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Passepartout: Properties, Performance, Packaging: Reevaluation of an Environmental Package for Traveling Works of Art on Paper

ABSTRACT

In the 1991 *Book and Paper Group Annual*, Victoria Blyth-Hill presented an article, "Passepartout (Stabilized Humidity Control Package)," which discussed the use of a desiccant sheet in a sealed package for traveling works of art on paper and the method of its assemblage. This package method has since been used at the Los Angeles County Museum of Art (LACMA) for maintaining a controlled environment around a work of art on paper during transport. However, the efficiency of the method had only been monitored by visual observation of humidity indicator strips.

In a recent project, experiments were conducted to address several questions regarding the performance and efficiency of the passepartout package under various conditions. These experiments were also designed to assess the necessity of a desiccant and the longevity of the package under extreme conditions.

The data compiled suggest that sealed packages, both with and without a desiccant, maintained acceptable relative humidity after they were subjected to extreme conditions during the test period; whereas unsealed packages closely followed the relative humidity of their exterior environment.

INTRODUCTION

Over the last fifteen years, the paper conservation laboratory at Los Angeles County Museum of Art (LACMA) has been sealing all works of art on paper leaving the museum in travel packages based on Victoria Blyth-Hill's 1991 article, "Passepartout (Stabilized Humidity Control Package)," published in the *Book and Paper Group Annual.* The article discussed a method termed "passepartout," which introduced a procedure for creating a sealed package around a work of art to buffer the internal environment against changes in the relative humidity of the external environment. This passepartout package was designed to buffer a travel environment for a short period of time and was not meant to be a permanent package.

As this method has been used over time, anecdotal observations of the positive effects of this package have been recorded, but quantitative assessment of its performance, efficiency, or even its necessity, has not been evaluated until now.

To conduct such assessments, nine sample packages were subjected to repeated tests in a humidity chamber or dry-heat oven, and a long-term temperature cycling.

These experiments were designed to address several questions.

1. Was a desiccant really necessary in this package, and if so, how much was required?
2. How long would the package maintain its interior condition before it started to change under extreme exterior conditions?
3. Was there any difference in the performance of the passepartout package if other sealing materials were used in place of the traditional polyester film and book tape?

Advantages and limitations of the passepartout enclosure and optimal assemblage will be presented in detail.

RECOMMENDED ENVIRONMENTAL CONDITIONS

The recommended standard museum environment, according to Gary Thomson (1978), is stated to be 70 ± 2 °F and relative humidity 50 ± 5%. These conditions can fluctuate depending on the materials and media present, but are a general range most institutions try to maintain.

Ideally the environment in and around a work of art, either on display or in storage, should maintain these recommended standard museum conditions. However, when

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an object leaves an institution it can be subjected to dramatic climate changes. Thus, the traveling work of art is placed in a passepartout.

PASSEPARTOUT

The passepartout package proposed by Victoria Blyth-Hill consisted of a glazing material, a mat, a sheet of a desiccant, and a sheet of polyester film assembled together and sealed along the edges with book tape. The general design of the package has not been altered over the years. The desiccant used is Art-Sorb, manufactured by Fuji Silysia Chemicals Ltd., and a standard humidity card has been added as a visual monitor. In this experiment the original design of the package has been referred to as the "book tape mat package."

When a survey was conducted to investigate other variations of the travel packages, several institutions mentioned the use of Marvelseal as a sealing material.[1] It was incorporated as a part of the experiment in order to make a comparison with the original book tape mat package. In these Marvelseal packages, the polyester film backing and book tape were replaced with a sheet of Marvelseal, which was adhered to the glazing with a hot-melt glue.

COMPOSITION AND SETUP OF PASSEPARTOUT TEST PACKAGES

For the experiments, nine test packages were made. These packages measured six by eight inches with a one and one-half inch depth to accommodate the thickness of a HOBO H8 datalogger.[2] This datalogger was incorporated to record changes in temperature and relative humidity inside the packages as the experiments proceeded.

Four of the test packages consisted of: an ultraviolet blocking glazing material, specifically an Acrylite OP-3 sheet used as a top layer of the packages; and fourteen sheets of acid-free 100% cotton rag buffered four-ply boards. Among them, two of the packages contained one six-by-eight-inch sheet of Art-Sorb preconditioned to 50% RH. These packages were sealed either with Marvelseal and hot glue or with two-inch wide 3M Scotch 845 book tape attaching the glazing to the polyester film on the back. The other two packages were sealed with Marvelseal or the book tape without a sheet of Art-Sorb. These four packages tested the sealing properties of the book tape and Marvelseal as well as the buffering effects of Art-Sorb and mat boards.

