros museos en el país, así como ofrece opciones de erradicación de extensas plagas que afecten una amplia variedad de artefactos culturales. La técnica de almacenaje anóxico inaugura el uso de un sistema de alta tecnología para la protección del patrimonio cultural mueble en Bután.

North American textiles conservators were made aware of anoxic storage for the preservation of rubber artifacts as early as 1988 (Grattan). Textile color technologist Eugene Chevreul discovered that an anoxic environment might affect Prussian Blue and turmeric (Chevreul, Rowe). Recently The Tate Conservation in London published early data on research into the effects of long term anoxia on works of art on paper, and the pigments and dyes. This work is ongoing and will contribute important findings to the future applications of anoxic storage of artifacts (Hackney *et al.*).

The basic principles of anoxia were highly suitable to the needs of the project in Bhutan. The heavy plastic barrier film envelope remains an effective physical barrier even if the oxygen levels within the enclosure rise. The enclosure protects the contents from water damage and smoke. Both are prevalent causes of deterioration in Bhutan's homes and monasteries. Moreover, the packages would protect the actual artifacts from excessive handling, skin oils and soiling. Because this system would effectively "seal up" the artifact in transparent film and not permit free access or handling, the need for building a photographic and detailed database was part of the overall project. A good database, a by-product of the anoxic storage efforts, was another critical tool for the preventative care of the collections.

The goal of the project was simple – to create constant and reduced oxygen environments. This was done by making a sealed environment and displacing the air or oxygen in it with an inert gas. If the level of oxygen is maintained at less than 0.05%, then pests cannot survive, and most other aerobic biological growth is destroyed or halted, (Burke 1999) Oxygen scavengers or absorbers can be left inside the sealed system to ensure that any additional oxygen is consumed. The anoxic storage system seemed to be a cost effective answer to many problems encountered with the long term storage and security of textile artifacts in Bhutan.

Materials

Six supplies are needed to implement the anoxic microenvironments:

- Barrier film (multi layer laminate film)
- "Ageless" ® Oxygen Absorbers/Scavengers (ferrous oxide, chloride salt and a humectant)
- "Ageless" ® eyes or indicators (optional)
- Heat Sealer
- Nitrogen gas & regulator
- Vacuum cleaner.

Barrier film, Escal®

The barrier film used for this project is called Escal® and manufactured by Mitsubishi Gas Chemical Company. It is a multi-layered film which severely limits the flow of oxygen and moisture through the film. It is similar to the bags used for food storage, such as potato chips. The composition of a barrier film is critical to effective sealing. Generally the outer layer is made of a strong plastic with a high melting point, such as polyester, nylon, or polypropylene. The middle layer or barrier of Escal® is made of a transparent layer of vacuum deposit ceramic material. The inner layer is a low density polyethylene which melts at low temperatures. There are a variety of films to use for the purposes of anoxic applications. Available literature outlines the oxygen transmission rate (OTR) that is best suited for the specific project. Other important criteria are the length of time for maintaining the micro climate, cost, object visibility through the film, and type of system to be employed (Dynamic, dynamic-static, static) (Burke 1992).

Ageless®

Ageless® is the oxygen absorber, manufactured by Mitsubishi Gas Chemical. It consists of Ferrous oxide, a chloride salt and a humectant sealed into a small sachet or bag. The type of Ageless® used for this project was Ageless Z 1000®, effective at a relative humidity between 35% and 85%. Ageless® is less effective in very dry climates, and this is may be draw back. The absorbing capacity is represented by the number of the product, such as Ageless 100 or 1000®. It refers to the volume of oxygen absorbed in hundreds of milliliters (Burke 1992). Ageless® does not need to be refrigerated when not in use. It is recommended to use two to three times the amount of Ageless® than actually calculated. This will prevent failing systems. The use of nitrogen purging will substantially reduce the amount of Ageless® required (Grattan, Gilberg and Grattan).

A basic calculation is used to determine how much Ageless® is needed for specific volumes of microenvironments.

Volume of bag in cm (L × W × H) – weight of object in grams/5 = ml of oxygen in bag or, about six Z 1000 sachets per cubic foot (Burke, 1999).

