



Article: Separate but Equal: Testing Treatment Techniques to Separate Water-Damaged Blocked Film-Based Negatives from the Henry Clay Anderson Collection of the Smithsonian National Museum of African-American History and Culture

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**Separate but Equal:
Testing Treatment Techniques to Separate Water-Damaged Blocked Film-
Based Negatives from the Henry Clay Anderson Collection of the Smithsonian
National Museum of African-American History and Culture**

Alisha Chipman

ABSTRACT

A group of 343 non-accessioned black and white silver gelatin 4 x 5 inch sheet film negatives from the Henry Clay Anderson Collection of the Smithsonian National Museum of African-American History and Culture (NMAAHC) served as experimental treatment objects for this research project. The goal of the project was to systematically evaluate treatment options for separating severely water-damaged and blocked film-based negatives. A comprehensive list of 23 treatment strategies was identified and the treatments were tested and evaluated. The most promising treatment technique identified involved immersing the blocked negatives in cold de-ionized water followed by freezing. Immersing the negatives in cold de-ionized water, slightly acidic water, and in a 3:1 ethanol and de-ionized water bath were also found to be satisfactory treatment options.

INTRODUCTION

A group of 343 non-accessioned black and white silver gelatin 4 x 5 inch sheet film negatives from the Henry Clay Anderson Collection of the Smithsonian National Museum of African-American History and Culture (NMAAHC) served as experimental treatment objects for this research project. The project was carried out from September 2010 through July 2011 during the author's graduate internship in photograph conservation at the Smithsonian Institution Archives (SIA) under the supervision of Sarah Stauderman, Collections Care Manager, with additional guidance from Andrew Robb, Department Head of Special Formats, Library of Congress. The goal of the project was to systematically evaluate treatment options for separating severely water-damaged and blocked film-based negatives. Multiple treatment strategies were identified, tested, and evaluated.

THE HENRY CLAY ANDERSON COLLECTION

Henry Clay Anderson (1911-1998) was a professional photographer who lived and worked in Greenville, Mississippi. He established the Anderson Photo Service Company in 1948. Throughout the 1950s, 60s, and 70s Anderson photographed the daily lives of the relatively prosperous yet segregated African-American community of Greenville. He created images of family and community gatherings including weddings, funerals, sports events, proms, and a wide range of professionals at work including nightclub musicians and itinerant entertainers. Anderson also documented the Civil Rights Movement in Greenville. Anderson's photographs provide evidence of "a virtually ignored chapter in African-American history, that of the proud, dignified community of middle-class African-Americans that existed throughout the South during the Civil Rights Movement" (Steven Kasher Gallery 2007).

In 1997 Shawn Wilson, a New York filmmaker, returned to his hometown of Greenville, Mississippi to meet Anderson and ask him about a portrait he had taken of Wilson's mother in her youth. Wilson and Anderson quickly became close friends. After Anderson's death, his archive was bequeathed to Wilson. Wilson then partnered with Charles Schwartz, a NY-based photography collector and dealer, to preserve, organize, and present Anderson's collection. In 2002, they published a book titled *Separate but Equal: the Mississippi Photographs of Henry Clay Anderson*. In March of 2007, the first exhibition of Anderson's work was presented at the Steven Kasher Gallery in New York City, in collaboration with Charles Schwartz and Shawn Wilson. The exhibition was also titled *Separate but Equal: the Mississippi Photographs of Henry Clay Anderson* and consisted of over 70 vintage prints as well as Anderson's camera and several artifacts from his studio. Concurrent with this exhibition the entire Anderson archive was offered for sale intact as a single lot.

In *Separate but Equal* it is explained that in 1998 Wilson and Schwartz "discovered more than 1,500 negatives in corroded cardboard boxes under the kitchen sink in Anderson's home. The negatives were in deplorable condition, damaged by water and compacted together with mold. Wilson and Schwartz had the negatives separated, washed, and archived in acid-free envelopes" (Anderson 2002, 142). In another section, it is stated, "many negatives had been damaged by water, dirt, and heat, leaving them ripped, curled, and scratched, or corroded. But when carefully washed and cleaned, the subjects were still visible, and we have included some of these images, judging that the damage was part of their story" (Anderson 2002, 1). Indeed, several images included in the book show severe emulsion loss and water staining located near the exterior edges of the negatives.

