INFLUENCE OF HEXENURONIC ACIDS ON CONSUMPTION OF CHLORINE DI-OXIDE AND ON KAPPA NUMBER IN D0 BLEACHING STAGE.

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During wood alkaline pulping the uronic acids, which are side groups linked to the xylan chain, losses methanol generating hexenuronic acids (HexA). The unsaturated structure of these acids is responsible for excessive consumption of bleaching agents, such as chlorine dioxide, and contributes to the pulp kappa number therefore representing a “false” lignin. These problems are more pronounced in hardwood pulping due to the high xylan content. Nevertheless, HexA can be degraded under acidic conditions (Vourinen et al. 1997, 1999). The selective hydrolysis of HexA before the bleaching sequence allows reducing kappa number of unbleached pulp and thus decreasing the chemical consumption of oxidants. In this context some studies have reported the influence of HexA on the contribution to the kappa number of unbleached kraft pulp and on the harmful effects in the bleaching process (Vourinen et al. 1999; Jiang et al. 2000; Chakar et al. 2000; Furtado et al. 2001). However, its contribution to the micro kappa number and to the chlorine dioxide consumption in the pre-delinification stage of an ECF sequence has not been well documented. In this sense, the main purpose of this study is to clarify the influence of HexA on the stoichiometry of chlorine dioxide during the pre-delinification (D0 stage) of a hardwood pulp (Eucalyptus globulus).

In this work an industrial E. globulus kraft pulp was used. The pulp was collected after the cooking stage and then thoroughly washed, having a kappa number of 15.54. The hot acid pre-treatment of the pulp, after pH adjustment at 3.0 with sulphuric acid, was performed at 10% consistency and 90°C in plastic bags placed in a thermostated bath during 2 hours (Primo and Carvalho 2003).

All bleaching experiments with chlorine dioxide were carried out in a 2.6-litre thermostatic glass reactor at low pulp consistency (0.7%), temperature of 55°C, chlorine dioxide charge of 3% (on o.d. pulp) and at a stirring rate of 600 rpm. In each experiment, a liquid sample was taken with a syringe equipped with a glass filter and immediately analysed after thermal conditioning. With regard to the pulp, rapid washing with a large volume of cold water was done to stop the reaction and the sample was then further washed with an excess of warm water (35°C). Each run comprises a set of interrupted experiments where chlorine dioxide concentration, kappa number (K), lignin content (L) and HexA were measured as a function of time, between 15 seconds and 30 minutes. The pulps were characterized using TAPPI and ISO methods and HexA were quantified as furan derivatives by UV spectroscopy (Pedroso and Carvalho 2003).

During the acid pre-treatment (A) the kappa number, the lignin content and hexenuronic acids were reduced 3.44 units, 0.5% (pulp base) and 23.3 mmol/kg pulp, respectively. The profiles of the chlorine dioxide consumption and kappa number reduction (K/K0) in D0 and AD0 bleaching experiments are shown in Figures 1 and 2, respectively.

As expected, the two pulps exhibit a similar behaviour with respect to both variables. However, the increase of the chlorine dioxide consumption for the unbleached pulp relatively to the acid pre-treated pulp suggests a competition between the lignin and the other fibre components that react with this oxidant, namely the hexenuronic acids. Based on the analysis of lignin content in D0 and AD0 pulps it can be observed in Figure 3 that the profiles of lignin removal for both cases are almost similar, regardless the higher content of hexenuronic acids in the unbleached pulp. On the contrary, the Figure 4 shows different behaviours of the studied pulps in the chlorine dioxide bleaching stage: the HexA content is almost constant when the unbleached pulp is pre-treated with acid, while for the unbleached pulp an HexA removal of about 45% can be obtained in the D0 stage after 30 minutes.

Although a decreasing on the total chlorine dioxide consumption has been observed by the introduction of a selective hydrolysis stage (A) before the D0 stage (Figure 1), the consumption of this bleaching agent calculated per kappa number reduction increases in the case of the pre-treated pulp (Figure 5) in spite of its lower HexA content. These results suggest that the lignin may suffer structural modifications under the acidic conditions that lead to a decrease on lignin reactivity with the chlorine dioxide in the next D0 stage.

The experiments revealed higher chlorine dioxide consumption in D0 stage as compared with an AD0 stage. However, its consumption per kappa number reduction in the bleaching stage increases when the pulp was pre-treated with hot acid. These results support the idea of a poorer reactivity of the lignin after a selective hydrolysis stage. Furthermore, the lignin removal in D0 and AD0 stage is almost similar, while the removal of HexA, after 30 minutes, is about 45% in the D0 stage and 19% in the AD0 stage.

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Figure 1. Profiles of chlorine dioxide consumption at 55°C.

Figure 2. Profiles of kappa number reduction at 55°C.

Figure 3. Profiles of lignin removal at 55°C.

Figure 4. Profiles of hexenuronic acids removal at 55°C.

Figure 5. Chlorine dioxide consumption vs. kappa number reduction.

REFERENCES