Ageless Eye®/indicator

The Ageless Eye® or indicator is a small tablet which turns from pink to purple when the oxygen levels exceed 0.05%. It is taped into the inside of the microclimate bag. The tablet is the simplest tool in monitoring the stability of the microenvironments. But it is not fool-proof, as it will become exhausted over time, or due to exposure to heat or light, and has a shelf life of only six months if kept at cool temperatures.

Heat sealer

The *most* important part of the anoxic micro-climate system is the impermeability of the system. Therefore, microenvironments need to be carefully designed and constructed. The bags or containers *must* have effective seals. The barrier films need a wide seal in order to prevent lateral leakage through the inner layer material. The selection of a reliable, wide-seal model (minimum 1 cm) is essential for long term systems. There are excellent low techs, easy-to-use, hand-held sealers available with wide sealing capacity. Impulse sealers for plastic bags are usually not adequate.

Procedure

Figure 1. Removing oxygen from film bag with vacuum and Y hose

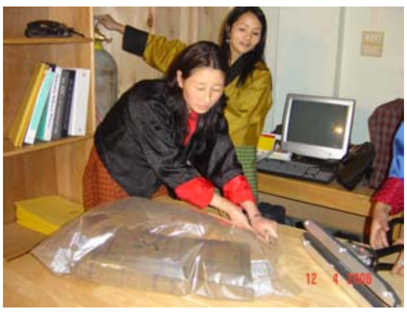

Figure 2. Purging the bag with nitrogen

Three essential supplies were brought to Bhutan. The Escal® barrier film, Ageless® oxygen scavenger and a 220 V adjustable heat sealer were imported from Japan and Germany. The vacuum cleaner was purchased locally. Nitrogen tanks and a two-stage regulator were acquired from Phuntsoling, the major dry port city in southern Bhutan. The task of assembling the local equipment for the purging posed a challenge, and ingenuity played an important role. Extensive sourcing and assembly finally yielded the simple but sophisticated Y-hose and valve system made of all local parts. Working with a skilled plumber or mechanic will help in constructing an effective injection hose apparatus.

A small bore hose is used to remove air from the bag and inject oxygen. The hose can be as small as ½ inch/12 mm in diameter, and about 3 ft/1 m long. The insertion end may be cut to a 45 degree angle to make insertion easier. The other end is permanently connected to both the vacuum cleaner hose and the nitrogen source. A variety of methods and materials may be used to construct this system.

Six museum staff were trained in the exacting techniques of this system. First, each textile was evaluated, photographed and catalogued, creating a valuable database. Fragile textiles or artifacts were boxed to protect them from any pressure of the film. Textiles were aired outside (low winter humidity) or in a room overnight with a heater, to ensure complete dryness. Work proceeded in batches of textiles, for efficiency and the use of complete containers of Ageless®. (Ageless® has a short shelf life when exposed to full

Figure 3. Purging the barrier film with nitrogen

Figure 4. Detail of sealing

Figure 5. The finished film bag with Ageless packets and eye

oxygen, so has to be placed in anoxic housings immediately.) Pillow shaped bags were made of the Escal in advance, leaving one side open to insert the textile. Escal® fuses at about a temperature of 117 °C. Many samples and tests were performed to perfect the protocol and ensure airtight seams. Perfecting the technique of heat sealing is *essential* before committing costly materials.

Textiles were folded a minimum number of times to prevent excessive creasing. Folds were padded out with imported polyethylene rods or locally made mulberry paper. Smaller textiles were laid flat, and hats, shoes, crowns and accessories were prepared in advance with interior supports or boxes. Accession numbers written on large acid free index cards were placed in the bag. At this time, the appropriate number of Ageless® packets for the size/volume of the bag was inserted. The Ageless® packets were placed inside the bag, but not directly on the textile. Then the final side was sealed, leaving a 1" diagonal gap at one corner for the purging.

First, most of the air containing oxygen was removed using a vacuum cleaner attached to one end of the injection hose. The removal of the oxygen causes the bag to compress down on the textile and nearly "shrink wrap" it. Once much of the air was removed, the vacuum is turned off, and the nitrogen source is turned on to fill the envelope to a suitable level. Alternatively, to save nitrogen, valves can be inserted on the injection hose. The nitrogen brought the volume of the bag up enough to ensure that the film was not crushing the artifact. The completed bags were stacked four high on shelves, or placed in drawers or cabinets. Since the Escal® is transparent, it is important to use a curtain on storage furniture to prevent light deterioration of the textiles.