Another four packages were created to test the effectiveness of varying quantities of desiccant, to see specifically how much Art-Sorb was needed to buffer the internal environment of a package when there were no other buffering materials present. In these packages six sheet of Coroplast were used as the buildup between the acrylic glazing and polyester film backing.[3] Each Coroplast package contained one to four sheets of Art-Sorb preconditioned to 50% RH. The assembled materials were sealed along the edges with book tape.

The ninth package consisted of fourteen sheets of mat boards with an acrylic glazing and polyester film backing, but it was not sealed and did not contain a sheet of Art-Sorb.

All materials were preconditioned to the paper conservation laboratory environment of 70 ± 2 °F and 50 ± 5% RH before assembling the packages.

EXPERIMENTAL PROPERTIES AND PROCEDURES

The test packages were subjected to the following conditions to measure their ability to maintain the initial internal relative humidity:

One set of packages was placed in a high-relative humidity chamber to record how long it would take for water vapor to penetrate into these packages. Another set was placed in a dry-heat chamber to gauge how much water vapor would be released from the Art-Sorb and other buffering material under elevated temperatures, and the last set of test packages was placed in a single-paned north-facing window to simulate temperature cycling.

Each experiment also contained a loose HOBO H8 datalogger to record the external conditions as a comparison to the internal environment of the packages.

EXPERIMENTAL RESULTS

Humidity Chamber Experiment

To simulate a high humidity environment, all nine packages plus a loose datalogger were sandwiched between two sheets of Gore-Tex resting on and covered with a damp cloth in a plastic tray. The tray was covered with a polyester film and an acrylic sheet to create a microclimate. This chamber was left undisturbed for seven days.

The relative humidity of the chamber rose to 95% immediately and maintained this condition until the end of the experiment. The temperature of this microclimate remained constant between 68 and 72 °F.

In conjunction with the change in the external relative humidity, the internal relative humidity of the unsealed package increased 10% in the first hour and a half, reaching its maximum of 87% RH in less than four days.

Among the four packages with mat boards, the Marvelseal package performed the best with less than a 1% fluctuation throughout the experiment. Both the Art-Sorb and non-Art-Sorb mat packages containing book tape showed a gradual increase in relative humidity, with less than a 2% increase at the end of the experiment. This gradual rise in relative humidity of the book tape mat packages indicated that the book tape allowed a slight moisture

migration, but when compared to the unsealed package, it still provided an excellent seal in this extreme humidity.

The Coroplast packages with different amounts of Art-Sorb showed a similar trend to the book tape mat packages. All four Coroplast packages gradually increased in relative humidity, but at different rates. At the end of the experiment, the relative humidity in the package with one sheet of Art-Sorb increased by 4%, whereas the package containing four sheets increased by 1%. This result showed that the moisture migration though the book tape exceeded the buffering capacity of one sheet of Art-Sorb, and that more Art-Sorb in the package provided a better buffer.

Dry-Heat Chamber Experiment

In the humidity chamber experiment described above, temperature did not play a role in the results. Thus, a dry-heat experiment was conducted in order to gauge the buffering capability of Art-Sorb and the performance of the sealing materials when temperature is a factor. This experiment also was done to evaluate a statement made by the manufacture of Art-Sorb that temperature does not affect the performance of Art-Sorb as a buffering material.

All nine test packages plus a loose datalogger were placed in a Cenco oven for five days. During the experiment, the temperature of the oven rose quickly from 73 °F to 110 °F within the first hour, and then continued to rise more slowly, reaching a maximum temperature of 140 °F in four days. As the temperature rose, the relative humidity of the oven showed a dramatic drop from 50% to 24% RH in the first hour. The oven maintained this condition for four hours. Then the relative humidity increased to approximately 32%, which was maintained until the end of the experiment.

The relative humidity recorded for the unsealed package showed an interesting result. As the internal temperature of the package went up drastically, the relative humidity rose from 50% to 56% in the first forty minutes then dropped to 24% RH within two days. This percentage was approximately 10% lower than the relative humidity of the oven environment. This dramatic drop might indicate that the mat boards released moisture with the elevation of temperature and then became desiccated.

The relative humidity of book tape mat packages, both with and without Art-Sorb, made a similar initial move to the unsealed package. Within the first fifty minutes, the relative humidity of these sealed packages increased approximately from 50% to 56% RH. However, unlike the unsealed package, this relative humidity was maintained. During the course of five days the relative humidity in both sealed packages decreased, gradually ending at approximately 52% RH.

