Electrolysis in Removing Soluble Salts from Paper

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Introduction
The aim of this research was to test the use of electrolysis in removing soluble salts from paper that had been damaged by seawater. Two types of watercolour paper were tested, smooth-pressed and uncalendered. The absorption and desorption of soluble salts of the two different papers were determined using two different washing techniques: low-voltage electrolysis and standard washing in demineralized water. Reducing washing times and finding the most efficient method of removing salts from paper were the ultimate goal of the experiment, along with maintenance of mechanical stability of the paper, legibility of the media and integrity of the object.

Materials and Samples

Materials

- H₂Ocean Natural Reef Salt
- Arches 40lb Hot Pressed Watercolour Papers
- Arches 40lb Uncalederated Watercolour Papers

Samples

- Three control and two experimental sets were used.
- 600 samples were prepared: 300 for fold endurance testing and 300 for tensile testing.
- Samples of each paper were made using India ink and graphite.

Experimental

- Two types of watercolour papers, hot pressed and uncalendered, were placed in a climate chamber at 80°C and 65% relative humidity for eight weeks.
- The papers submerged in the H₂Ocean salt water solution mixed to 35ppt for 24 and 48 hours.
- Trials were carried out using two different treatments: washing in demineralized water, and electrolysis.
- Sodium levels in the paper before and after treatments were determined using Inductively Coupled Argon Plasma Emission Spectra (ICP-AES).
- Fold endurance testing, as well as standard tensile elongation tests were performed to determine strength and ductility of paper.

Results

During the electrolysis treatment of paper soaked in salt water solution, a yellow sediment was observed to settle at the bottom. FTIR testing concluded that the yellow sediment was an animal protein, with the spectrum closely matching that of gelatin. It was determined that the protein was most likely a sizing agent included in the paper. The leaching out of the size only occurred during electrolysis treatment of papers that contained sodium.

Fig. 1. H₂Ocean Natural Reef Salt

Fig. 3. Electrolysis equipment (top) and paper being treated with electrolysis (bottom).

Fig. 4. Fold endurance tester

Fig. 5. FTIR spectrum of yellow sediment with a comparison spectra for gelatin.

Fig. 6. Image of electrolysis bath water and demineralized water after washing salted paper.

Fig. 7. Salt levels in paper salted for 48 hours, as determined by ICP. Untreated paper assumed to be 0.

Fig. 8. Fold test results for uncalederated paper (left) and smooth pressed paper (right).

Conclusion

Papers that had been immersed in salt water, then treated with regular washing were stronger than papers treated with electrolysis, most likely caused by the loss of the sizing agent during electrolysis. Electrolysis proved more effective in removing soluble salts from both smooth-pressed and uncalendered paper. Paper that had been treated with traditional washing maintained was stronger, and more ductile than paper treated with electrolysis, although both types of treatment increased the overall strength of the paper compared with untreated paper.

Acknowledgements

Many thanks to: Dr. H.F. (Gus) Shurvell, Dr. Alison Murray, Paul Begin, Mary Andrews, Dr. Graham Cairns, Dr. Alison Rutter, Charlie Cooney, John O’Neill, Ryan Kelly, Tessa Thomas, Alexander Gabov, Bernie Zomkiewicz and all of my classmates, without whom this research would not have been possible.