

Does Salt Damage Natural Organic Materials ?

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Summary

Flood or tsunami-damaged paper documents and cultural properties will lose the value if molds grow on them and spoil the important information. Two major solutions to cope with this problem are based on the drying method including water absorption with paper towels and vacuum freeze drying. However, it will take time to start the drying process practically in devastated areas. Therefore, we proposed the saltwater immersion method as a supplemental first-aid to prevent mold growth until the drying methods become ready to be applied. Although this new method was found to be effective in preventing mold growth, there still was unsolved anxiety that paper properties required for a recording material might be lost and this research examined those possible adverse effects.

The strength of paper immersed in artificial seawater and dried decreased with the increasing amount of residual salt with deliquescence. However, the strength of paper immersed in a solution of NaCl that does not have deliquescence measured at 50% RH was greater than that immersed in pure water as shown in **Fig. 1**. Salt crystals are not considered to be bonded with fibers chemically and osmotic pressure due to ions such as Na^+ , Ca^{2+} , Mg^{2+} , and Cl^- is possible to interact with cellulosic fibers. The phenomenon of volume increase of fibers due to water absorption is called “swelling”. Water retention values (WRV) as a measure of the amount of water retained by swollen fibers after centrifuge to remove free water are shown in **Fig. 2**. Fiber walls have nano-pores that exclude ions and the surrounding saltwater phase pulls water out of them, thus leading to reduction in the amount of water inside the nano-pores and a low degree of swelling. This finding implies that saltwater reduces fiber swelling and thus keeps paper strength by preventing inter-fiber bonding from breakage by water. Therefore, salter water is considered to provide a better environment to preserve paper than pure water.

In conservation and restoration of cultural properties, efforts to maintain the present condition in terms of components, state, and functions should be respected. The retention of 3 main components other than pulp fibers were examined with copy paper. AKD, a sizing agent for control of water penetration, was confirmed not to be lost during saltwater immersion by gas chromatography. Calcium carbonate, a filler to improve brightness and opacity of paper, was not lost as shown by the result of unchanged ash content after incineration. Although only starch that are regularly applied on printing paper surfaces also for water penetration control was dissolved in saltwater to half the amount before immersion, this dissolution is not a serious problem because paper documents to be treated are assumed to have been flood-damaged with some of the starch already lost. In conclusion, from the viewpoint of component loss, there is no salt damage to paper as a material consisting of natural organic polymers.

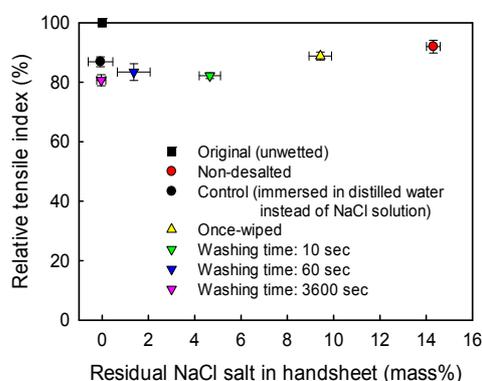


Fig. 1. Influence of residual NaCl on tensile index of laboratory sheet measured at 50% RH

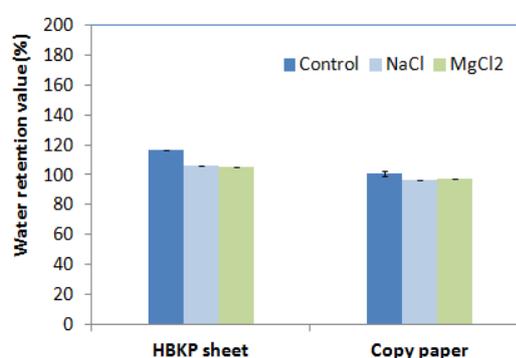


Fig. 2. Influence of NaCl and MgCl₂ salts on fibre swelling tested with HBKP handsheet and Copy paper