The Marvelseal packages, with and without Art-Sorb, responded in a similar manner initially, but it was more extreme. In less than twenty minutes the relative humidity of the Marvelseal packages without Art-Sorb went up from 50% RH to 65% RH, while the package with Art-Sorb went up to 71% RH. In both cases, the relative humidity then dropped approximately 10% in thirty minutes, followed by a gradual decrease until the end of the experiment, by which time the relative humidity was around 51%.

When comparing the internal temperatures of the Marvelseal and book tape packages, the temperature inside of the book tape mat packages was close to, if not lower than, the external conditions. However, the temperature of the Marvelseal packages started to exceed the external temperature when the oven reached 100 °F. The temperature of the Marvelseal packages remained six to ten degrees higher than the external oven temperature throughout the experiment.

As in case of book tape mat packages, the relative humidity of the Coroplast packages, containing various amounts of Art-Sorb, increased from 51% to 63% RH in the first thirty minutes, but dropped back to 55% RH in approximately one hour. Then the relative humidity decreased gradually in all four packages during the experiment. Interestingly, at the end of the experiment, the relative humidity of the Coroplast package with one sheet of Art-Sorb decreased 9.5%, and the packages with four sheets decreased 5.8%.

An assumption could be made that when the temperature of the packages goes up drastically the buffering materials, Art-Sorb and/or mat boards, emit moisture to compensate for the drop in relative humidity, and that the amount of moisture released is greater for Art-Sorb than for mat boards alone. Also, the Coroplast packages with more Art-Sorb had a better buffering capacity when subjected to low humidity conditions.

Temperature Cycle Experiment

Given that temperature does plays a role in the performance of these packages as evidenced by the previous "dry-heat experiment," a "long-term temperature cycle experiment" was conducted.

In this experiment, all nine packages plus a loose datalogger were placed in the single-pane north facing windows of the paper conservation laboratory at LACMA. Each package remained in these windows for thirty-three days. The temperature of the external environment ranged from 60 to 90 °F and between 27% and 70% RH during the experiment.

Although, the relative humidity of all test packages was affected in conjunction with the change in the external environment, the change was a maximum of 10% in any given twenty-four-hour period. Relative humidity in all the packages—sealed, unsealed, and Marvelseal—changed with less than 1% difference to each other.

The similar trend was found in the Coroplast packages. The fluctuation in the relative humidity remained constant at 10% maximum, regardless of the quantity of Art-Sorb throughout the experiment.

CONCLUSIONS

Throughout this experiment important information about the performance of the passepartout package was gathered, providing general answers to the initial research questions.

The necessity of including a desiccant in the passepartout package was supported by the performance of the "book tape systems." The conclusion could be made that Art-Sorb does add additional buffer in maintaining the relative humidity of the internal environment of these packages under extreme conditions. Also, it was determined that the quantity of Art-Sorb suggested by the manufacturer was not optimal, because increasing the amount of Art-Sorb in the experimental packages improved the buffering behavior. For the "Marvelseal systems" there are many additional questions. It is premature to conclude at this time that Art-Sorb is or is not necessary in these packages.

The original passepartout package was not designed to be a permanent enclosure. Gauging the buffering capability of the packages was essential in determining the length of time these packages could maintained an acceptable internal environment before being affected by external conditions. It was concluded that as long as temperature does not fluctuate dramatically over a short period of time, the standard museum recommended relative humidity of 50 ± 5% could be maintained within the packages for several days.

Finally, a comparison of the performance of two different sealing materials, Marvelseal and book tape, showed no significant differences as long as the packages were not subjected to extreme fluctuations in temperature. However, when packages were subjected to temperature fluctuations, the internal relative humidity of the Marvelseal packages was greatly affected. The same trend was not observed in the book tape systems.

From this experiment, it is safe to conclude that creating a sealed environment around a work of art, which limits the exchange of air, is essential in maintaining the relative humidity of the travel environment.

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NOTES

1. A general survey about the use of passepartout was conducted at the beginning of this research project. Fifteen responses were collected from various institutions. Out of all the responders, six used the book tape method and four used Marvelseal. Art-Sorb was the desiccant of choice, and only one institution had quantitatively tested the performance of their packages.

2. The HOBO H8 datalogger has a temperature sensor that ranges from -4 to 158 °F ± 2 °F and a relative humidity sensor that ranges from 25 to 95% RH ± 5% at 77 °F.

3. Coroplast is an extruded twin-wall plastic sheet produced from a high-impact polypropylene copolymer. This corrugated plastic sheet is chemically inert and it is not affected by adverse weather conditions: it does not absorb or emit moisture and remains unaffected by temperatures below 200 °F.

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