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Investigating the Causes of Paper Strength Loss after Aqueous Treatments

Abstract

Previously published studies on 8 different papers showed that aqueous treatments (i. e. washing and deacidification) resulted in the general decrease of tensile strength and the increase of stretch at break, which were statistically significant in most cases. A search revealed similar findings scattered in the relevant literature. As a result, a study was launched in order to investigate the causes of paper strength loss after aqueous treatments.

Hornification, a phenomenon related with strength loss after drying, has been widely investigated by the paper industry. The term is used for the irreversible changes that occur after the first drying of cellulosic fibers, resulting in the reduction of water retention value and tensile strength. Both properties are very important in paper recycling.

Under the assumption that changes at the microstructure level – similar to the ones occurring as a result of hornification – may be responsible for the strength loss, various microstructural parameters were studied, mainly on a model pure cellulose paper (Whatman Nr. 2 filter paper) and occasionally on a number of historical samples. The following methods were used:

- Air resistance determination (Gurley method)
- Determination of the Specific Surface Area of cellulose by a water vapour sorption method (CIsorp), described in detail elsewhere. The method of the f-plots was utilized for the comparison of the absorption isotherms.
- Determination of volume changes, deduced by the changes in the dimensions of the sheets of paper
- Determination of Crystallinity Index
- Mercury porosimetry for the evaluation of porosity changes

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The results were not conclusive in all cases, but generally showed that after washing, the specific surface area and the porosity of the Whatman samples increased. Evidence also indicated that the surface area corresponding to smaller pores slightly decreased, while that corresponding to the larger pores increased.

A tentative mechanism is proposed that accounts for the microstructural changes, strength loss and higher stretch at break observed after aqueous treatments. Further investigation is needed to ascertain the validity of the suggested mechanism and the possible connection with hornification. An experimental approach is proposed.

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