In 2008 the National Museum of African-American History and Culture (NMAAHC) acquired the Henry Clay Anderson Collection. The NMAAHC is a newly formed branch of the Smithsonian Institution in Washington, D.C. It was signed into authorization by President George W. Bush in 2003 and is dedicated to preserving the memory of the African-American experience. The museum building is currently under construction and will occupy the last available space on the National Mall. The museum is planned to open to the public in 2015. In preparation for the acquisition of the Anderson Collection, NMAAHC hired Sarah S. Wagner (private practice photograph conservator) in October 2007 to conduct a condition survey of the negatives in the collection. At the time of acquisition, a group of approximately 343 negatives was not accessioned into the NMAAHC collections due to their very poor condition. This group of negatives was transferred to SIA as expendable research materials to be used for treatment, experimentation, and/or as teaching tools. It is possible that some of the negatives in the NMAAHC Anderson Collection were treated in 1998, while in the care of Wilson and Schwartz. However, documentation of these past treatments does not currently exist.

The group of severely damaged negatives donated to SIA consists of approximately 343 4 x 5 inch sheet film negatives. Most of the negatives depict portraits of unidentified African-American sitters. Some of the negatives have two images per sheet indicating they were exposed with a rotating or sliding camera back. It is believed that these negatives were stored for several years under a kitchen sink in Anderson's Mississippi home (as described by Wilson and Schwartz in *Separate but Equal*). The negatives are in very poor condition. They are severely water-damaged, blocked together, and encrusted with a large amount of dirt, insect debris,

accretions, and possibly mold. Because of the severe damage to these negatives and the nature of their long-term storage under a kitchen sink, it is difficult to positively identify the exact nature and extent of the various debris materials covering them. There are 33 groups of blocked negatives in groups of 2 to approximately 30 negatives each. Most of the negatives have minor to severe emulsion loss, water-based tide-line stains, minor planar distortions, and minor silver mirroring located near the edges. Some of the anti-halation dyes in the negatives have spread resulting in localized blue or red dye staining.

It is believed that the majority of the negatives in the collection are on a cellulose acetate or polyester base material. However, it is possible that some cellulose nitrate is also present. Many of the negatives have edge printing reading “Kodak Safety Film” or “Safety” suggesting a cellulose acetate base. The known dates for the negatives, 1950-1970, also suggests they are on cellulose acetate and/or polyester. Film pack sheet films were made on cellulose nitrate until 1949 but otherwise nitrate sheet film was uncommon after 1940 (Reilly 1993, 22). Kodak and most other manufacturers ceased production of cellulose nitrate after 1951 (Adelstein 1987, 33). In 2007, Nora Lockshin (paper conservator, SIA) performed Fourier-transform infrared spectroscopy (FTIR) analysis on seven sample negatives from the Anderson Collection and found evidence of cellulose acetate and polyester base materials.



Fig. 1. Alisha Chipman examining and sorting the Anderson Collection negatives at SIA.

A-D strips were used to evaluate the level of acetate deterioration to the negatives. A-D strips are acid indicator papers, developed by the Image Permanence Institute, to measure the approximate level of acetate degradation. After four days enclosed along with the negatives in a polyethylene bag, the strips showed no color change indicating a level 0, or good film condition with no deterioration. However, the age of the collection (30-60 years old) places it at the point of initial acetate deterioration.

LITERATURE REVIEW AND IDENTIFICATION OF TREATMENT TECHNIQUES

A wealth of information now exists that addresses the topics of disaster preparedness and recovery of damaged photographic collections. These sources provide excellent information about planning for emergencies as well as very practical advice about the salvage of damaged photographic materials. Guidelines for drying, freezing, and basic recovery treatment procedures are outlined. However, very few sources actually discuss options for the treatment of water-damaged blocked negatives.

Water-damaged negatives are very difficult to treat because they typically have very weak gelatin layers that are water sensitive or even water soluble. Gelatin is also prone to attack

by mold under prolonged damp conditions and mold releases enzymes that further soften or dissolve gelatin (Reilly 1993, 17). Furthermore, if the negatives are on deteriorated cellulose acetate or nitrate base materials, they may already have weakened gelatin layers due to the damaging effects of off-gassed acid vapors. This makes the treatment of blocked water-damaged negatives particularly challenging since the weak deteriorated gelatin will need to be manipulated in some way in order to separate the gelatin layers of facing negatives. Hence, treatment often results in further loss of image material and gelatin emulsion layers.

A list of 23 different potential treatment strategies to separate blocked negatives was produced. The list was compiled through a literature search and communication (in person and via email) with several conservators including: Andrew Robb, Sarah Stauderman, Doug Munson, Barbara Lemmen, Mogens S. Koch, Greg Hill, Debra Hess Norris, Gary Albright, Nora Kennedy, Richard Stenman, Constance McCabe, and Sarah Wagner. The techniques chosen explore variations on the use of aqueous bathing, humidification, freezing, and solvents. All 23 treatment techniques were tested and evaluated on the Anderson Collection negatives at SIA.

