Investigation of Interactions of Cationic Starch Derivatives with Cellulose Fibres with Respect to Paper Strength

Marco Ulbrich, Sylvia Radosta and Waltraud Vorwerg, Golm (Germany)

Summary

Cationic starch derivatives are often used in papermaking process in the wet-end to enhance the dry strength of the paper. The cationic starch must be completely dissolved to enable the interaction with the anionic cellulose fibres and binding of starch polysaccharides. As a result of closed-water cycle processes in the paper mill the process water contains a high electrolyte loading. That leads to screening effects on the charges of the polyelectrolytes and affects the starch adsorption. Not adsorbed starch remains in the filtrate and increases the biochemical oxygen demand (BOD) of the process water. To optimise the starch input it is necessary to get knowledge about the impact of the degree of substitution (DS) of the starch derivatives, different electrolyte environments and different starch concentrations in the suspension on the adsorption behaviour.

Cationic starch derivatives with six graded DS were adsorbed in different electrolyte contents with four graded initial concentrations to prove the adsorption behaviour on a dried cellulose fibre under laboratory conditions. Adsorption isotherms have been created to make clear differences in terms of the adsorbed amount of cationic starch on the negatively charged cellulose fibres. The starch solution before and after adsorption experiments was characterized using High Performance Size Exclusion Chromatography-Multi Angle Laser Light Scattering (HPSEC-MALLS) to get information about the concentration and the molecular composition of the adsorbed starch. The tension length and bursting strength of the paper sheets with addition of 4 % starch were measured to explore the impact of starch input on paper quality. The design was evaluated statistically with Statgraphics Plus 4.1 software.

The native potato starch and cationic starch derivatives with DS gradation 0.015, 0.03, 0.06, 0.10 and 0.13 were investigated in terms of adsorption behaviour and resulting paper quality in water of different ionic strength. It could be shown, that the adsorption of DS 0.10 was statistically significant the highest within the experimental design. With higher DS values (0.10, 0.13) and in the case of the native starch no significant effect of the water quality on adsorption was established. The starches with lower DS (0.015, 0.03) values showed higher adsorption in water with low ionic strength than in higher electrolyte content. In water with low salt concentration starch adsorption was significant higher than in higher salt content, where increasing initial starch concentration did not effect an increase of starch adsorption. In general, a good correlation between starch adsorption and resulting paper strength was found. The adsorption of derivatives with higher DS than 0.10 is not affected by electrolyte environment.

Beamer-Presentation shown at the meeting.

Address of author:

Marco Ulbrich
Fraunhofer Institut für Angewandte Polymerforschung
Geiselbergstr. 69
D-14476 Potsdam-Golm
-Germany-