**Induced Wet Strength in Paper**
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**Introduction and resumé**
This project has the general objective of understanding the interactions between water and fibrous materials. The motivation is to improve the resistance of paper and hence increase the range of applications of this ecological material. In this project, it has been shown that a suitable heat treatment may significantly increase the wet strength of paper. Two possible explanations have been advanced for this improvement: (i) the creation of chemical bonds between the cellulose fibers and (ii) compaction of the lignin, which protects the paper fibers from water.

**Materials and methods**
Pulps with different lignin contents (i.e. different kappa numbers) have been prepared from chips of spruce from south of Sweden. These were used to produce sheets of paper. The paper was subjected to tensile tests in the wet and dry states. A heat treatment (125 °C, 2.8 bars, 30 minutes) was applied to certain specimens prior to wetting. Different heat treatment atmospheres (azote, oxygen, vacuum) were investigated and wetting was carried out at different pH. Thermal analysis was carried out using thermal gravimetric analysis (TGA) and differential scanning calorimetry (DSC).

**Results**

- **Heat treatment coupled with a high lignin content can increase the wet strength.**
- **How long will this paper boat take to sink? How can one make the boat resistant to water?**
- **Water absorption is far slower in the heat treated specimens (black) than in the untreated specimens (red).**
- **Effect of water alkalinity/acidity on wet strength.**
- **Effect of different heat treatment atmosphere on the tensile index of wet samples.**
  - Steam and oxygen appear to be important for the effectiveness of the heat treatment. Alkaline water limits the benefits of the heat treatment, possibly owing to hemiacetal bond breakage.
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**Conclusion**
The wet strength of the paper increases with the lignin content. The heat treatment also increases the wet strength up to 20 % of the dry strength, which is considered to be very good in the paper industry. The heat treatment also lowers the water absorption rate. One hypothesis to explain these results could be the formation of hemiacetal bonds between cellulose and hemicellulose, consistent with deleterious effect of alkaline water. Another hypothesis could be that flow of the lignin during the heat treatment results in improved encapsulation of the cellulose fibers and reduced water absorption. These two hypotheses are not mutually exclusive.

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