1. Manual separation
2. Bathing in room temperature de-ionized water
3. Bathing in cold de-ionized water
4. Bathing in room temperature reverse osmosis water
5. Bathing in cold reverse osmosis water
6. Bathing in room temperature pH 8 de-ionized water with ammonium hydroxide
7. Bathing in room temperature pH 4 de-ionized water with citric acid
8. Bathing in room temperature de-ionized water buffered to pH 5.6
9. Bathing in room temperature de-ionized water with Kodak Photo-Flo
10. Humidification in chamber with room temperature de-ionized water
11. Humidification in chamber with hot de-ionized water
12. Placing into vapor proof packaging, freezing, removing from freezer, and immediately separating manually followed by brief bathing in cold de-ionized water
13. Placing into a polyethylene bag, freezing, removing from freezer, and immediately separating manually followed by brief bathing in cold de-ionized water
14. Placing into vapor proof packaging, freezing, removing from freezer, and placing into a 200 proof (absolute) ethanol bath
15. Placing into a polyethylene bag, freezing, removing from freezer, placing into 200 proof (absolute) ethanol bath
16. Bathing in cold de-ionized water, placing into vapor proof packaging while wet, freezing, removing from freezer, immediately separating manually followed by brief bathing in cold de-ionized water
17. Bathing in cold de-ionized water, placing into a polyethylene bag while wet, freezing, removing from freezer, immediately separating manually followed by brief bathing in cold de-ionized water
18. Bathing in cold de-ionized water, placing into vapor proof packaging while wet, freezing, removing from freezer, placing into 200 proof (absolute) ethanol bath
19. Bathing in cold de-ionized water, placing into a polyethylene bag while wet, freezing, removing from freezer, placing into 200 proof (absolute) ethanol bath

20. Bathing in a 3:1 solution of 95% (HPLC grade) ethanol and room temperature de-ionized water
21. Bathing in a 2:1 solution of 95% (HPLC grade) ethanol and room temperature de-ionized water
22. Bathing in a 1:1 solution of 95% (HPLC grade) ethanol and room temperature de-ionized water
23. Bathing in acetone

PREPARATION

Prior to treatment testing, the negatives were sorted into 33 blocks and 164 individual negatives. Each block of negatives was assigned to one of the treatment techniques to be tested during the project.

The exterior surfaces of all of the negatives were surface cleaned in order to reduce the large amount of loose dirt, debris, insect frass and mold present. Surface cleaning was performed on a down draft table while wearing nitrile gloves and an N95 mask. Use of a high-efficiency particulate air (HEPA) vacuum with and without a screen, a soft brush, cotton, a Pec-pad®, a Pec-pad® moistened with Pec-12® solution, cotton swabs moistened with de-ionized water, a metal probe, and a bamboo skewer were tested. An optivisor, a stereo-binocular microscope, a light table, and a raking light were used to evaluate the effectiveness of cleaning and to determine if any scratching or other damage was created as a result of the cleaning.

Most of the dirt and debris was well-adhered and water-soluble, thus use of the Pec-12® solution, the soft brush, and vacuuming were ineffective. The metal probe easily scratched the negatives. The use of cotton swabs moistened with de-ionized water was the most successful technique. Where tested (on the emulsion and the non-emulsion sides), this approach removed nearly all of the debris with minimal, if any, damage to the emulsion or the base material. However, it was determined that this approach would be too time-consuming to be used for this project.

The most successful dry cleaning technique involved the use of cotton or a Pec-pad® to gently loosen large accretions, followed by selective use of a bamboo skewer to lift additional embedded accretions and a HEPA vacuum and a soft brush to remove the loosened debris. A



Fig. 2. Alisha Chipman dry surface cleaning with a Pec-pad.

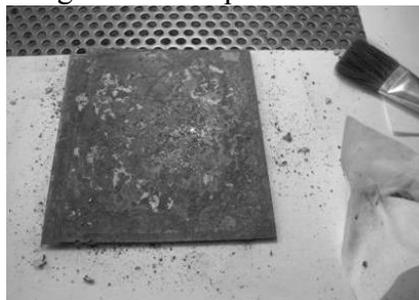


Fig. 3. During dry surface cleaning.



