

# Historical Paper Conservation: Washing with Boiling Water Followed by Sun Bleaching

## ABSTRACT

A paper washing treatment published in a book for print collectors was performed in order to observe its immediate and long-term effects on three historical papers and Whatman filter paper. The papers were documented to record their color and appearance using digital photography and a colorimeter before treatment, after treatment, and after artificial aging. The results were compared and the treatment was evaluated on the basis of improved brightness in the papers and trends in yellowing with aging. Compared to control samples, the treatment offered a great improvement for the three historical papers.

## 1. INTRODUCTION

The primary goal of this project was to re-create a historical paper washing treatment, observe its effects on various papers, and understand how artworks treated in the past might appear today. This research was carried out as part of a senior specialization project at Buffalo State College (Smith 2005). A method of washing prints from C. Davenport's *Mezzotints* (1904) was performed on three historical papers and Whatman filter paper, described below. Samples of each paper were designated "washed" and "untreated" controls. The washed controls were immersed together in three successive twenty-minute baths of cold tap water with occasional gentle agitation. All papers were photographed and colorimetry measurements were taken to record appearance and color before and after treatment.<sup>1</sup> Artificial aging (TAPPI 1998) of treated sam-

ples and controls was carried out at 90°C and 50% RH for 840, 1440, and 3000 hours (3.5, 6, and 12.5 days respectively).<sup>2</sup> Each sample was photographed again and colorimetry measurements were made after aging. The results were compared to determine the immediate and long-term effects of the historical washing treatment on these papers.

## 2. TREATMENT DIRECTIONS

The best remedy for such stains is a rather drastic one: it is to soak the whole print in water. To do this effectually the print should be laid face downwards on a piece of coarse muslin stretched across a tub or basin, and boiling water should be poured over the back. The water in time will percolate through the paper and drive out not only the reddish stain, but also effectively clean the print from many other stains or dirt-marks if they exist. In obstinate cases the print on its muslin support, arranged so as to be quite immersed, may be left to soak, still face downwards, entirely in the water, and if, after some days' treatment, there are still stains to be seen, they may perhaps be bleached by exposure to sunlight, combined with a careful and constant wetting in the places where the stains are. But a local treatment like this will not do unless the entire print is as clean as it can be made, or else the red stain is likely only to be replaced by a white spot. (Davenport 1904, 35–36)

## 3. THE PAPERS

Three historical papers were selected for the project. The first was a handmade, linen fiber, laid paper from a Netherlandish book of 1726 (fig. 1). It was slightly uneven in thickness, beige colored, and without foxing or major staining. Sizing was present as indicated by the water droplet test and a positive test for alum. Though the paper tested negative for gelatin and starch, originally it would

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have been tub-sized with gelatin, possibly hardened with alum.

The second historical paper was a machine-made, linen fiber, wove paper from an American book of 1836 (fig. 2). It was off-white in color without foxing or major staining.

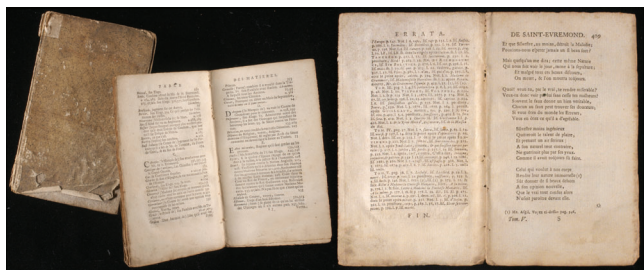


Fig. 1. Handmade, linen fiber, gelatin-sized book pages, Amsterdam 1726

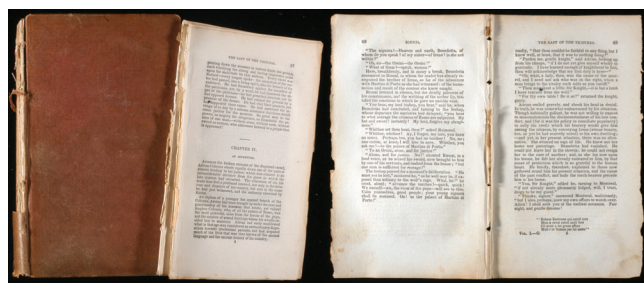


Fig. 2. Machine-made, linen fiber, unsized book pages, New York 1836



Fig. 3. Machine-made, cotton and linen fibers, unsized etching paper, London nineteenth century



Fig. 4. Machine-made, cotton fiber, unsized Whatman chromatography filter paper

No size was present as indicated by the water droplet test and tests for alum, starch, and gelatin, but it was probably lightly sized with gelatin or alum-rosin size originally.

The third historical paper was a machine-made, nineteenth-century, cotton and linen fiber, wove etching paper from a disbound book printed in London (fig. 3). Microchemical tests indicated that sizing was not present, though it was probably sized with gelatin or alum-rosin originally. The paper was cream-colored, medium-weight, with extensive foxing stains and tidelines. The biological activity that caused the foxing likely contributed to the breakdown of the sizing.

Whatman chromatography filter paper was treated to isolate the effects of the treatment on pure, unsized alpha cellulose from cotton linters and to allow comparison to other conservation research studies (fig. 4).