Ageless Eyes® or oxygen indicators were placed inside of the completed bags to monitor the effectiveness of the system. Flushing with nitrogen assisted in bringing the oxygen level to less than 0.05% while reducing the need for Ageless® sachets. In addition, it added volume to the bag, preventing crushing of the textiles. This is very important for most artifacts. The artifacts are visible through the film bags, and bags can be easily opened and resealed. This system can also be done without gas purging, but the calculations for the amount of Ageless® are different and the entire system much less reliable for long term storage.

Findings and future applications

In order to implement this storage system, approval had to be granted by the Textile Museum Patron, Director and Curator. Essentially, the anoxic packaging renders textiles inaccessible. Film bags have to be cut open to provide physical access for examination, and then either re-sealed (this can be done a number of times, until the bag is too small), or new bags made and the artifacts repackaged. (In two years, 24 bags have been opened and re-sealed.) In other institutions, this may not be acceptable to curators, visiting scholars or conservation staff charged with managing the system. However, in Bhutan, decision makers recognized that the benefits of this preventative conservation program greatly outweighed the inconveniences.

Fifty textiles were re-housed into microclimates during the 2005 training period. Purging with nitrogen was essential to the success of the system, as it created full volume bags for delicate textiles and better ensured the 0.05% oxygen level aimed for. Moreover, it cut costs for additional Ageless® and assisted in the long term goals of anoxic storage. The Textile Museum staff continues the anoxic work, and has packaged 110 textiles. Ageless Eyes® were installed in about half of the packages. To date, there have been nine incidents of failure. The influx of oxygen can only be proven with an oxygen meter or some other invasive test.

The goal is to re-house the complete collection (about 700 textiles) and share the technology with other institutions in Bhutan. The system remains active on a long-term basis, and is being monitored with the oxygen indicators and regular observation. Since this is the first test of anoxic technology for long term storage, its success is dependent on the precision of the system and the test of time. In 2008, Julia Brennan will return to train at the Textile Museum and continue the implementation and testing and evaluation of the anoxic system in at the Textile Museum and Bhutan's monasteries.

Implementation of the anoxic system in monasteries poses theological challenges. The religious artifacts are objects of devotion and are used. Therefore, there may be resistance to the "sealing up" of living artifacts. In a real sense, the technology interferes with long time religious traditions, rituals and daily use. The success of this system in religious institutions rests on the dialogue between the Textile Museum and the religious authorities. The balance between tradition and technology is at the crux of this project; respect for and understanding of the religious prescriptions coupled with the acceptance and understanding of long term preservation will be introduced. The technology may then be imparted to monk caretakers and a professional support system put in place to assist with re housing and protecting textiles in rural areas. The results and application of the expanded anoxic storage work conducted in 2008 will be part of an updated conclusion to this paper.

Conclusion

This small scale experiment has accomplished its short term goals of protective storage and expanding the program of preventative conservation at the Textile Museum. The anoxic system has been adopted, well executed and will be expanded in 2008. This sets a successful example for other museums in the country, as well as providing options for extensive pest eradication for a variety of cultural artifacts. The anoxic storage technique heralded the first time use a high tech system in Bhutan for cultural protection. The scientific novelty was championed in the local press and by the government agencies. (Dorji) Ultimately, its success at the museum will determine its broader application in the future to protect other urban and rural religious collections.

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Materials

Ageless® Oxygen Absorber Z 1000 and Indicators
Keepsafe Systems
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Toronto, Ontario
Canada M5V 1M3
Tel.: +416-703-4696
Website: www.keepsafe.ca

Barrier Film, Escal®
Keepsafe Systems or regional Mitsubishi Gas Chemical Distributor

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Tel.: +49-(0)-7663 608 99 0
E-mail: info@llfa.de
Website: www.llfa.de

Nitrogen Gas and Regulator
Contact local hospital or industrial gas supplier

Vacuum Cleaner, with rheostat
Contact local supplier