Fig. 4. Upper right corner – after cleaning with cotton swabs moistened with de-ionized water.

minimal and acceptable amount of scratching did occur with the use of this technique. All of the Anderson Collection blocked negatives were cleaned in this manner.

PROCEDURES

During treatment testing, all pH readings were taken with a Accumet portable AP61 pH meter with a Thermo Scientific Orio 8235 BN PerpHect Ross Flat Surface pH probe. All negatives that were frozen were placed into gasketed cabinets inside the SIA walk-in freezer unit, which was set at 18° F with no humidity control.

1. *Manual separation*

This technique was used to establish a baseline in which to compare the other treatment techniques. While the blocked negatives were dry and at room temperature (approximately 70° F and 40% RH), they were initially separated using a Teflon spatula followed with pulling by hand.

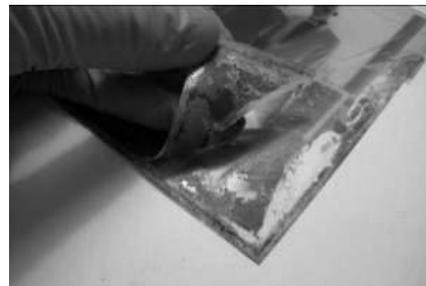


Fig. 5. Manual separation.

2. *Bathing in room temperature de-ionized water*

A plastic tray was filled with room temperature (68° F) de-ionized water. The negatives were immersed in the bath and manual separation was tested after 30 seconds of immersion and again after one minute of immersion.

3. *Bathing in cold de-ionized water*

A metal tray was filled with de-ionized water and placed into a larger plastic tray filled with ice water. The use of a metal tray was crucial in order to allow for thermal conductivity. Once the de-ionized bath water reached a temperature of 50° F, the blocked negatives were placed into the bath. Manual separation of the negatives was tested after 30 seconds, one minute, five minutes, and 10 minutes of immersion.



Fig. 6. Cold de-ionized water bath.

4. *Bathing in room temperature reverse osmosis water*

A plastic tray was filled with room temperature (68° F) reverse osmosis water. The pH of the bath was recorded at pH 8.02 prior to treatment. The blocked negatives were immersed. Manual separation of the negatives was tested after 30 seconds, three minutes, five minutes, and 10 minutes of immersion.

5. Bathing in cold reverse osmosis water

A metal tray was filled with reverse osmosis water and placed into a larger plastic tray filled with ice water. Once the reverse osmosis bath water reached a temperature of 50° F, the blocked negatives were placed into the bath. Manual separation of the negatives was tested after one minute, five minutes, and 10 minutes of immersion.

6. Bathing in room temperature pH 8 de-ionized water with ammonium hydroxide

A concentrated solution of ammonium hydroxide was added drop-wise to room temperature (68° F) de-ionized water until a pH of 8.03 was reached. A plastic tray was filled with the water and the negatives were immersed. Manual separation of the negatives was tested after 30 seconds, one minute, five minutes, and 10 minutes of immersion.

7. Bathing in room temperature pH 4 de-ionized water with citric acid

A concentrated solution of citric acid monohydrate was added drop-wise to room temperature (68° F) de-ionized water until a pH of 3.98 was reached. Manual separation of the negatives was tested after 30 seconds, one minute, and five minutes of immersion. The pH of the bath after treatment was 4.16.

8. Bathing in room temperature de-ionized water buffered to pH 5.6

Approximately 48g of citric acid monohydrate was added to 900 ml of room temperature (68° F) de-ionized water. 10% sodium hydroxide solution was then added drop-wise while stirring until a pH of 5.6 was reached. The solution was topped off with de-ionized water to a total volume of 1000ml. This buffer solution was prepared following a recipe in The Modular Cleaning Program database (Stavroudis 2009). This pH was desired because it is the approximate iso-electric point of gelatin, the pH at which gelatin has a net neutral charge and is its least soluble (McMurry 2008, 1024). The solution was transferred to a plastic tray and the blocked negatives were immersed. Manual separation of the negatives was tested after 30 seconds, two minutes, five minutes, and 10 minutes of immersion. The pH of the bath water after treatment was 5.6.

9. Bathing in room temperature de-ionized water with Kodak Photo-Flo

A 1:200 solution of Kodak Photo-Flo 200 in de-ionized water was made by adding 4 ml of Kodak Photo-Flo to 800 ml of room temperature (68° F) de-ionized water. The solution was placed in a disposable Mylar tray and the negatives were immersed. Manual separation of the negatives was tested after one minute, five minutes, 10 minutes, and 15 minutes.