#### 4. TREATMENT PROCEDURE

The washing frame was made of unbleached cotton muslin attached with stainless steel staples to a wooden strainer. The paper samples were placed face down on the washing frame suspended over a sink, and boiling tap water was poured over them (fig. 5). The samples were then immersed in cold tap water for twenty-nine hours (fig. 6). Sun bleaching was done outside on a sunny, May day in Buffalo, without ultraviolet filtration (fig. 7). The papers were kept moist by spraying with tap water and the stains were repeatedly rewetted by brush. The papers were bleached for two hours on the back and one hour on the front.



Fig. 5. Pouring boiling water over the samples from 1836



Fig. 6. Paper samples soaking for twenty-nine hours in tap water

## 5. DISCUSSION

Several aspects of the historical washing treatment bear discussion. Ordinary tap water was used for this project. The directions did not specify a source for the water used, so household tap water was assumed. Though tap water today probably has little in common with that available in London in 1904, its use more closely replicated the historical treatment conditions than distilled or deionized water. The average amount of chlorine in the Buffalo tap water was 1.26 ppm (Buffalo Water Authority 2004). This concentration was too low to have been responsible for any whitening action of the treatment.

Compared to cold water, hot or boiling water swells paper fibers more aggressively, more effectively removing discoloration and acid degradation products. Unfortunately, hot water is also more effective at removing beneficial materials such as alkaline salts, which help counteract the effects of acids during aging. The extended immersion bath kept the paper fibers swollen and the sheet expanded, allowing water to continually diffuse through the paper and remove any remaining water-soluble discoloration. Hot water and the extended bath would also cause



Fig. 7. Sun bleaching outside on the muslin washing frame

a loss of gelatin size during washing, which would increase the brightness of paper, and lower its physical strength.

The effects of specific wavelengths of light on wet and dry paper have been well studied. Exposure of dry paper to sunlight can result in darkening of paper tone, especially with lignin-containing papers. Even in wet conditions, paper containing wood pulp can darken after exposure to ultraviolet radiation. For this project the papers were kept damp and exposed to the full spectrum of sunlight. None of the papers contained wood pulp or lignin, and no darkening was expected or observed.

## 6. RESULTS

The boiling water and sun bleaching treatment improved the brightness of the three historical papers. The greatest improvement was in the nineteenth-century etching paper, which was quite discolored before treatment (fig. 8). This paper was unique in retaining an improvement in brightness even after the longest period of aging. The treatment darkened the Whatman filter paper some-

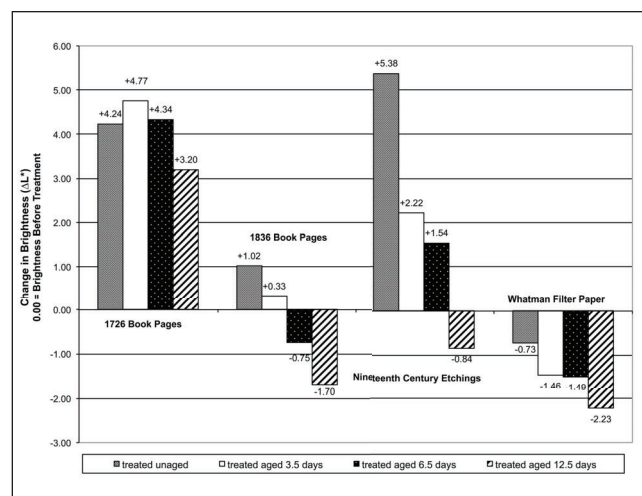


Fig. 8. Changes in brightness after treatment and aging

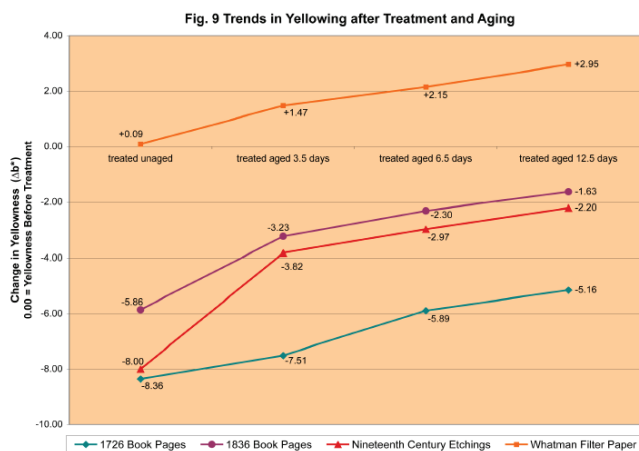


Fig. 9. Trends in yellowing after treatment and aging

what, though there were only slight differences between the treated, washed, and control samples of the filter paper after aging. After three thousand hours of artificial aging, the three historical papers were still less yellow than before the treatment (fig. 9). In terms of achieving and maintaining brightness and resisting yellowing with age, the treatment was better than washing (not shown) for the 1726 book paper and the nineteenth-century etchings. The treatment was roughly equivalent to washing for the 1836 book paper. Compared to the control samples, this treatment offered a great improvement for all three historical papers.

#### ACKNOWLEDGEMENTS

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#### NOTES

1. Artificial aging was performed in a Thermal Product Solutions SPX Blue M Electric aging chamber according to TAPPI Test Method T 544, sp-97 (TAPPI 1998).

2. Colorimetry measurements were taken with a Minolta Chroma Meter CR-221 using the CIE L\*a\*b\* Color System. Measurements were taken at the same three locations on each sample using a Mylar template to ensure repeatability. For each single measurement, the Chroma Meter averaged three consecutive readings.

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