Photo-Flo is a non-ionic surfactant which consists of 10% Triton X-100 (octylphenol ethoxylate) and 30% propylene glycol in water. It is commonly used as a rinsing aid for photographic negatives. This surfactant is classified as a xenoestrogen, or an estrogenic chemical, which mimics estrogen in the bodies of living creatures (Stavroudis 1995). For this reason it should be handled and disposed of as hazardous waste. During this treatment, nitrile

gloves were worn and a disposable Mylar tray was used. The bath water and all contaminated solids were disposed of as hazardous waste.

10. Humidification in chamber with room temperature de-ionized water

A humidification chamber was set-up using a plastic tray with a metal screen inserted to elevate the object above a shallow layer of room temperature (68° F) de-ionized water. The blocked negatives were placed onto the screen over a sheet of non-woven polyester. A humidity indicator card was also placed in the chamber and the chamber was sealed by laying a sheet of Plexiglas and weights over the top of the tray. The chamber reached an RH of 80%. Manual separation of the negatives was tested after three hours in the chamber and again after a total of 4.5 hours.



Fig. 7. Humidification chamber.

11. Humidification in chamber with hot de-ionized water

A humidification chamber was set-up, as previously described, with a shallow layer of hot (175° F) de-ionized water in the bottom of the tray. In order to prevent condensation build-up from dripping directly onto the negatives, the Plexiglas was periodically flipped over and condensation was wiped off the surface. The negatives curled severely and touched the Plexiglas surface. Manual separation of the negatives was tested after one minute, ten minutes, and thirty minutes.

12. Placing into vapor proof packaging, freezing, removing from freezer, and immediately separating manually followed by brief bathing in cold de-ionized water

The blocked negatives were placed into vapor-proof packaging. The negatives were first placed into a sealed polyethylene bag, then into a marvelseal bag, which was folded over several times and sealed with small gator clips. This was then placed into a thick polyethylene bag along with a humidity indicator card. The outer polyethylene bag was folded over and sealed with J-Lar tape. The RH in the lab at the time of packaging was 25%. The packaged negatives were placed into gasketed cabinets in the SIA walk-in freezer. The packaged negatives were removed from the freezer after 7 days and the RH indicator still read 25% RH. The packaged negatives were taken into the lab and the packaging was opened and manual separation of the negatives was attempted immediately. As soon as the negatives were separated, they were placed into a cold (50° F) de-ionized water bath. The negatives were rinsed for approximately two minutes.



Fig. 8. Vapor-proof packaging.

13. Placing into a polyethylene bag, freezing, removing from freezer, and immediately separating manually followed by brief bathing in cold de-ionized water

The blocked negatives were placed into a polyethylene bag along with a humidity indicator card. The bagged negatives were then placed into gasketed cabinets in the SIA walk-in freezer. The RH in the lab at the time of packaging was 25%. After seven days in the freezer, the interior of the polyethylene bags were at 45% RH, according to the Humidity Indicator Temperature Correction Chart (www.sud-chemie.com). After seven days in the freezer, the packaged



Fig. 9. Packaging in polyethylene bag.

negatives were removed from the freezer and taken into the lab. The negatives were immediately removed from the polyethylene bag and manual separation of the negatives was attempted. As soon as the negatives were separated, they were placed into a cold (50° F) de-ionized water bath. The negatives were rinsed in this bath for approximately two minutes.

14. Placing into vapor proof packaging, freezing, removing from freezer, and placing into a 200 proof (absolute) ethanol bath

The blocked negatives were placed into vapor-proof packaging, as previously described. The packaged negatives were then placed into gasketed cabinets in the SIA walk-in freezer. After seven days in the freezer, the packaged negatives were removed and taken into the lab. The packaging was opened immediately and the negatives were placed into a metal tray filled with 200 proof (absolute) ethanol. This step was carried out in the fume hood. While the negatives were in the ethanol bath, they were separated using metal tongs and a Teflon spatula.

15. Placing into a polyethylene bag, freezing, removing from freezer, placing into a 200 proof (absolute) ethanol bath

The blocked negatives were placed into a polyethylene bag and then placed into gasketed cabinets in the SIA walk-in freezer. After seven days in the freezer, the packaged negatives were removed. They were taken into the lab, opened immediately, and the negatives were placed into a metal tray filled with 200 proof (absolute) ethanol. This step was carried out in the fume hood. While the negatives were in the ethanol bath, separation was attempted using metal tongs and a Teflon spatula.

16. Bathing in cold de-ionized water, placing in vapor proof packaging while wet, freezing, removing from freezer, and immediately separating manually followed by brief bathing in cold de-ionized water

The blocked negatives were bathed in cold (50° F) de-ionized water for 10 minutes. The negatives were removed and placed directly into vapor proof packaging, as previously described. The packaged negatives were then placed into gasketed cabinets in the SIA walk-in freezer. After seven days in the freezer, the packaged negatives were removed, unpackaged, and immediately separated manually. The separated negatives were then rinsed in a cold (50° F) de-ionized water bath for two minutes.

17. Bathing in cold de-ionized water, placing in polyethylene bag while wet, freezing, removing from freezer, and immediately separating manually followed by brief bathing in cold de-ionized water

The blocked negatives were bathed in cold (50° F) de-ionized water for 10 minutes, then placed into a polyethylene bag and placed inside gasketed cabinets in the SIA walk-in freezer. After seven days in the freezer, the negatives were removed, taken out of the bag, and immediately separated manually. The separated negatives were then rinsed for two minutes in a cold (50° F) de-ionized water bath.

18. Bathing in cold de-ionized water, placing into vapor proof packaging while wet, freezing, removing from freezer, placing into a 200 proof (absolute) ethanol bath

The blocked negatives were bathed in cold (50° F) de-ionized water for 10 minutes, and then placed into vapor-proof packaging, as previously described, and placed into the freezer. After seven days in the freezer, the negatives were removed, taken out of their packaging, and immediately placed into a glass tray filled with 200 proof (absolute) ethanol. This step was carried out in the fume hood. While the negatives were in the ethanol bath, separation was attempted using metal tongs and a Teflon spatula.

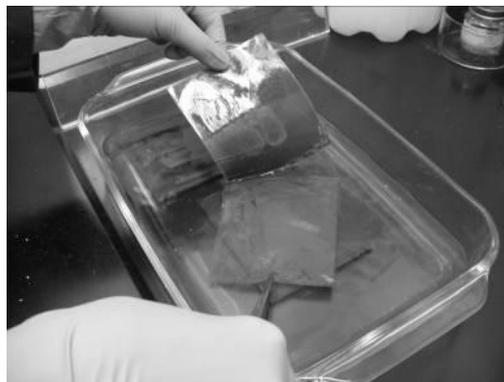


Fig. 10. Separating the negatives in the ethanol bath.

19. Bathing in cold de-ionized water, placing into a polyethylene bag while wet, freezing, removing from freezer, placing into 200 proof (absolute) ethanol bath

The negatives were bathed in cold (50° F) de-ionized water for 10 minutes, then placed into a polyethylene bag, and placed in the freezer. After seven days in the freezer, the negatives were removed, taken out of the bag, and placed into a glass tray filled with 200 proof ethanol. This step was carried out in the fume hood. While the negatives were in the ethanol bath, separation was attempted using metal tongs and a Teflon spatula.

20. Bathing in 3:1 95% (HPLC grade) ethanol and room temperature de-ionized water

A glass tray was filled with denatured 95% ethanol (HPLC grade) and de-ionized water in a 3:1 ratio of ethanol to water. This treatment was performed in the fume hood. The blocked

negatives were placed into the tray. While the negatives were in the bath, separation was attempted using metal tongs and a Teflon spatula after 10 minutes and again after 15 minutes of immersion.

21. Bathing in 2:1 95% (HPLC grade) ethanol and room temperature de-ionized water

A glass tray was filled with denatured 95% ethanol (HPLC grade) and de-ionized water in a 2:1 ratio of ethanol to water. This treatment technique was performed in the fume hood. The negatives were placed into the tray. While the negatives were in the bath, separation was attempted using metal tongs and a Teflon spatula after 10 minutes and again after 15 minutes of immersion.

22. Bathing in 1:1 95% (HPLC grade) ethanol and room temperature de-ionized water

A glass tray was filled with denatured 95% ethanol (HPLC grade) and de-ionized water in a 1:1 ratio of ethanol to water. This treatment technique was performed in the fume hood. The negatives were placed into the tray. While the negatives were in the bath, separation was attempted using metal tongs and a Teflon spatula after 10 minutes and again after 15 minutes of immersion.

23. Bathing in acetone

A glass tray was filled with acetone in the fume hood. The blocked negatives were placed into the tray. The goal of this treatment technique was to separate the gelatin emulsion from the cellulose acetate base material. This treatment technique is typically used to remove a gelatin pellicle from a channeled and deteriorated cellulose acetate base. A negative that was on a channeled base which was tested with FTIR and known to be cellulose acetate was also tested as a control.

Drying

All of the aqueous treated negatives were hung with clips on a metal wire rack to air dry after treatment. Negatives that were treated with solvent were placed over non-woven polyester and left in the fume hood for approximately two hours in order to allow the solvent to evaporate. The negatives were then hung with clips on a metal wire rack for at least six hours with fume trunks placed nearby to continue to capture any residual solvent fumes.

RESULTS

Each treatment technique was tested and subjectively evaluated by comparing each technique's effectiveness to that of manually pulling the negatives apart while dry. When evaluating each treatment approach the overall ease of set-up and execution of the technique was considered in addition to the effectiveness of separation and the after treatment condition of the negatives tested. Please see the table of results at the end of the article. The treatment techniques rated as poor were not considered viable, those rated as fair may be viable in some situations if modifications are made, and those rated as good were considered viable options.

In general, aqueous treatments alone performed poorly. In most cases the introduction of water resulted in large loss of already deteriorated and fragile gelatin emulsion layers. The best options for introducing water to the negatives were with cold water, slightly acidic water, or in small amounts such as in a 3:1 ethanol and water bath. Immersing the negatives in chilled water provided increased stability of the gelatin while allowing for swelling, which aided separation. Immersion in a bath with slightly acidic water provided an acidic environment for the gelatin protein to become predominately positively charged. In this environment, charge repulsion may have aided in separation of the gelatin layers (Wolbers 2011). With the 3:1 ethanol and water bath the limited amount of water lessened damage to the gelatin, while allowing for controlled swelling of the gelatin.

The best treatment technique observed during this project involved a series of steps including immersion in cold de-ionized water followed by freezing. In all cases this treatment approach significantly improved the ease of separating the negatives. In most cases a thin layer of ice was seen formed between the negatives. It is believed that the negatives may have been gently pushed apart as the water trapped between the negatives expanded and froze. Once the negatives were removed

from the freezer they were either separated immediately by hand or placed into a 200 proof (absolute) ethanol bath to allow them to thaw before being separated. Placing the frozen negatives directly into ethanol reduces the gelatin emulsion's exposure to water and also lowers the freezing point, thus increasing the speed of thawing. This thawing technique proved successful for Mogens Koch and his colleagues in Germany during recovery of frozen photographic materials after the 2002 flood in Dresden (Kochs 2011). During this research project, the results of the ethanol thawing and the manual separation while frozen were very similar and



Fig. 11a. Block #6 - before treatment.



Fig. 11b. Separated negatives from block #6 - after treatment – using technique #17.



Fig. 12a. Block #7 - before treatment.



Fig 12b. Separated negatives from block #7 - after treatment – using technique # 20.

equally good. In addition, there was little noticeable difference in the results between negatives that were packaged in vapor-proof packaging and those that were placed in a polyethylene bag before freezing.

The results from treatment technique #23, bathing in acetone, were surprising. The control negative known to be on a cellulose acetate base reacted as expected. After approximately 20 minutes in the acetone bath, the base material shattered into small pieces which could be separated from the gelatin pellicle using tweezers and a metal spatula. It was hoped that the block of negatives would react in a similar manner and that the pellicles could be separated once the base material was removed.



Fig. 13a. Block # 18 - before treatment.

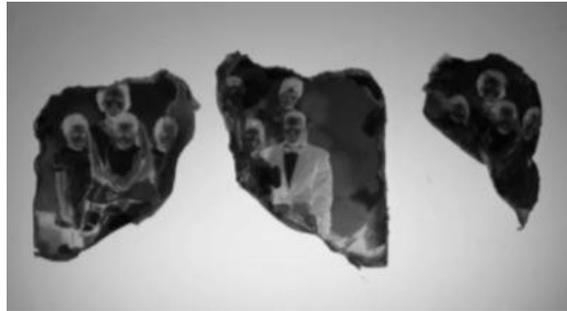


Fig 13b. Separated negatives from Block #18 after treatment - technique # 23.

After approximately 20 minutes the perimeter of the blocked negatives turned to a soft gelatinous material, which adhered to the bottom of the glass tray. This resulted in a large amount of complete loss around the perimeter of all three negatives in the block. This particular block of negatives was stuck together only along the outside edges, so once the blocked material was lost, the negatives were separated. It is believed that the negatives in the block were not on a cellulose acetate base and this is why they did not behave as expected.

This outcome shows that this treatment technique would not be an effective option for separating blocked negatives. Large negative collections are often a mix of cellulose acetate, polyester, and/or cellulose nitrate and this technique would only potentially be effective if all of the negatives in the block were on an acetate base. It is often impossible to clearly identify the base material of negatives that are blocked together.

CONCLUSIONS

This project was an experimental treatment research project. Conclusions were based on observations of the ease of separation of negatives and the condition of negatives after treatment. The rating system (located in the table at the end of the article) is subjective and strictly based on the limited results observed during this project. Treatment results will be highly dependent on the condition of the materials treated. The results of this project should not be considered a universal treatment protocol for all blocked, water-damaged, film-based negative materials.

Treatment Technique	Results	Notes
1. Manual Separation	Poor	Very difficult to separate Little loss of emulsion Some tearing of base
2. Bathing in room temperature (68° F) de-ionized water	Poor	Very difficult to separate Large loss of emulsion
3. Bathing in cold (50° F) de-ionized water	<i>Fair</i>	Moderately difficult to separate Little loss of emulsion
4. Bathing in room temperature (68° F) reverse osmosis water	Poor	Very difficult to separate Large loss of emulsion
5. Bathing in cold (50° F) reverse osmosis water	Poor	Very difficult to separate Large loss of emulsion Some tearing of base
6. Bathing in room temperature (68° F) pH 8 de-ionized water with ammonium hydroxide	Poor	Very difficult to separate Large loss of emulsion Some tearing of base
7. Bathing in room temperature (68° F) pH 4 de-ionized water with citric acid	Good	Significant ease in separation Little loss of emulsion
8. Bathing in room temperature (68° F) pH 5.6 de-ionized water buffered with citric acid and sodium hydroxide	Poor	Very difficult to separate Little loss of emulsion
9. Bathing in room temperature (68° F) de-ionized water with Kodak Photo-Flo 200	Poor	Moderately difficult to separate Large loss of emulsion Some tearing of base
10. Humidification in chamber with room temperature (68° F) de-ionized water	Poor	Could not separate Large loss of emulsion Some tearing of base
11. Humidification in chamber with hot (175° F) de-ionized water	Poor	Very difficult to separate Large loss of emulsion Severe curling of base
12. Placing into vapor proof packaging, freezing, removing from freezer, and immediately separating manually followed by brief bathing in cold (50° F) de-ionized water	Poor	Could not separate
13. Placing into a polyethylene bag, freezing, removing from freezer, and immediately separating manually followed by brief bathing in cold (50° F) de-ionized water	Poor	Very difficult to separate Large loss of emulsion Severe tearing of base
14. Placing into vapor proof packaging, freezing, removing from freezer, and placing into 200 proof ethanol bath before separating	Poor	Very difficult to separate Little loss of emulsion Some distortion of base
15. Placing into a polyethylene bag, freezing, removing from freezer, and placing into 200 proof ethanol bath before separating	Poor	Could not separate

16. Bathing in cold (50° F) de-ionized water, placing in vapor proof packaging while wet, freezing, removing from freezer, and immediately separating manually followed by brief bathing in cold (50° F) de-ionized water	Good	Significant ease in separation Little loss of emulsion
17. Bathing in cold (50° F) de-ionized water, placing in polyethylene bag while wet, freezing, removing from freezer, and immediately separating manually followed by brief bathing in cold (50° F) de-ionized water	Good	Significant ease in separation Little loss of emulsion
18. Bathing in cold (50° F) de-ionized water, placing in vapor proof packaging while wet, freezing, removing from freezer, and placing into 200 proof ethanol bath before separating	Good	Significant ease in separation Little loss of emulsion
19. Bathing in cold (50° F) de-ionized water, placing in polyethylene bag while wet, freezing, removing from freezer, and placing into 200 proof ethanol bath before separating	Good	Significant ease in separation Little loss of emulsion
20. Bathing in 3:1 ethanol and de-ionized water	<i>Fair</i>	Moderately difficult to separate Little loss of emulsion Some distortion
21. Bathing in 2:1 ethanol and de-ionized water	Poor	Could not separate Moderate loss of emulsion Some tearing
22. Bathing in 1:1 ethanol and de-ionized water	Poor	Very difficult to separate Large loss of emulsion Some distortion
23. Bathing in acetone	Poor	Separated with 50% loss of base and emulsion

This project provided an opportunity to compare many different treatment approaches to one collection of blocked water-damaged negatives. The information gained does begin to provide sound reasoning for the selection of treatment approaches to separate blocked negatives. Furthermore, this information can be added to the field's collective knowledge on this under-researched and difficult treatment topic. In many ways this project, like most research projects, produced more questions than answers. More research is needed, and the successful treatment protocols need to be refined and tested further.

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